ITS4C Congress

Smart Mobility for Climate

17 - 19 September 2019

Decarbonisation Toolbox
WORKSHOP 5

5 Mobility as a Service for Climate (MaaS4C)

The ITS for Climate initiative (ITS4C) was established in 2015 during the ITS world Congress held in Bordeaux, under the leadership of the Nouvelle-Aquitaine Region in France to highlight the potential contribution to the reduction of CO_2 emissions of Intelligent Transportation Systems (ITS) and smart mobility innovations. In 2019, 32 Climate and Mobility experts set out to provide a "Decarbonization Toolbox» for cities, regions, national governments as well as for the ITS community and all stakeholders in the transport & mobility sector. This work was presented during the ITS4Climate Congress in Bordeaux.

www.its4climate.eu

An event organised by TOPOS DIGITAL AQUITAINE

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Highlights

Introduction

This ITS4C Topic 5 Briefing Paper looks at the ways ITS and smart mobility can reduce emissions, with a focus on smart mobility and Mobility as a Service (MaaS).
MaaS is a recent concept for mobility services delivered via an online "broker" platform that matches mobility users' demand and transport providers' supply. It can combine mobility demand and transport supply for both people and goods and can include all modes of transport as well as services related to mobility as well as accessibility. Typically, MaaS aims to make travel by private car less attractive than using collective, shared or active transport modes.

MaaS is becoming mature at the same time as the global heating crisis becomes top priority for governments at all levels, and for businesses and citizens. In this paper we ask if MaaS already can or is potentially able to reduce CO2 emissions, and how accessibility and mobility as a service should be shaped to maximise such emission savings.

The paper addresses the following key questions:

- What is the extent today of actual and planned MaaS deployment?
- What is known from real experience of the impact of MaaS on CO_2 emissions?
- If MaaS is effective to help reduce CO_2 emissions, in what ways can it be optimized for lowest-carbon mobility? For which journey factors can it reduce emissions?
- What will future MaaS look like, and how could its climate-change impact be maximized?
- How could MaaS planning and deployment be supported and encouraged?

Figure 1 - MaaS Advantages
Source: MaaS Alliance

MaaS and mobility

Mobility as a Service (MaaS) is the integration of various forms of transport services into a single mobility service accessible on demand[1]. It is a user-centric approach to mobility that treats travel and transport as another product available via an online service.
MaaS services are delivered via an online "broker" platform that matches mobility users' demand with transport providers' supply, and can work for mobility of both people and goods. Typically, MaaS aims to make travel by private car less attractive than using collective, shared or active transport modes.
MaaS can facilitate a shift from individual car-based mobility towards multi-modal mobility. This in turn can bring significant collective benefits. Specifically, one important collective benefit expected is reducing environmental footprint of our journeys.
Different modalities of transport have significantly different environmental footprint as shown on the diagram bellow. Therefore, a shift in the right direction can significantly reduce our impact to climate.

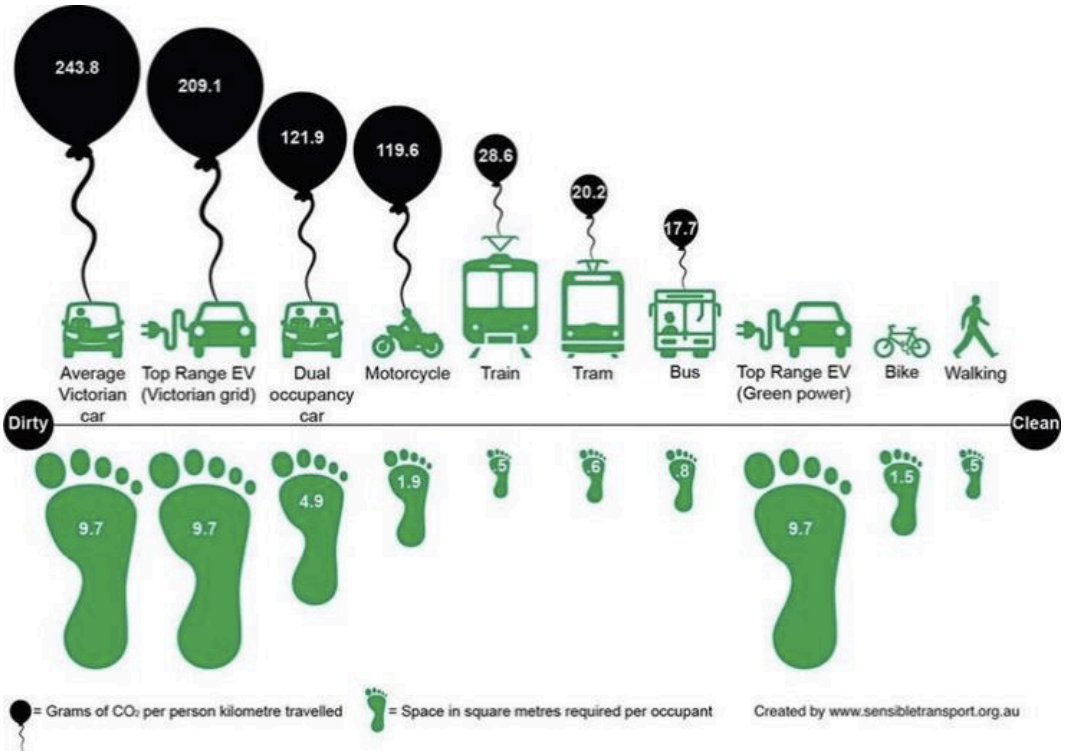

Figure 2 - Comparison of different modalities of transport in terms of CO2 footprint[2]

MaaS as a global movement is strongly influenced by several other uprising trends worldwide. It is projected that by 2050, 68% of the global population will be living in urban areas[3]. Already many cities worldwide are encountering transport-related issues like pollution, congestion and noise pollution, which are caused by the mobility patterns and behaviour of the population, which also in return reduces the quality of life for the inhabitants in urban areas. In Europe, transport of people and goods already represents almost one quarter of total greenhouse gas emissions and is the main cause of air pollution in cities[4].

[1] - MaaS Alliance 2017
[2] - Institute for Sensible Transport 2018
[3] - Hannah Richie 2018.
[4] - European Commission n.a.

MaaS deployment today

MaaS is still in its infancy, and while there is a great deal of activity in developing platforms, theory and planning for MaaS, there are still probably not more than a dozen schemes fully operational in Europe. Early examples of pilot or full deployment can be found in Gothenburg, Hannover, Stuttgart, Helsinki, Vienna, Birmingham, Scotland, Ghent, Antwerp, Amsterdam, Mulhouse and Switzerland. However, very few of these are fully operational and even fewer are commercially profitable.

Most schemes acknowledge a positive potential impact on the environment, **but few give CO_2 reduction as one of the top priorities for investment.** A simulation study in Lisbon estimated a reduction of over 50% if MaaS could totally replace individual private car use. So the promise is recognised, but there is yet very little real evidence of such impacts. This paper looks at the evidence and arguments for a major impact of MaaS on greenhouse gas emissions, and at how MaaS could be optimised for lowest emissions

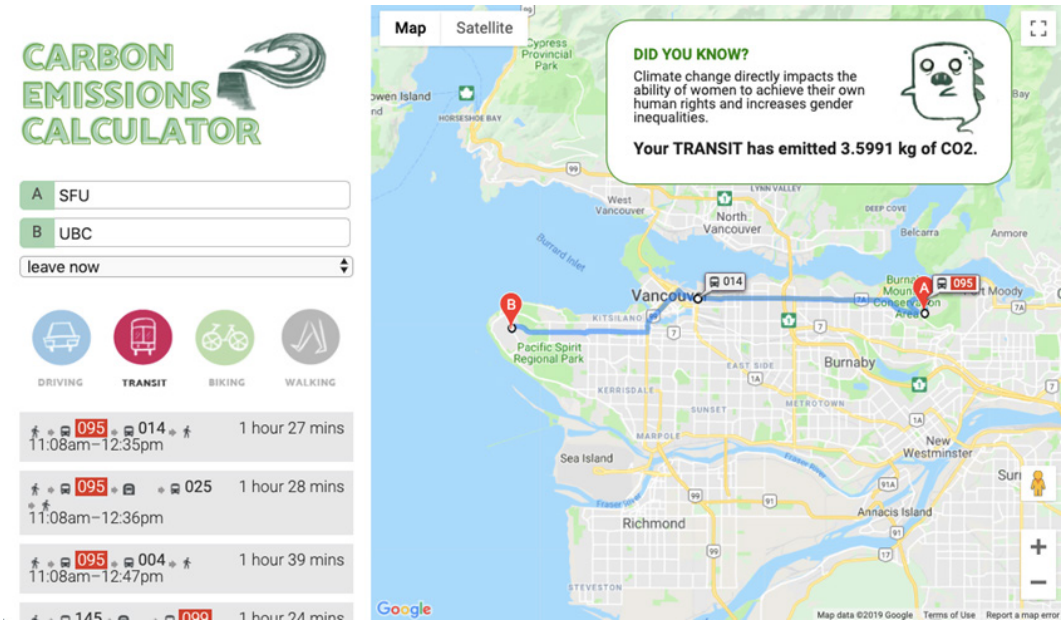

Figure 3 - Transportation Carbon Footprint calculator

MaaS for climate: it's for everyone

Many stakeholders are involved in MaaS deployment and use. This includes regulatory bodies such as the European Commission and Parliament; national governments; regions, municipalities and city councils. Governments at all levels are setting targets and adopting strategies towards a zero- emission future for transport. Electrification, alternative fuels and energy sources and new propulsion systems may offer pathways towards becoming carbon-neutral, but mobility demand may also need to be regulated and re-directed away from high energy consumption individual transport modes towards on-demand and collective transport. If MaaS can be demonstrated to help reduce CO_2 emissions, it could enter policy-makers' arsenal of tools.

The MaaS concept supposes that people in the future will consume mobility on-demand, using the "best" multi-and inter-modal transport option for each trip, thus leaving the currently predominant ownership model of vehicles. A new and complex market structure is evolving, based on local integrated mobility ecosystems rather than numerous single platforms. In this model, new mobility services work hand in hand with public transport systems. Specific local requirements need to be taken into consideration for a MaaS system to be successful. Car-dedicated infrastructure in urban areas such as road and parking space can be reduced and more infrastructure in cities can be dedicated to sustainable transport and leisure space for inhabitants.

As utilisation grows, MaaS systems will be able to provide a better level of service for their customers, gradually moving users away from privately owned cars and further reducing traffic volume. Where MaaS can offer public transport and a variety of zero-emission mobility services (bike sharing, EV carsharing, EV ride hailing etc.), carbon emissions in urban areas could be drastically reduced. A study conducted in the Netherlands showed that introducing a carsharing scheme resulted in a drop of car ownership from an average 1.08 to 0.72 cars per household, annual kilometres travelled by car declined on average by 1.600 km. Annual CO_2 emissions per respondent fell by 175 to 265kg CO2[5]. With purely zero-emission mobility services, this impact on CO_2 emissions would be significantly greater.

Figure 4 - GiveO2 app (carbon offset for daily activities)

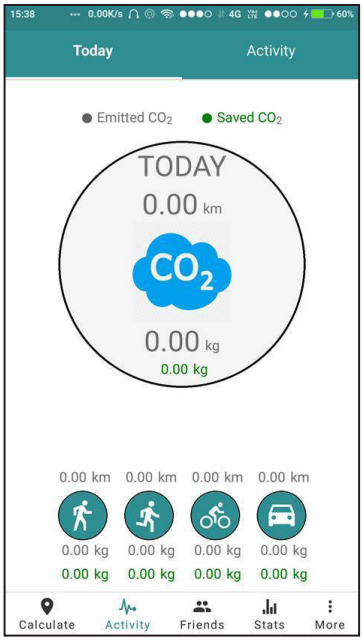

Figure 5 - Carbon Footprint Mobility app

[5] - Hans Nijland, Jordy van Meerkerk, Anco Hoen 2015.

Governance for MaaS for climate

Although a successful MaaS scheme may be established and operated as a commercial business with no public sector involvement, this is unlikely to deliver the maximum environmental benefits. Neither is a public-only model likely to achieve maximum sustainability impact. Reasons include the following :

- CO_2 emissions have little or no influence or economic value in most decisions about transport investment or use, hence are less likely to be taken into account by a commercial MaaS provider ;
- Unless subsidised by government, social needs may not be recognised and met by a commercial MaaS provider ;
- A public-sector MaaS provider is less likely to know and satisfy users' demand, or to shape services offering a more attractive offer than use of a car.

In fact, a mix of public and free market models is probably the most likely to achieve maximum reduction of emissions through a hybrid MaaS service optimised for climate impact. In either case, a prerequisite to creating sustainable MaaS is to include climate in the main objectives. The different models are shown in the figures below, from Transdev:

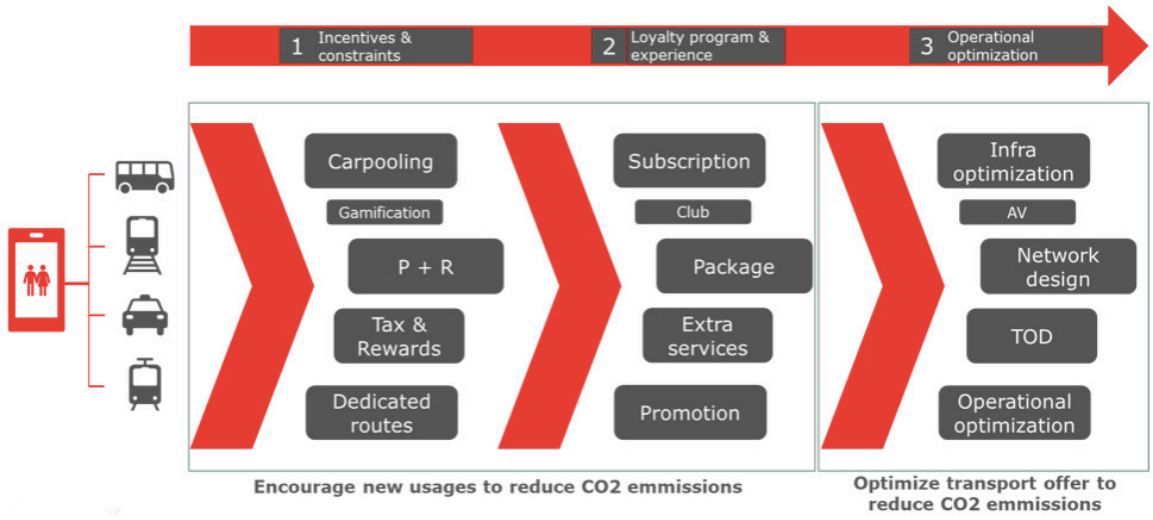

Figure 6 - 3 levers to change usage towards reduction of CO_2 emissions implicate PTA's engagement and governance

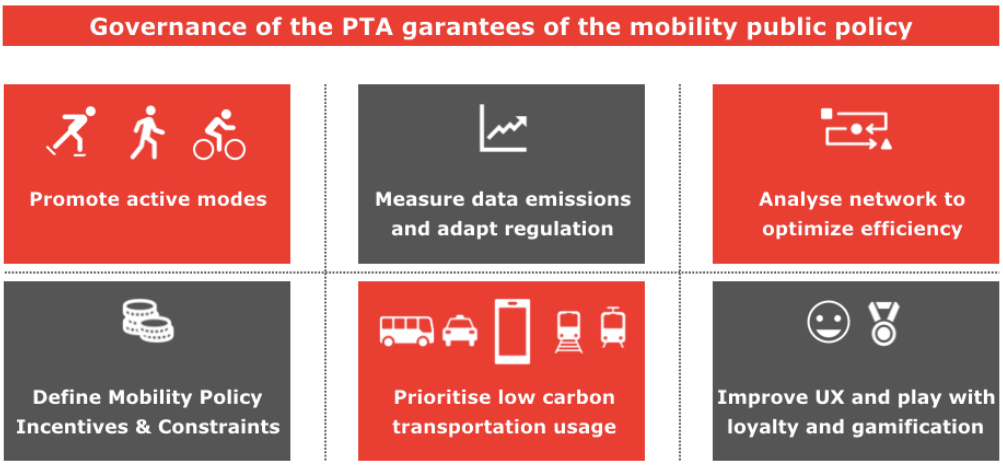

Figure 7 - Governance of the Public Transport Authority garantees of the mobility public policy

Governance for MaaS for climate

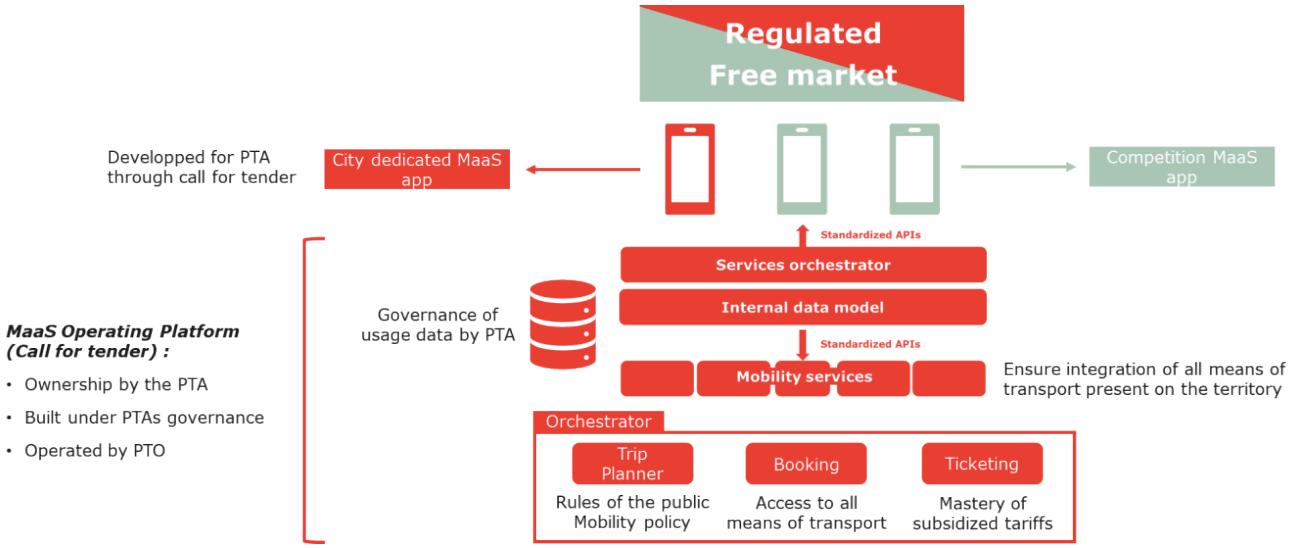

Figure 8 - Regulated free market combining PTAs/PTOs governance on mobility policy and allowing free competition

Mobility as a Service (MaaS) schemes can be built according to different models:
• The commercial integrator model needs agreements between the MaaS provider and transport operators. The Maas provider can choose to integrate mobility solutions depending on its own goal (economic benefits for private MaaS provider vs public policies for public MaaS provider).
• In the open back-end platform model, mobility services on the platform are authorised or chosen by the public authority in charge of it, and MaaS providers can integrate mobility solutions among the ones on the platform.

In order to be integrated in a MaaS solution, mobility services need to deal with one or two stakeholders and to be compliant with their specifications in a technical, business and policy point of view.

So, what can public bodies do to enhance green MaaS?

Role of public bodies

Public bodies are at the core of any MaaS eco-system, either framing or as enablers the services provided by the market or being actively part of the service provision, as platform builder or MaaS provider. When considering options having a public sector actively involved in the service provision, in the first case of having public body as a platform provider, mobility operators need to be present on the platform as it will be used by most of MaaS providers; and in the second case, they need to be present on the branded public MaaS app, well known by inhabitants. But other – big – mobility operators may not want to be integrated on such platforms, because they want to be THE platform or think they are strong enough and don't want to share revenue.

Free-floating (without a fixed station) mobility services have increased a lot in the last months, and authorities have begun to regulate them. Cities can regulate by allowing such free-floating services to occupy public space, for free or with limited parking fees. Secondly, public MaaS providers (typically a PTA – public transport authority) can regulate by allowing them be present on MaaS platforms and apps. If the public MaaS provider and the city can work together, they can have a common regulation controlling both physical and digital presence.

Depending on business models, any regulation will have to manage requirements and allowances. Requirements can be linked to the fleet (quick replacement of vehicles, spatial dispatching by putting vehicles in all areas, even if non profitable, minimum or maximum number of vehicles per area, and of course low climate impact), to the cooperation with public bodies (public transport compliant communication, cooperation on charging infrastructure and compliance with MaaS APIs in order to be present on the platform...).

Permissions and allowances could be free or low parking fees, but in some cases public bodies can give money to mobility operators to provide a useful mobility service for inhabitants that public transport can't reach. For services such as taxis or vehicles-for-hire, they can be allowed in the system or co-financed for specific purposes: for instance for night hours, or maybe depending on their motorization.

In respect of the new French Mobility Law, MaaS providers must integrate all public mobility services (public transport, station-based bike-sharing systems, public car-sharing systems etc.). Other mobility services must be chosen in a non-discriminatory way. Hopefully climate impact should not be considered as discriminatory.
Since car drivers cause a high level of CO_2 emissions, MaaS schemes should target and include them, and offer services useful for greener driving (real time information, routing, tracking, parking information). Once using a MaaS app, drivers can be nudged towards lower-carbon alternatives: becoming aware of other ways to travel, then understanding how they work (schedules, tariffs, connections...), then testing different options and finally perhaps adopting them.

For a commercial MaaS service, environmental aspects may be less emphasised by providers and users. The bottom-up European project "eMaaS" is an exception, where electric mobility service providers are working together to build a 100% electric MaaS.

Influencing travel choices

When a user requests a service from MaaS, the proposed itinerary should give the best modes and the best routes. It is algorithms that decide which is best, and public bodies can influence or create these algorithms, or require a service provider to comply with requirements of public policy. For example, routing results can exclude polluting modes, such as private car: it is often the case in public MaaS or multimodal information systems, but in this case, car drivers won't use the system and won't change their behaviour.
Routing results can be given for all modes without any ranking, and users themselves decide how to combine time, cost, and maybe climate impact. In this case, a MaaS provider can choose which mode is shown first and so more used.
MaaS operators can also give a weighted score for results with green modes, instead of or in addition to the user preferences which can already give such rankings. This is a real strategic point, but operators need to be careful: users must have real and unbiased information. The way of presenting results or sorting them can vary, but each must have correct information !

Role of public bodies

At the end, public bodies can also influence itinerary results, for instance by giving a more weighted score when using motorways than local streets. They can thus favour a collective rather than individual optimum. This may bring less congestion but perhaps more kilometres, balancing out climate impacts.

Which incentives can attract citizens to use MaaS?

As the integration of various forms of transport services into a single mobility service accessible on demand, Mobility-as-a-Service (MaaS) is a valuable ally for cities to reach their policy goals. Multimodal and user-centric by nature, MaaS has the potential to provide an attractive and efficient alternative to private car use and to promote a shift towards sustainable transport modes and a more efficient use of transport networks. Therefore, MaaS is seen as a tool for the reduction of congestion, CO_2 emissions and pollution as well as for the renaissance of more lively urban areas and connected communities.

MaaS can bring new sets of measures to public authorities to analyse and monitor the mobility situation, encourage sustainable choices as well as to engage with stakeholders and citizens. While the traditional toolkit of transport policy typically consists of heavy and politically unattractive measures, Mobility as a Service may be considered an attractive policy option as it provides users (residents and tourists) with better and more personalised services while supporting policy goals. MaaS implies also policy, regulation and technical elements that go beyond the local authorities' competencies and therefore coordinated efforts with other levels and branches of administration (e.g. those deciding on taxation, company car advantages, paratransit services, etc.) are needed.

Regardless of the role the city and its administrative bodies in the MaaS implementation model, defining the overall strategy for MaaS is the responsibility of the city, in a good dialogue with all stakeholders. Setting up a MaaS scheme typically involves multiple stakeholders coming from public and private sectors and from many mobility related businesses, such as public transport, paratransit, vehicle sharing, parking, public transport authorities, traffic management, content providers, application service providers etc. The challenge for a city is to get the above stakeholders to work together towards a common sustainable mobility strategy. To do so, the MaaS system should be used as a tool with commonly agreed and defined elements, such as strategic objectives and incentive schemes.

It is crucial to put the traveller at the heart of MaaS: services need to respond to travellers' needs, or else they will not be able to attract enough users to make a difference and deliver the expected modal shift towards sustainable modes. An interesting approach is to channel transport subsidies to the end user rather than to operators or service providers, thus levelling the playing field between modes. In this framework, public authorities would set norms and incentives for desired behaviour according to its policy objectives, whether to reduce congestion, support low-carbon mobility options, boost the demand of active and shared modes or steer company car policies and respective measures towards environmentally friendly user behaviour and vehicles.

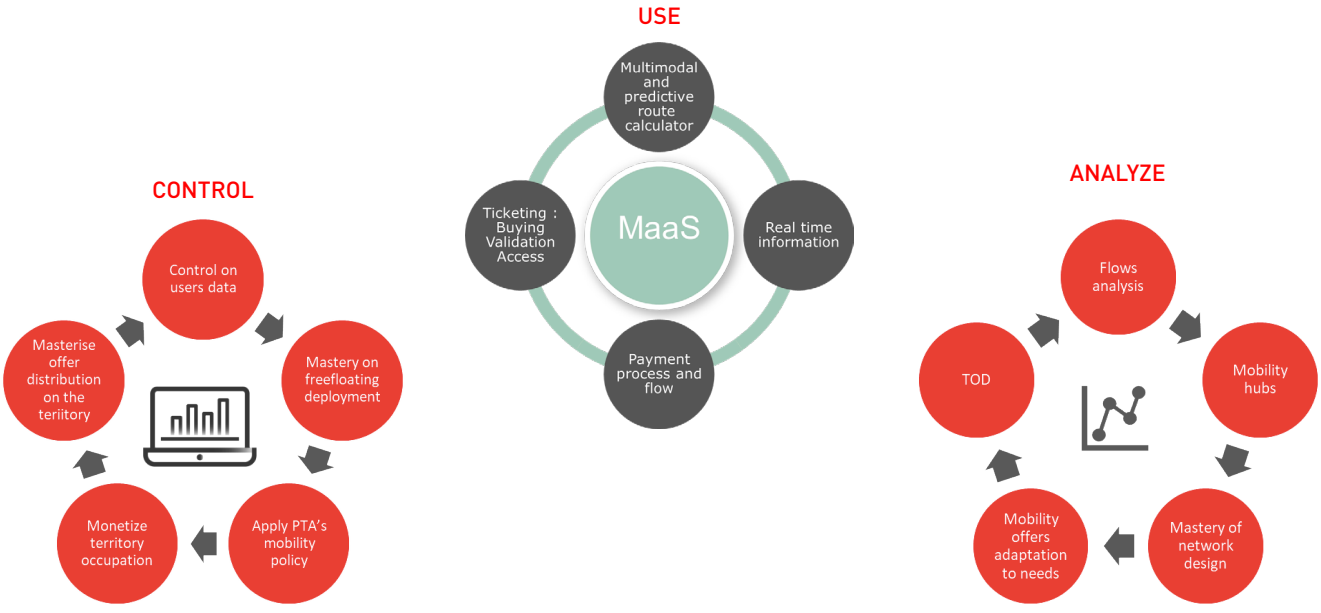

Figure 9 - The tools to encourage new usage, orchestrate mobility deployment and optimize offer towards less vehicle on the streets

Source: Transdev

Which incentives can attract citizens to use MaaS?

Towards universal adoption and use

To unlock fully the potential of encouraging commuters to use more sustainable transport option, some further incentive measures might be helpful. Gamification and nudging are elements of motivational techniques to be used with rewards as an incentive for recognised desired travel behaviour. Further means of stimulating sustainable travel behaviour include bonus / loyalty schemes, where travellers are rewarded for using shared or eco-friendly modes. Rewards must be considered carefully – different user segments may respond to different types of reward such as free or discounted travel or partner discounts. Below some incentive options with the most potential are presented:

- Promotional and/or push information; information is pushed to the user on sustainable mobility alternative choices either at purchase phase or on trip.
- Financial incentives; for example, discounts, discount codes, free rides, taxation exemptions, discounts on added value services etc.
- City-wide loyalty schemes; this could include loyalty points for using sustainable modes.
- Enhancing a socially responsible user profile; the user is motivated by recognition from the system of his/her socially responsible behaviour. Similarly, the user could acquire an active and healthier mobility user profile; for example, by cycling or walking rather than driving a car.

Bearing a huge potential in encouragement of wide data sharing within the MaaS ecosystem, although not directly linked to original topic of incentives, **data reciprocity can be imposed as a principle, from one side to improve the service level and usage of mobility services and on the other side to have up- to-date information for transport planners:** aggregated, anonymized usage data (including demand data such as origin-destination requests) should be shared in a reciprocal way among cities, public transport authorities (PTAs), public transport operators (PTOs) and other mobility providers. The use of customer data should always be treated in compliance with the relevant legal requirements such as the General Data Protection Regulation (GDPR). **To that end, working with open data and architectures as well as standard interfaces can help and also the establishment of a neutral platform for data sharing with an effective governance can be envisaged, if it is not available in the market.** From public policy perspective, various measures for imposing the data sharing, reciprocity and interoperability schemes through public procurements, PSOs (Public Service Obligations) and mobility data sharing requirements, similar to one established by LADOT, should be considered. To that end, public authorities are expected to enhance their data management capabilities and develop policies on the use of algorithms in order to safeguard a level playing field amongst transport operators and prevent undesirable effects such as a shift from collective modes to individualised modes or a shift from sustainable to motorised modes in the value propositions of MaaS solutions or route planners.

Further reading :

MaaS Alliance, MaaS of the Month – Whim :
https://maas-alliance.eu/maas-of-the-month-whim/

MaaS Alliance, MaaS of the Month – S'hail:
https://maas-alliance.eu/maas-of-the-month-shail/

ITF, Transport Outlook 2019:
https://read.oecd-ilibrary.org/transport/itf-transport-outlook- 2019_transp_outlook-en-2019-en

Norden, Mobility as a Service and Greener Transport Systems in a Nordic context:
https://www.norden.org/en/publication/mobility-service-and-greener-transportation- systems-nordic-context

Which incentives can attract citizens to use MaaS?

SUM BIO '19
SUSTAINABLE URBAN MOBILITY CONGRESS

Bilbao Petronor

DECLARATION OF BILBAO:

"Towards a more sustainable urban mobility"

The Declaration of Bilbao emerges as an **international document** that brings together the commitments shared by local governments, international organizations, private companies from different sectors (automotive, transport, energy, technology, start-ups) and the academic and knowledge centres, with the objective to implement models of sustainable urban mobility in our cities.

Objectives:

The main objective of the Declaration of Bilbao is to compile the commitments shared by an array of public and private stakeholders, who have the capacity to transform and generate an impact towards the construction of more sustainable urban mobility models. In this regard, the Declaration of Bilbao adheres to the efforts made at an international level to promote sustainable global development, **in line with the New Urban Agenda and the Sustainable Development Goals (SDGs)** and the **2030 Agenda.**

Commitments:

The public and private entities which are signing this document commit to undertake the following actions:

1. Local and regional governments commit to create spaces for the exchange of ideas and citizen participation in order to nourish the decision-making process in urban mobility. While the private and academic sector, as well as civil society organizations commit participate in this governance system.

2. Governing bodies commit to promote regulatory frameworks which allow the development of new mobility models, setting up the minimum standards that ensure environmental and social sustainability as well as incentive the socioeconomic development based on sustainable urban mobility. The business sector commits to comply with these regulatory frameworks and to develop and to new businesses around sustainable urban mobility models.

3. Local governments commit to putting urban planning at the service of sustainable mobility, guaranteeing the proper functioning of efficient, sustainable and inclusive public transport systems.

Which incentives can attract citizens to use MaaS?

4. Transport, automotive and energy sector companies commit to gradually guide their design and production processes related to mobility towards sustainable means of transport, which generate minimal impact on the environment, while being safe and efficient. This commitment includes embracing alternative fuels as well upgrading the fleet, which will reduce emissions and improve the urban quality of air.
5. Companies and governing bodies commit to establish a roadmap that promotes the energy transition process in a more collaborative way, taking into consideration environmental issues and socioeconomic realities. Likewise, agents involved in the electric mobility industry agree to stablish a common road map for the implementation of electric mobility in cities, facilitating the construction of charging infrastructure.
6. Transport, automotive and technology companies commit to put their R&D&i processes and new technologies at the service of sustainable urban mobility. Likewise, companies which work in the handling of personal or sensitive data from citizens commit to protect their privacy. Public authorities will look after the fulfilment of this commitment and also integrate it into the governments' Smart City programmes, reinforcing smart mobility.
7. The authorities responsible for planning for transport and mobility in cities commit to implement equality and a gender perspective, promoting the participation of women in decision-making to design more safe and accessible transportation systems.
8. The agents involved in sustainable urban mobility will work to favour the social inclusion responding to the demands of the most vulnerable population groups. The private sector agrees to collaborate in the formulation and implementation of these initiatives which promote inclusiveness.
9. Local governments commit to promote the use of collective transport through the investment on collective transport systems which are affordable, accessible and effective. Local governments and society commit to seek and find a formula to make transportation both efficient and affordable.
10. Local governments commit to push forward initiatives related to urban mobility to reduce air and acoustic pollution, while companies commit to find alternatives which align to this vision.

In addition to the previous commitments, the organizations and entities signing the Declaration of Bilbao also agree to periodically follow up on each other and use future editions of the Sustainable Urban Mobility Congress to share the progress made by their actions.

Signatories:

Which incentives can attract citizens to use MaaS?

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SUSTAINABLE URBAN MOBILITY CONGRESS

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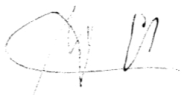
ROLAND RIES,
Mayor of Strasbourg



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Which incentives can attract citizens to use MaaS?

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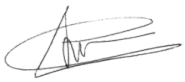

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Which incentives can attract citizens to use MaaS?

Case Study: Sweden engages in MaaS for Climate

In the vision of the Mistra SAMS (Sustainable Accessibility and Mobility Services) program, Sweden by 2030 has achieved a transition to sustainable mobility in urban regions by the support of services that both meet the needs of broad user groups and contribute to sustainability targets.
In order to decarbonize the mobility system, digital technology must play a vital role. Digital technology can cut emissions by 15% in other sectors by 2030. The digital sector is already well on track to reduce its own emissions, which represent 1.4 % of the global total.
In the transport sector, digital technology can be used to RETHINK, decrease demand for transport and move to more efficient modes such as walk, bike and public transport. It can also be used to OPTIMIZE the use of current transport infrastructure and vehicles.
Mistra SAMS have developed indicators to identify promising innovations in mobility and accessibility that can help to cut emissions. Promising innovations are those that

1) contribute to lower demand for transport by giving access without travel such as virtual meetings, e-commerce, e-health and e-education
2) optimize the use of the current infrastructure, which include shared access and MaaS.

Other promising innovations are route planning and navigation as well as autonomous cars.

Innovative mobility solutions require partnerships between academia, industry and the public sector. Mistra SAMS therfore work with partners from different organizations:

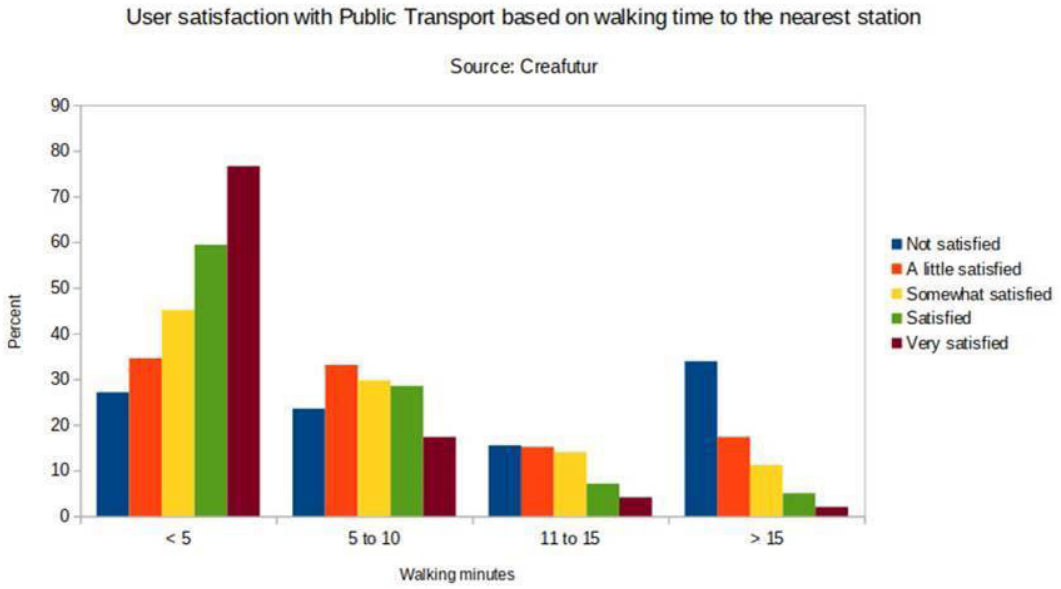
- Academic partners are KTH Royal Institute of Technology, Lund University and Karlstad University. A core partner is the Swedish National Road and Transport Research Institute VTI.
- Public partners are Swedish Transport Administration, City of Stockholm, and Municipality of Botkyrka with 90.000 citizens.
- Industry partners are Ericsson, Scania and Hertz.
- Public transport partners are Samtrafiken and K2.

The Mistra SAMS program includes Living Labs as a research method to explore behavioural change and different stakeholders' perspectives. In Mistra SAMS Living Lab "Work near – Smart mobility" more than 50 participants participates. They live within 3 km from Tullinge station in Botkyrka municipality south of Stockholm, where a co-working hub has been established close to people's homes. The participants work in or north of Stockholm, and have approximately 2 hours of commuting every day. They are recruited by partners Ericsson, Scania and City of Stockholm and through Facebook. The workplace in the hub can be booked via a digital platform offering other services as well, including planning, booking and paying for public transport, peer to peer ridesharing, electric bikes and more to come.
First findings are that this kind of service is very popular among employees, who use the hub not only to tele-work a couple of days per week but also to start work early in the morning and then travel to the office after peak time. HR departments may be hesitant to let employees work elsewhere than their ordinary workplace, but the city is happy to be providing a new service to their citizens.
Factors encouraging the success of AaaS and MaaS include:

1) set rules of play for the transport system and facilitate innovation;
2) regulate mandatory open APIs for participating companies;
3) work closely with municipalities and companies;
4) develop easy to use ticketing and payment for public transport.

Mistra SAMS contribute to the transport section of the Exponential Climate Action Roadmap that was presented at the Global Climate Action Summit in San Francisco where innovations were presented to cut emissions by half, by 2030. In 2019 an updated version will be presented at the UN Climate Action Summit in New York in September. (https://exponentialroadmap.org/).

Which incentives can attract citizens to use MaaS?



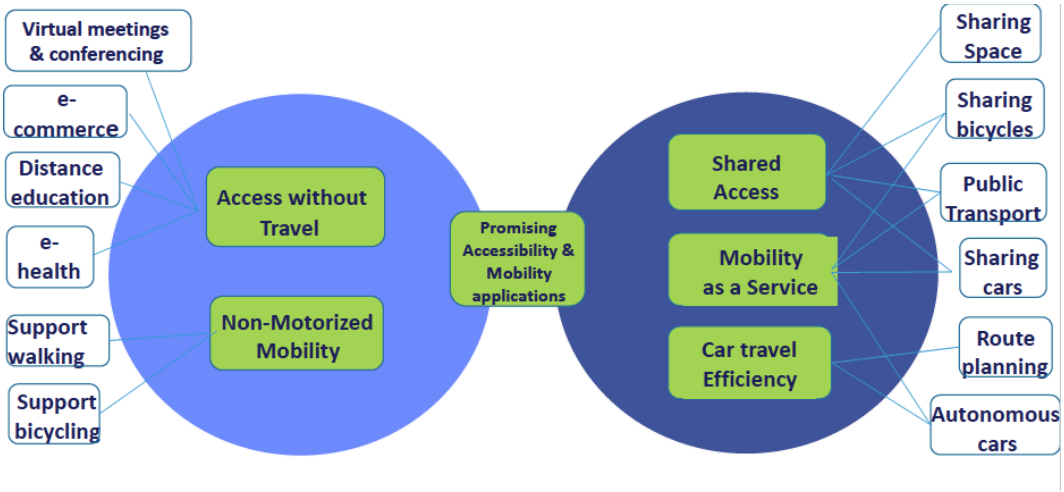


Figure 10 - Innovation in Mobility and Accessability enabled by Digital Technologies
Source: Creafutur

MaaS to reduce CO_2 emissions – a vision from Barcelona

Case Study: Barcelona

The serious pollution and congestion that affect major European cities (including Barcelona) are leading public authorities to take measures favouring sustainable mobility. Such measures are expected to continue during the next few years, in particular those to limit the impact of road traffic. Passenger transport in the Metropolitan Area of Barcelona (by private vehicle and public transport) is responsible for 62% of CO_2 emissions generated by road traffic[7]. The European Commission has repeatedly censured Spain due to its failure to comply with atmospheric pollution limits in Madrid and Barcelona metropolitan areas, demanding greater effort on local, regional and national levels to comply with the obligations set by the EU legislation and to protect public health.

On the other hand, the mass use of smartphones and connected devices has led to development of a variety of shared mobility services offering an alternative to use of private vehicles (mainly cars) and public transport, that can be easily combined into a multimodal offer through Mobility as a Service aggregators.

Despite the considerable increase in the roll-out of such services internationally in recent years, few are implemented in Barcelona. In fact, a local study by Fundació Creafutur (2017)[8] found that such services are not very often used. Moreover, these services are mainly concentrated in downtown areas, while most of the mobility problems are due to commuters between Barcelona centre and its metropolitan area.

Figure 11 - Use of mobility services
Source : Creafutur

7 - Source: "Seguiment de l'evolució de la mobilitat i les emissions de gasos d'efecte hivernacle i contaminants a la Regió Metropolitana de Barcelona el 2014" ("Monitoring of the evolution of mobility and the pollutant greenhouse gas emission effect in the Metropolitan Area of Barcelona in 2014"), ATM (July 2016).
8 - https://www.slideshare.net/creafutur/citizens-and-mobility-in-barcelona

MaaS to reduce CO_2 emissions – a vision from Barcelona

The accessibility to public transport seems to be a critical aspect for user satisfaction, driving the modal choice for Barcelona citizens:

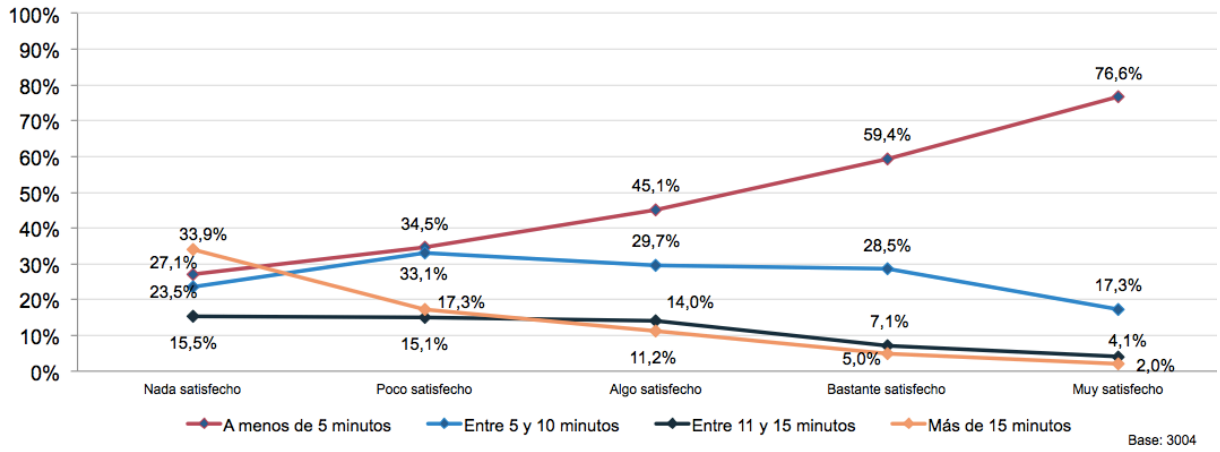
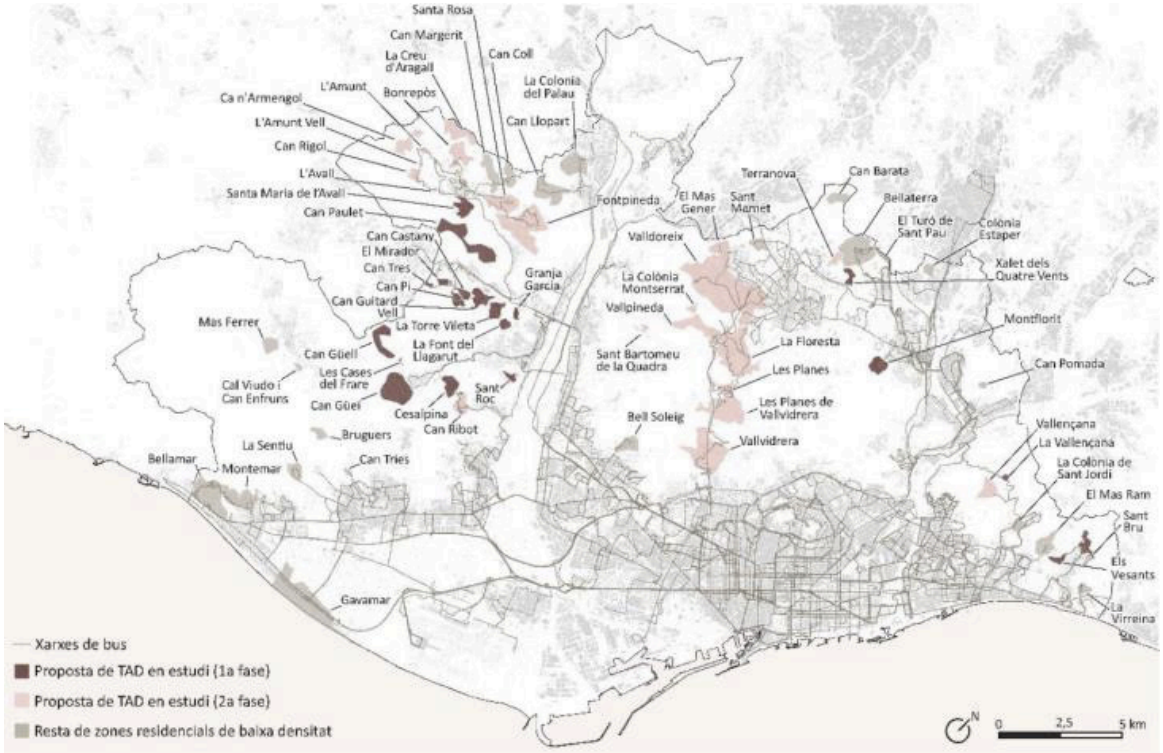


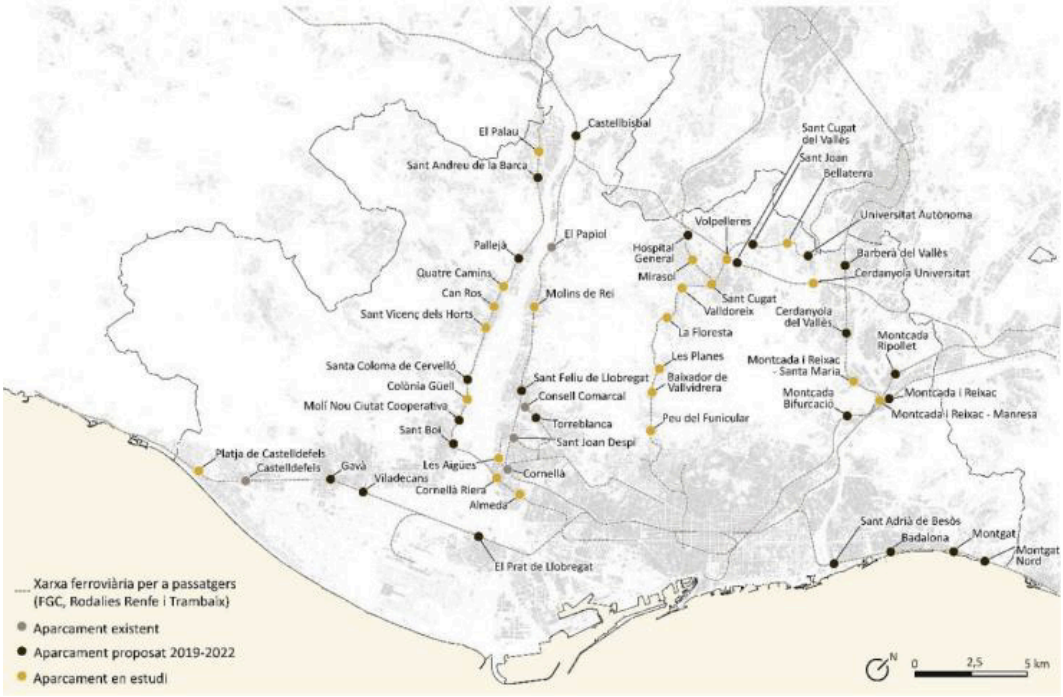
Figure 12 - Relation between satisfaction with Public Transport and walking time to the nearest station
Source: Creafutur (in Spanish)

Mobility as a Service that helps to combine different means of transport to solve last-mile access to public transport, can therefore be a key tool to unlock modal shift away from private car use. But for that, an offer of flexible transport solutions should be offered in periurban areas and remote business parks. Otherwise, there's little that can be done from an aggregator point of view. The Metropolitan Area of Barcelona has engaged in an ambitious programme to deploy demand-responsive transport (DRT) solutions in periurban areas, starting with a first pilot in Cervelló (2019).



MaaS to reduce CO_2 emissions – a vision from Barcelona

There´s also an ambitious plan to increase park & ride offer in railway stations on the Barcelona outskirts:



Both solutions can be enhanced by MaaS, which becomes a driver for a cleaner mobility. There are unique elements in Catalonia that are an excellent baseline on which to build a vision of the mobility of the future: a modern concept of the city and urbanism, social consciousness, an active and dynamic citizenship, early adopters of new mobility, a diversified economy and a leading technology sector. In addition, Barcelona has recently been selected by the European Commission to lead the European public-private consortium KIC-MOBiLus, which will channel the largest funding for innovation in urban mobility (1,600 million euros)[9]. Catalonia holds great potential to become an advantageous region to attract projects around mobility and thus lead this transformation, but for this to happen a joint effort and coordination from all involved stakeholders is needed, and this change cannot wait.

In this context, and among other initiatives, at the beginning of 2018 CARNET (one of the main promoters of KIC-MOBILUS together with the Barcelona City Council) and FACTUAL launched the "MaaS Manifesto", a set of ideas that outline some basic principles on how a MaaS scheme could be deployed that has received the support of more than 40 entities both at national and international level. FACTUAL and CARNET are now undertaking a study for a selection of relevant stakeholders of the Catalan mobility ecosystem to capture and understand their point of view on the MaaS Manifesto and what opportunities and challenges, in their opinion, is facing the development of Mobility as Service in Catalonia.

This first phase of the study has generated a first set of relevant insights :

- Mobility as a Service is considered an opportunity to offer a viable and attractive alternative to the use of the private vehicle and thus favor a more sustainable mobility, setting the conditions for a more rational use of public space and improving the quality of life of citizens.

[9] - http://ajuntament.barcelona.cat/imi/en/noticia/the-new-eit-innovation-community-in-urban-mobility-will-be-run-from-barcelona

MaaS to reduce CO_2 emissions – a vision from Barcelona

- Mobility as a Service, as an idea or concept, has been formulated and has gained acceptance in a context of emergence of a set of flexible mobility services that have been developing in recent years, largely driven by private initiatives (with notable exceptions such as Bicing bikesharing in Barcelona).
- These new mobility services, as well as their aggregation under a Mobility as a Service scheme, represent a business opportunity for the private sector, which is ready and willing to invest.
- They represent, however, a risk or threat for the current "traditional" mobility operators (such as the taxi sector, for example), who face a risk of disintermediation with customers / end users.
- There is also the risk that new mobility services would grow in a way such that social goals regarding mobility are not met, displacing users towards less sustainable modes and generating negative side effects on the mobility system.
- In order to avoid these negative side effects, Public Transport must remain the backbone of mobility, complemented by other mobility services that offer a viable option to communities of users with specific needs, ultimately improving accessibility.
- Current regulation is not yet ready to efficiently incorporate new mobility services and must be upgraded.
- It is, therefore, necessary and impending that the Public Administration adopt an active role in defining how it all should be done, rethinking the current mobility system, overcoming distrust among stakeholders, ensuring that new mobility services will be introduced in an orderly manner and maximizing the positive impact that can be achieved towards a more sustainable mobility for all.
- Besides private companies and the Public Administration, citizens must get involved so that the change towards new mobility takes place in generating a positive impact towards society as a whole, especially young people, digital natives and groups that are more open to adopt new mobility services.
- Mobility as a Service and new mobility services have directed their first deployments to the center of large cities.

However, it is necessary to find strategies so that the benefits of MaaS reach other areas that may also benefit, such as peri-urban areas, medium-sized cities or rural areas.
In this complex and dynamic environment, both public and private stakeholders agree on the need to work in the direction of drawing up a shared strategy at regional level that allows ordering the development of Mobility as a Service and which, in turn, fosters innovation, thus becoming an element of economic development. Although the Public Administrations have the interest and responsibility to lead this strategy and define the governance model, there must be a shared space where this strategy is discussed and promoted, in a constructive manner, together with the private sector.

Impact: a scenario to reduce private car use

Besides modal shift, MaaS has the potential to support CO_2 emissions in other ways:

- "Fleet effects":
  - Circular economy : increased use of vehicle and components (physical assets that need to be manufactured through CO_2 intensive processes)
  - More rotation -> cleaner motorization
  - B2B market -> Easier to implement measures through agreement with fleet operators (efficient driving tools, speed control systems, incentive schemes, etc.)
- Behavioural change :
  - Information on cleaner options
  - Easy communication for awareness campaigns
  - Incentives on cleaner routing options or operators
- Better knowledge :
  - Identify problems and bottlenecks on transport offer
  - Monitoring of CO_2 emissions`
- **By making transport network operations more efficient:**
  - **Reduction in vehicles – reduction in parked vehicles – reduction in traffic & congestions related to search of the parking space**

MaaS to reduce CO_2 emissions – a vision from Barcelona

- **Data gathered by MaaS app can be used for predictive traffic management services and network and capacity management**

CO_2 reduction is in a slowly declining trend, and today's efforts are insufficient. However, MaaS can help drive a revolution, as part of a disruptive innovation process.

Human and climate impacts of Mobility as a Service

"Sustainable development meets the needs of current generations without compromising the ability of future generations to meet their own needs"

(World Commission on Environment and Development, Our Common Future, 1987.)

Mobility as a Service (MaaS) represents a paradigm-shift in how we consider and design transport systems. It shifts the focus from infrastructure, regional politics, and other transport-centric concepts, and places the emphasis on human needs. By focusing on human needs, it becomes easier to see the impacts of the transport service on human wellbeing and quality of life.

This chapter will explore several high-level ways that MaaS can improve the lives of people.

MaaS really Impacting Environment and Climate

"We can create transformational action that will safeguard living conditions for future generations. Or we can continue our business as usual and fail. That is up to you and me."

(Greta Thunberg - World Economic Forum, Davos, 25 January 2019)

Transport designed for personal car ownership and predominantly single-occupancy vehicles is placing an enormous strain on the environment and climate, such as air and noise pollution and large-scale impacts on ecosystems and water systems. MaaS, when optimized for high-density and active modes of transport, can have many benefits for the environment and future generations. MaaS can reduce carbon emissions, noise pollution, congestion, and infrastructure burdens, such as highways and parking lots that take up valuable space and contribute to the net carbon impact of transport.

Although the processes by which MaaS could reduce climate-change impact, there is almost no hard evidence until now of its effectiveness. So it's important to establish a Europe-wide monitoring programme to assess the environmental effects of MaaS implementations.

High tech for low cost

MaaS can ease people's transport-related financial burdens in several ways. First, by promoting competition among transport service providers, transport costs will tend to be lower than in monopoly markets meaning increased affordability for end-users. MaaS customers will experience additional savings, including lowered insurance rates, parking expenses, and personal vehicle maintenance costs.

Since transport providers are maintaining the vehicle fleet, individual commuters don't have to directly concern themselves with financial aspects of vehicle maintenance or replacement. Transport fleet operators will be in a better position to negotiate vehicle pricing and longevity directly with manufacturers, since they are interested in reducing costs and waste involved in managing many vehicles.

To the extent that MaaS reduces costs for individuals and organisations, this can act as an incentive to adopt low-carbon MaaS services in the place of high-emission modes.

Human and climate impacts of Mobility as a Service

Impact on health?

MaaS design can operate across several transport modes, as it is not limited to a single operator or vehicle fleet. This cross-modal design space means that MaaS users can make their transport decisions based on considerations like physical activity or calories burned. Health and activity considerations should be based on individual capabilities and preferences but can clearly impact a person's lifestyle when presented in the context of daily commuting.

Additionally, encouraging the use of transport modes with high-capacity and low carbon footprint can have benefits for physical and mental health by reducing environmental factors like pollution and congestion.

MaaS user friendly and Smart ?

Many detailed considerations go into personal mobility. MaaS offers an abstraction layer to insulate people from the complexity of various transport services, such as zones, availability, variable pricing, and more. From a MaaS user's perspective, they care about where they are and where they need or want to go. The MaaS platform handles the underlying gymnastics of route planning, negotiating costs and product availability, trans-provider and market integrations, and user-preference modelling. The end-user simply wants the trip that best fits their dynamic needs to get them where they want to go.

MaaS for all

Equitable access to transport is a key element in social mobility, or people's ability to elevate their social and economic status. Having simple and affordable transport options may open people's horizons with regards to work, education, healthcare, and leisure, by expanding their ability to reach those resources that may be outside of a smaller radius accessible by walking, bicycle, etc.
It can also mean that people in rural areas are able to access a wider "catchment" of opportunities for personal or familial development. Elevating people's socioeconomic status has positive effects on health, education, and, in many ways, the environment.

Health impact area	*Nature*	*Likelihood*	*Timing*
Physical activity	▲▲	Probable	Short term
Traffic safety	▲	Probable	Long term
Environmental stressors	▲	Probable	Long-term
Accessibility	▲	Probable	Short-term
Equity	≈	Speculative	Long-term

Figure 13 - Health Impacts of MaaS, masters thesis by Juliette Krantz, called Mobility-as-a-Service from a health perspective

How to measure MaaS impacts

Which scenarios to compare?

MaaS projects are frequently step by step projects. And the behaviour changes will be observed in the months after new digital options appeared. So it means we need several months after one main release of the system, without big changes, to be able to observe the new behaviours.
Most MaaS projects are not only digital projects but include changes in mobility services (more or less depending on the project). In this way, it can be useful to assess separately impacts of new mobility services changes and impacts of a MaaS app and digital multimodal services.
The first step is a classical modal shift assessment, trying to guess how people would have moved without this mobility service. The second one is more complex, as it is not a mobility solution, but help users to have a better understanding of all the mobility solutions. Even users can have difficulties to know how they would have moved without this information. And if it is a public MaaS system, the question is : what would have appeared without it ? Would a private MaaS system have appeared ?

Data requirements

Before deciding new transport projects, modelling tools are frequently used. They calculate the time saved by the project and can tell what the new habits and the economic benefits will be. It is possible as we know people choose their mode and itinerary depending on their cost and time... But in MaaS systems, we don't really know how it can help people to save time, as classical modelling assume that people know the cost and the time of each mobility choice. And the interest of MaaS systems is that they give people a better knowledge of the possibilities, with the time and cost.

So, it seems to be too soon to make ex ante assessment. We should have more studies about the way users are building their own map in their brain, and how they imagine the best way with and without such digital systems...
When MaaS projects are running, they can give useful data. Available data will depend of the way the system is built. There can be 3 types of data collected by MaaS systems: itineraries requests (mobility wishes), access validations (check-in, and in some cases for check-out), and tracking data.

For instance, with WienMobil app, you can buy public transport tickets, but as in most of Austrian cities, you don't need to validate before entering a public transport vehicle. QR-codes have only to be shown if there is a control. Data demand analysis is only done with SDK and GPS data (50% people agree with MaaS provider using their own data in this way), trying to find stop points and modes with algorithms.

In MaaS systems where the card/app is needed in order to validate or access each vehicle, the amount and the richness of data are bigger. It helps having a precise knowledge of mobility habits but it has to be completed with the knowledge of past habits of each one (or actual habits without the MaaS system), in order to compare them. New surveys are useful for that.

Survey tools

A good assessment needs a precise description of mobility patterns, without and with the project. MaaS system can bring a good view of actual habits, but it must be completed with a survey towards users, asking them how they are moving and how they would have moved without the MaaS system. As for household surveys, questions need to be asked about all the moves done on a given day (precise places, reasons, modes, ...) but, they also have to ask people how they think they would have moved without this MaaS app. It means, considering the same mobility needs, describing the whole supposed moves (would you have moved towards the same places? with the same modes ?)

If they agree in respect of GDPR requirements, users' identity can be linked with their personal data entered when subscribing, or they can be notified in their app.

How to measure MaaS impacts

Step by step evolution can also be analysed by regularly asking cohorts (the same individuals) the same questions. One main difficulty is to have a representative sample. It means to ask users socio-demographic questions and to apply the recovery in order to have representative results.

Rotterdam is doing a MaaS assessment pilot: a sample of representative users are proposed a digital MaaS tool. The first month, it is a basic package of mobility, the next month, an updated offer, and again updated offers for 4 months. At the end, the mobility behaviours will be analysed, comparing them for each step of this step by step MaaS.

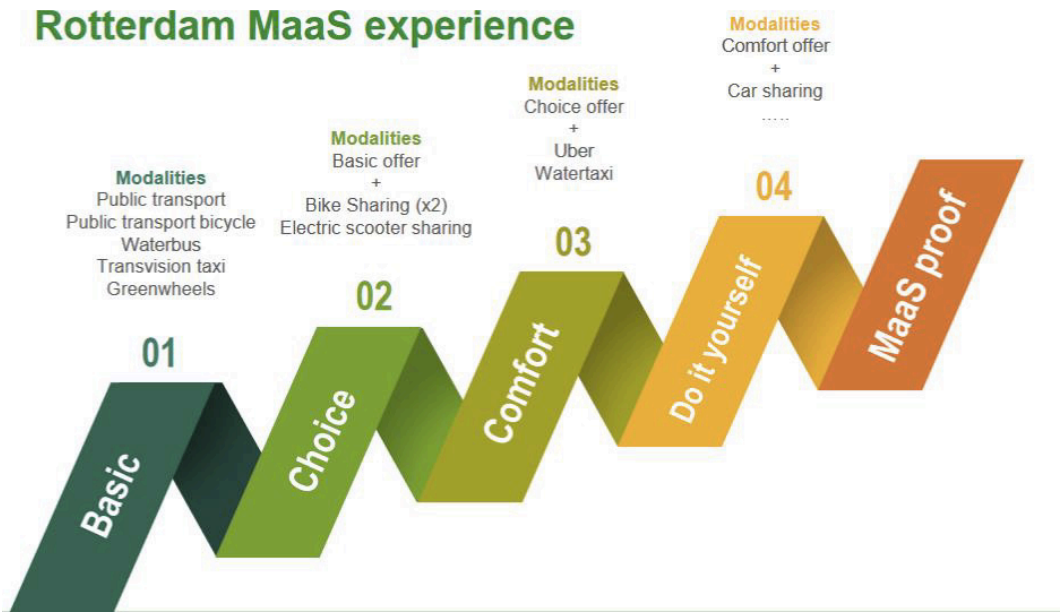


Figure 14 - Rotterdamn MaaS experience

How to measure MaaS impacts

From habits to emissions

By using MaaS data system and surveys, it is possible to know more or less accurately travellers' movements with and without the MaaS project. For each move, it is possible to calculate distance (thanks to routing algorithms) and estimate the CO_2 emissions per kilometre thanks to personal data which can be available in MaaS system or with the survey or standard medium modal emission data.
For some trips, the impact may be negative for the climate, but we can hope that for most of them, MaaS will bring positive impacts. A MaaS data dashboard can plan, do, check and react in the direction of some users to apply them the right communication and information to help them to change their travel habits.

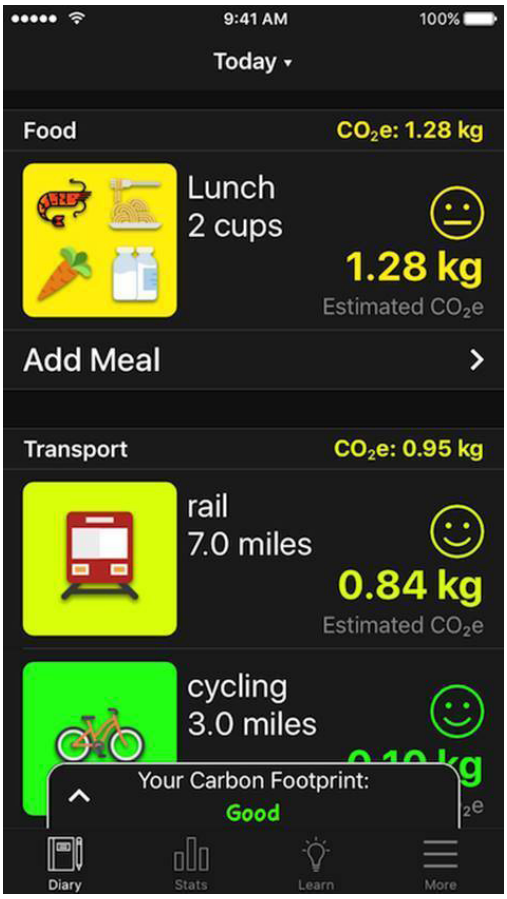


Figure 15 - EcoBuddy app

Recommendations for success

In order to move effectively towards a climate-friendly MaaS-enabled future in urban areas, new standards, regulations and industry-wide collaboration will be needed, driven by strong public-private engagement and cooperation. New ecosystems can drive innovation and create user centric MaaS solutions. End users need first to become aware of their CO_2 emissions and their impacts, then familiarised with what MaaS offers in their area.

The few existing MaaS schemes have proved to be popular with their users. The scale of deployment and uptake remains relatively small, however. MaaS for climate will not achieve its potential impact unless it can capture the mobility needs of an entire community, and for the majority of their travel and transport needs. **The following success factors would favour such a maximum-impact scenario:**

- the user interface must be easy to understand and use, for all user types,
- the service should be (made) affordable for every user,
- service quality should be equivalent to, or better than, a user's previous means of travel / transport, so they are attracted to use it,
- transport providers offer reliable, on-demand mobility using the most suitable vehicle for a user's needs,
- transport providers develop innovative services using the more complete and detailed data on user demand available from the service platform,
- users benefit from information on their CO_2 emissions, and a mix of incentives to use lowest-carbon means, and disincentives to use their own, oil-fuelled car,
- governance by public authorities ensures an open MaaS marketplace; equal access to services for all users and to the marketplace for all transport providers; and availability of support for social and other non-commercial services,
- MaaS for climate is the "official" framework for its service area, becoming the default for all individual, business and other collective users – with a goal to supply 100% of mobility and transport needs with 100% carbon-free services.

Maas is for Climate! A visionary tale

It's 2025, a day in the life of a suburb of a small countryside city, 30 km from the nearest metropolis.

Richard is very excited this morning. For the first time in his adult life since getting his driving licence, he will not take his car to go to work this morning. In fact, Richard no longer has a personal car!

His 10-year old son David took a major place in this decision process. Since 3 years he has had a weekly lesson at school on climate change and actions to contribute positively to emission reduction.

On his personal tablet, his teacher gave him an animated app to educate his family and a simple simulation tool to help him convince others about the benefits and financial savings possible with new mobility solutions. Two months ago, David explained to his father how to calculate the total cost of having a personal car that was used only 5% of the day.

But what really convinced his father (who was one of the 60% of citizens not willing to get rid of his car) were these arguments:

- This year four towns close to their own decided to co-invest in a flexible on-demand hydrogen bus, since no trains served their region.
- The metropolis where Richard work decided to install a tolling and access-control system that would oblige Richard to change his car for an all-electric one.
- Richard's boss offered him a new bonus: an annual package with unlimited multimodal transport, funded 50 % by his company, provided he sold his personal car. This mobility service package for the whole family was called MaaS4Climate.
- David got a prize at school for starting up a childrens' committee to give their views to the city on setting up a "MaaS 4 Climate Manifesto".

According to federal government transport law, each city must deploy a strategy to reduce personal car ownership by 5% each year: a very challenging target to reach. Many short-term alternatives exist if you can demonstrate that your car is used and shared by a large community of people. For example, a new application called "Amigo Navigo" is very trendy in the metropolis. This application asks you to take a selfie in your car each time you start the engine. Recognizing the number of persons and faces in the car, you and your passengers get your choice of "good citizen" bonus.

Thanks to his son, Richard was elected representative of the group of citizens commuting to the metropolis. He is super motivated to push for public funding of a flexible E-bus service to his town, at the same level as the big-city Metro, with seamless integration into the regional MaaS scheme.

Richard and his son are also working with his father who is a local organic farmer. They want to arrange the carbon-free delivery of vegetables to restaurants and shops in the city, perhaps using a modular trailer to be added to the E Bus! Is MaaS only for persons?
For David no question MaaS is for Climate first! Richard is very proud to be saving 3,5 tons of CO_2 per year by selling his car. But first he needs the portfolio of MaaS global applications and the public / private funding of his MaaS commuter service. For Richard, no question : **MaaS is for Climate first !**

David's MaaS service also gives him a discount of 15% of the total annual cost of a new electric car he should buy in 2025 to be compliant to the new urban mobility policy. Finally, his father is now preparing to sell his 15-year old diesel van generating 4,6 tons of CO_2 per year, as he expects a shared logistic service solution to start operating. Davis's mother dreaming of an on-demand shuttle for visiting her friends to play cards, and go shopping to the new mall once a week. This is promised by the MaaS plan.
Mobility as a Service is the transport revolution needed to travel and transport sustainably while stopping climate heating. It is possible - if we all help create and join our local MaaS scheme.

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Authors

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Jean-Luc Mate is graduated from the Polytechnic Engineering school of Grenoble in microelectronics and computer architecture and from DUKE university MBA.
He is considered as one of the French automotive electronics pioneer thanks to his participation to the build up of the Renault Bendix JV in 1979 in Toulouse. Jean-Luc occupied many executive positions as VP R&D in powertrain, interior, chassis ADAS, cockpit module, E/E vehicle architecture, ITS and innovation for western Europe at Siemens Automotive.
His last position @ Continental was VP Engineering Services for France and Spain. During his 38 years career Jean-Luc contributed to major European and worldwide initiatives that structure the Automotive industry standards : Autosar, ERTRAC,ITS telematics and Eco driving with ERTICO. Jean Luc support continuous innovation in the development of Connected, Autonomous and Clean car. He is the founder of the automotive and mobility cluster in Occitanie Automotech and also the European Eureka cluster on Smart Electronic Systems EURIPIDES². Today he is president of a consulting company encouraging cooperation on innovative mobility services, business development of autonomous and connected cars and shuttles as well as integrated MaaS portal for smart cities. Jean-Luc maintain strong cooperation in all those mobility fields with Belgium, Canada, Germany, Finland, Italy, Norway, Netherland, Spain and UK.

Brylie OXLEY,
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Brylie works to support stakeholder awareness in areas such as finance, planning, and environmental impact. His overarching goal is to promote sustainability, both within the company and in the broader ecosystem.

His hero and role model is Greta Thurnberg, who works tirelessly to promote collective action in the face of our current climate emergency.

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Anna Kramers is a Master of Science in Civil Engineering and holds a PhD in Environmental Strategic Analysis with a focus on smart cities and digitalization for environmental aims. Anna has over 20 years of experience from the IT and telecom sector and currently work as a researcher at KTH. She is the program director for the research program Mistra SAMS (Sustainable Accessibility and Mobility Services). Her research is about how digitalization can help reduce greenhouse gas emissions, primarily from transport and mobility.

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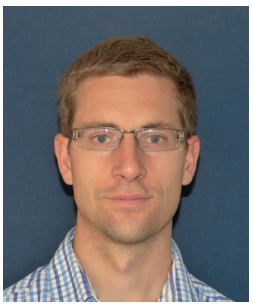
Marko Javornik is General Manager of Voyego, a standalone division of Comtrade Group that focuses on digital transportation and travel. Javornik is leading Voyego's partnership with key accounts, such as Ryanair and Daimler. He is also the founder of Voyego Digital Transportation Lab – one of the leading European expert centers on new technologies and business models related to transportation. During more than 20 years of experience, he has led large scale innovation projects for digital business solutions in various industry verticals worldwide. Javornik is also Chair of "Governance and Business Models" work group at MaaS Alliance.
As a regular keynote speaker and moderator, Javornik has taken part in leading industry events all over the world. He draws on his wealth of experience and passion for digital technologies to provide essential insights into the future of mobility and digital travel.



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As a public works engineer, Laurent Chevereau has been working for 15 years on transport supply data. He is currently leading Cerema's activities in the field of mobility as a service (MaaS).
He began his career by carrying out modeling and assessment studies about transport projects before becoming Cerema's referent on transport supply data and multimodal information.
As an expert, he contributes to the national working groups initiated by Minister Elisabeth Borne in 2018 on data and MaaS, working groups on the National Access Point, working groups with regions about multimodal information ans MaaS, and represents state services in open data events.

Martí JOFRE,
CEO, Factual

Martí Jofre is CEO at FACTUAL and ITS Business Manager at Pildo Labs. He holds a Master's Degree in Telecommunications, for both Telecom Paris and Polytechnic University of Catalonia, and a Master in Marketing Management for EADA Business School. He accumulates a wide experience in the definition, fundraising and management of R&D and innovation projects, mostly related to satellite navigation applications and urban mobility, obtained at companies such as European Space Agency (ESA), Centre de Tecnologia Aeroespacial (CTAE) and European GNSS Agency (GSA).

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David LAINE,
MaaS Director, Transdev Group

« Before joining Transdev as the Corporate Solution Manager MaaS in the Group Strategy and Innovation Department, David launched several start-ups. He created first the European subsidiary of an American sport company, opening several thousands stores across 20 countries. Strong of this experience, David creates its own distribution company in 2006, Next-Step, before funding Wattmobile in 2011. With Wattmobile, David was one of the first to launch a 100% electrical sharing service in France mainly dedicated for businessmen on the move. Based in the main train stations in France, Wattmobile was providing 100% electrical vehicles in self service allowing the users to jump in a car or on a scooter to go to their meeting without the constraints of waiting in line behind a counter, of filling forms... Wattmobile service was totally digital. The company was bought out by Indigo Park in 2016. Since 2018, after one year spent integrating Wattmobile to Indigo Group, David is bringing his innovation and mobility expertise to Transdev and is in charge of building and deploying Transdev MaaS strategy at Group level. David is now MaaS Director for Transdev Group."

Piia KARJALEINEN,
Senior Manager, Maas Alliance

Piia Karjalainen is currently working as Senior Manager for MaaS Alliance at Ertico. She is based in Brussels. Previously she has been working for the European Parliament and the Finnish Ministry of Transport & Communications. She has been working her whole career in different positions related to transport mainly with transport strategies, ITS Mobility as a Service, policymaking and EU regulation. She holds a Master of Science in Economics.

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