The Institution of Engineering and Technology

Could Mobility as a Service solve our transport problems?

Developing a better understanding of MaaS, its evolutionary path, benefits, unintended consequences and deployment challenges.

theiet.org/transport

About this report

This document is aimed at senior transport authority professionals and transport operator leaders worldwide with responsibility for delivering mobility services. It is designed to offer insight when considering how Mobility as a Service (MaaS) could contribute to improved access to transport in a financially sustainable way.

In addition to drawing on the experience from within a multidisciplinary working group, the report uniquely brings together ten use cases from around the world that illustrate the relative maturity of MaaS components and the role they fulfil in a MaaS service. These extracts are written by the use case providers and describe in their own words how their technology, invention or approach provides either a single component of MaaS, multiple components or a near-complete solution.

This paper is not intended to be a guidance note with a specified set of recommendations/actions, but rather aims to support developing informed decisions about MaaS. Furthermore, the document does not promote a specific MaaS solution or provider and rather provides a realistic and unbiased view of the role of MaaS and its ability to achieve intended objectives.

Contents

1. Foreword

Mobility as a Service (MaaS) is a phrase we hear increasingly often in transport and government circles, however to date there has been a great deal of hype and misunderstanding as to what is actually meant by the term.

Professor Phil Blythe
Chief Scientific Adviser,
Department for Transport

In the UK, it now forms a central role in the Industrial Strategy Future of Mobility Grand Challenge, with the premise that MaaS has the potential to deliver a paradigm shift in travel choice. There are many positives that it can deliver, which has been covered a great deal elsewhere, but what is becoming clear now is that much development is required to meet the needs of the various stakeholders involved and provide sustainable MaaS solutions.

I am pleased to see this report from the Institution of Engineering and Technology (IET), and its MaaS Working Group, highlighting so many of the key issues that still need to be fully addressed regarding MaaS to ensure we deliver the best possible beneficial outcomes from its introduction and understand the many ways MaaS may evolve.

For the customer or end user, it is essential that MaaS provides a service that society wants and will use, which can be a danger with technology-driven concepts such as this, with a clear message from this report that this must be a user pull rather than a technology push. MaaS must be suitable for everyone – people with different circumstances and mobility requirements, and not just varying personal preferences on how they would like to travel.

A move towards a sharing economy may be advantageous for many, but what about people with young children, the elderly or those with different accessibility needs? Changing between transport modes – a key element of MaaS – could well be a problem for these groups, as could accessing the services from a digital platform, if not designed suitably and accessibly. We often talk about the elderly struggling to use new technology, for example, but MaaS' multimodal approach could prove to be an even bigger barrier in their case. To be available to all, MaaS must also be affordable, and be capable of providing options to those currently finding it hard to pay for transport.

Among other stakeholders, some see MaaS as a panacea, and although it may solve a lot of the issues that we are currently seeing with our transport system once it is fully implemented, it should not necessarily be thought of as a complete cure-all – it will meet certain needs, for certain consumers. Our challenge is to ensure it makes transport available for all in terms of accessibility and cost.

There also remain many different definitions of what MaaS actually is, and what it can offer. More clarity is needed on the benefits of what MaaS can bring, but also awareness of the challenges that have to be overcome first and the unintended consequences to avoid, which are all crucial factors to consider if MaaS is to deliver on the early expectations.

Nevertheless, the opportunities that new technologies, digital connectivity and business models will bring is exciting, and if grasped well should result in the UK leading the world in shaping the Future of Mobility.

Professor Phil Blythe
Chief Scientific Adviser,
Department for Transport

2. Executive summary

With few exceptions, city leaders, planners, transport operators and governments across the world have found it difficult to grasp the complex inter-relationship between technology, infrastructure, users and commercial transport operations. Yet understanding this relationship is essential to fully exploit the opportunities that technology can bring in delivering efficient transport services to the user.

City, town and rural authorities are all challenged in different ways with the needs of growing and ageing populations, increased urbanisation, reduced funding and the need to meet sustainability targets. As a consequence, authorities are grappling with the impact of traffic congestion, under-utilised public transport services, dwindling resources and increased air quality problems.

Although still emerging, many consider Mobility as a Service (MaaS) to be an approach that could help authorities improve transport services and mitigate some of the challenges that the sector faces. Some transport authorities see a brighter future where public and private sectors come together to provide an end-to-end customer travel experience that delivers multimodal transport choices in a seamless planning and payment ecosystem.

As MaaS develops in maturity, it is likely to provide mobility benefits in different ways to different users across the world. However, unlike the ubiquitous mobile phone or the motor car, it is unlikely that a universal MaaS solution will be scalable globally. It will be essential for city leaders and planners to be sufficiently informed so as to grasp the MaaS options that suit their particular needs.

There are four key features that would need to exist to create a fertile landscape for MaaS deployment. These are:

1. **The existence of a strong and reliable underlying transport and digital infrastructure with open access**
2. **A commercial framework that allows competition and collaboration to provide a sustainable business model**
3. **An understanding that MaaS is an additional service layer that needs to be paid for by someone in the value chain**
4. **The recognition that MaaS is a user-centric service that should support the transport needs of a desired lifestyle**

Although some of the MaaS technologies and concepts are relatively new, there is sufficient breadth and choice of these technologies to cover the needs of a mobility service. It is anticipated that MaaS development will be three-dimensional: across geographies, across transport modes and through evolving services. The development of MaaS components will evolve at different timelines, which means that part solutions with different components are likely to exist.

The opportunities

MaaS has the capability to deliver a wide range of direct benefits, such as seamless journeys, better travel planning, incentivised trip making and best fare options. MaaS also supports indirect benefits too, such as easing congestion, reducing episodes of poor air quality and releasing road space. MaaS could be a catalyst for bringing better data and information services together to enhance the transport experience for the individual and exploit the indirect benefits.

Whilst data connectivity is a real challenge for MaaS, it could also be an opportunity. Where connectivity needs improving in rural areas and 'notspots', a shared business case and shared investment could be a way forward to deliver value for money and shared benefits.

Linking MaaS schemes to housing development can enhance policy effectiveness not just in cities but in rural settings as well, such as supporting active travel, shared travel and taxi use. Through linking MaaS and housing development to shared investment in infrastructure, connectivity or subsidies could deliver better value for money for all.

The opportunity arises for the plethora of primary and secondary MaaS stakeholders to share valuable data sets and insight, opening up other possibilities through better understanding of how transport networks operate, how user behaviour changes, and information dissemination.

Autonomous vehicles could be an important component of MaaS solutions, particularly for specific user groups, such as the elderly or those with disabilities. Another group who could benefit are service providers; for example, targeted education and health services such as 'the school run' or 'a medical appointment' could form part of a MaaS subscription.

The challenges

The challenges faced by MaaS introduction are not insignificant but must be worked through to fulfil its potential. The current commercial models that involve one or more of subsidies, competitive contracting, different contract cycles and inappropriate risk allocation drive unhelpful behaviours, siloed services and a protectionist position - all resulting in challenging and lower financial returns. Many public transport operators do not have the necessary authority, control or commercial appetite to join services and remove barriers. This is where government and local authority intervention is seen as essential to not only encourage an entrepreneurial approach to transport provision but also to make underlying infrastructure available for MaaS providers and transport operators alike.

MaaS is a digital-based service that provides transport to users and is intended to be inclusive to all. However, in its present form it requires digitally literate users, which would therefore exclude groups of the populations, such as those that are digitally challenged or do not want to be part of the digital majority. MaaS must find a way to overcome this challenge.

Data quality, reliability, security and discoverability are a pre-requisite for seamless travel and provision of rich, informative and accurate information on transport scheduling, service interruptions, pricing information and choices. Unlocking and making available hidden data to support MaaS is problematic and an expensive investment prior to MaaS operation. Whilst legislation for data privacy is seen as onerous it does provide a required level of protection to personal users.

There is a perception in some quarters that MaaS and car ownership are competing; there are many facets and views in this scenario with no overall winner. For the foreseeable future, MaaS should be seen to be complementary to car ownership and also be inclusive of the emerging autonomous vehicle - these should all co-exist to satisfy an individual's needs and desires.

If the issues touched upon in this report can be tackled, MaaS could provide the solution transport leaders are looking for to deliver technology-enabled efficient mobility services to all.

3. Introduction

The transport industry around the world is facing a number of economic, social and environmental challenges at the local, regional and national levels. These include dealing with the impact of traffic congestion and associated costs, and addressing the needs of growing and ageing populations, increased urbanisation, reduced funding and the need to meet sustainable targets.

Mobility as a Service (MaaS) is a relatively new concept in the transport industry that is receiving significant interest from both the public and private sectors given its potential to address some of the challenges faced. However, MaaS as a concept is currently associated with ambiguity in terms of its definition and what does and does not qualify as a MaaS offering. Furthermore, there are different perceptions in the transport industry in relation to the feasibility of delivering MaaS and its associated benefits.

In this document, we define MaaS as **the provision of an end-to-end customer experience that delivers multimodal transport choices through a seamless and integrated planning, payment and ticketing interface.** This definition aligns with the MaaS Alliance[1] and MaaSLab[2] definitions in terms of providing integration of multiple mobility and transport services into a single service. Although the definition in this document requires a single interface for MaaS, such an interface does not have to be "digital" unlike with other existing definitions [3-4] .

MaaS has been enabled by a number of technology revolutions in data, connectivity, and electronic payments; changes in the way services are developed (the Application Program Interfaces (API) economy); the shift towards a customer-oriented approach to services (e.g. the importance of customer feedback and user ratings); and a move away from the ownership model (the "as a Service" paradigm). An impactful MaaS system needs to rely on a strong and reliable underlying transport and digital infrastructure.

The components of a MaaS system are defined in this document and categorised into three types of offerings (Core, Advanced and Integrated) that are expected to be delivered through an evolutionary path organically expanding across three dimensions:

- **Geographical** - The coverage areas of MaaS
- **Transport** - The transport modes included in the MaaS offering
- **Service** - The nature of the offered service (journey planning, real-time multi-modal information, integrated single payment, journey experience)

The majority of the past and ongoing MaaS pilots and trials have demonstrated its operability at least from the technical perspective. These trials have also delivered some evidence regarding the benefits of MaaS in relation to: (1) addressing some governmental and societal transport challenges through MaaS ability to encourage using public and shared transport modes; (2) improving public transport revenue by increasing ridership; (3) improving customer experience by providing a one-stop shop for travellers to access all their mobility needs. However, the wide deployment of MaaS is faced with a number of challenges which can be broadly categorised into Technology/infrastructure, Regulations, Users and Business aspects. The potential benefits, challenges and unintended consequences are discussed in Section 7.

A set of ten use cases are presented in this document from around the world, representing different stages within the MaaS evolution path either providing different levels or parts of the service dimension, including a range of transport modes and covering different geographical areas. The aim of providing these use cases is to demonstrate the ability to deliver MaaS solutions today, provide demonstrated benefits, and discuss the barriers faced in delivering these solutions and how they have been overcome.

1 http://maas-alliance.eu/homepage/what-is-maas/
2 Kamargianni, M., Matyas, M., Li, W., Muscat, J., Yfantis, L., 2018. The MaaS Dictionary. MaaSLab, Energy Institute, University College London. Available at: www.maaslab.org
3 https://pdfs.semanticscholar.org/27d8/213e56930d86b1f1583a317a760c19dd3402.pdf
4 https://ts.catapult.org.uk/wp-content/uploads/2016/08/Mobility-as-a-Service_Exploring-the-Opportunity-for-MaaS-in-the-UK-Download.pdf

4. Implementation scenarios

Organisations — both public and private — are beginning to develop approaches to mobility provision based on the concept of MaaS. This exploration is leading to a diverse range of partial and full offerings, and there are many ways of delivering new models and forms of transport. This section aims to further explore MaaS by introducing some of the potential implications of various implementation scenarios.

Figure 1 summarises how MaaS might play out across the two dimensions of Urban/Rural and Public-led/Private-led. It should of course be noted that MaaS is in its infancy, with relatively little evidence of impact to draw upon, and so these scenarios are provided merely as a means of exploring the concept of MaaS further.

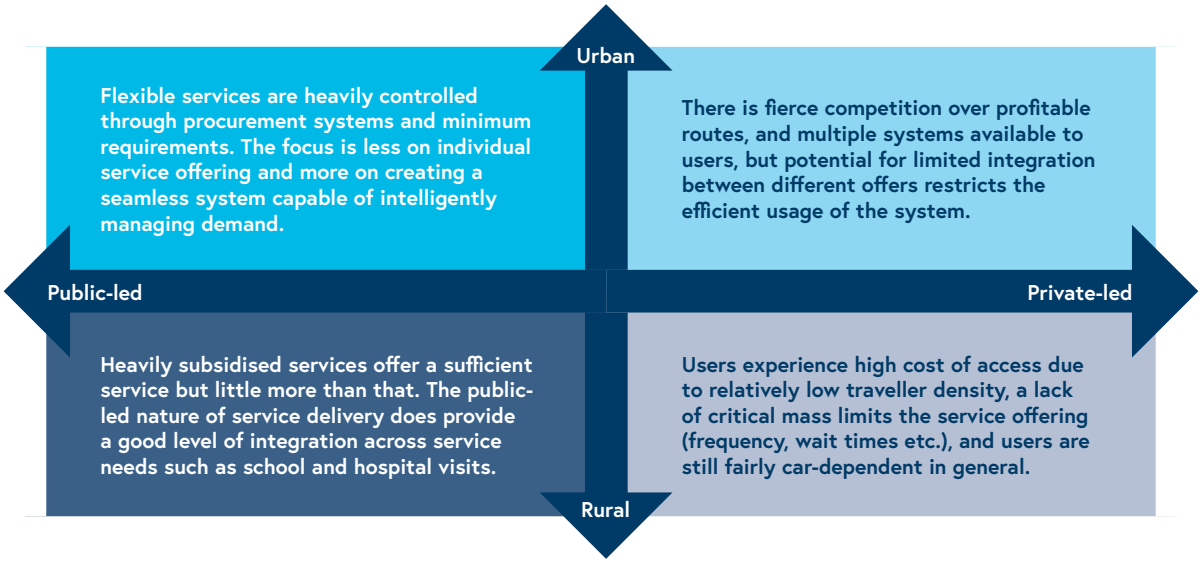


Figure 1: MaaS Implementation Scenarios

Axes Descriptions:

- **Public-led:** Public procurement and/or government regulation drive the creation of MaaS offerings, reflecting public bodies' need to manage economic, social, health and environmental impacts.
- **Private-led:** Private companies are the primary driver for MaaS offerings, requiring MaaS providers to form partnerships and alliances directly with transport providers. The drive is to maximise the revenue potential of the system.
- **Urban:** High demand density allows for a wide variety of commercially-viable services, including personal transport and mass transit systems. Ease of modal interchange is a key focus for those with system efficiency in mind.
- **Rural:** Lower demand density limits the availability of services available to the end user. There is greater focus on flexible, individual transport, such as next-generation car-share services.

Much of the emergence of MaaS to date has focused, not surprisingly, on areas of dense population demand and transport supply such as large cities. There is, however, growing interest and experimentation in how MaaS offerings could meet the needs of populations who are currently not well served by public transport and consequently have a high car dependency, such as those living in rural or peri-urban areas. As some recent service closures have shown, creating commercially-viable businesses that aggregate demand outside of densely populated areas is challenging.

The concept of MaaS promises much to the public sector: reduced emissions and congestion; more citizens with met needs; increased use of publicly funded or subsidised services; the opportunity to optimise the flow of people, goods and vehicles through cities and regions and enhancing land-use planning. A public-led MaaS implementation therefore presents a potentially transformative approach to meeting socio-economic and environmental policy goals. Whether it can deliver significant impact on all of these is yet to be seen.

Innovators are embracing the opportunities that digitalisation and 'as a Service' models can bring, and many new private players are entering the transport ecosystem. To compete with or complement existing services (e.g. by extending the reach of more traditional, fixed-route public transport services) and to be commercially viable, they are often tapping into society's growing needs around personalisation, immediacy and convenience. This is encouraging all players to think harder about their consumer offering, ultimately representing a significant step forward in positioning travellers at the heart of the transport system.

A set of four potential users are presented here along with a description of how MaaS can satisfy their different needs. Each user is colour coded to show where they would fit on the diagram in **Figure 1**.

A day in the life of...

An overseas traveller

Ellie is a 29-year-old data scientist working for a robotics start-up. Most of her trips involve commuting into the city for work, but she and her partner like to take regular breaks to foreign destinations. Ellie likes to feel she has got the best deal for her money.

Ellie and her partner are taking a short city break in Europe. Ellie has researched her travel options and worked out that the best deal from the airport to their hotel involves paying for the train and bus via the region's public MaaS provider. The app has provided her with all the information she needed to help her plan her journey. However, her train from the airport is delayed, meaning she will miss the last bus of the day. The MaaS provider sends her a notification that proposes getting off at an earlier stop and catching a different bus. She accepts this change and is automatically reimbursed for the cost difference.

A student

Nicholas is a 27-year-old PhD student at a city university. His primary driver of travel mode choice is cost and he's willing to wait a bit longer or take a more crowded route if it means saving a few pounds.

Nicholas hires a pay-as-you-go e-bike to get to university via the city's mobility app. On the way, he picks up and delivers a package so that he can earn some extra cash. He leaves his bike at the campus transport hub, where he meets his friends arriving by bike and autonomous shuttle. After class he gets to his part-time job at a shop by using his mobility app to find and purchase a ticket for the train and bus. At the end of his shift he shares an on-demand taxi with a colleague to get home, with the app automatically splitting the fare.

A commuter

Lovisa is a 45-year-old working for an online retailer in stock control. Lovisa cares about her impact on the environment and, with three children, is cost-conscious. Her place of work is located on the outskirts of a city and she lives in a rural location close to one of the surrounding villages. As the business she works for has grown, it has become increasingly difficult for Lovisa to find a car parking space in the morning.

Lovisa's day starts with getting her teenage children ready for school. Today she needs to be at work early for a meeting, and so last night she arranged a lift through the parent and carers car club. Lovisa subscribes to her company's MaaS provider and she orders a lift share to get to work. In the afternoon, she uses the MaaS provider to take an on-demand bus service home, but gets out three stops early so that she can earn some credits by walking the remainder of the journey.

A pensioner

Tom is a 70-year-old keen gardener who moved to the countryside when he retired from banking. Despite not working Tom sometimes has quite strict timings he needs to stick to, such as getting to medical appointments for his cancer treatment. He is willing to wait for services as long as he can reliably plan them into his day, and is happy to pay a premium to get the service he wants. Tom recently sold his car and now has an account with a private MaaS provider, whereby he pays a monthly subscription for a fixed mobility package.

In the morning, Tom receives a text notification from his local hospital reminding him of both his appointment time and when he can expect the on-demand transport service to arrive. After his appointment, Tom uses his phone to access his mobility account, from where he books a family-sized car with connectivity and video screens. His grandchildren are visiting for a few days and he is keen to treat them to some days out.

The MaaS user stories highlight some of the potential uses of MaaS and its ability to bring multiple transport modes under one offering to satisfy user needs, as well as introduce a number of social and environmental benefits. However, the delivery of MaaS is also associated with different challenges and could lead to unintended consequences as discussed in Section 7.

5. Components and value chain

Components of the MaaS system

The components of MaaS as a system are outlined in **Figure 2** below, and are based on the MaaS definition outlined in this document. The MaaS components are categorised into Core, Advanced and Integrated MaaS offerings, reflecting a MaaS evolutionary path.

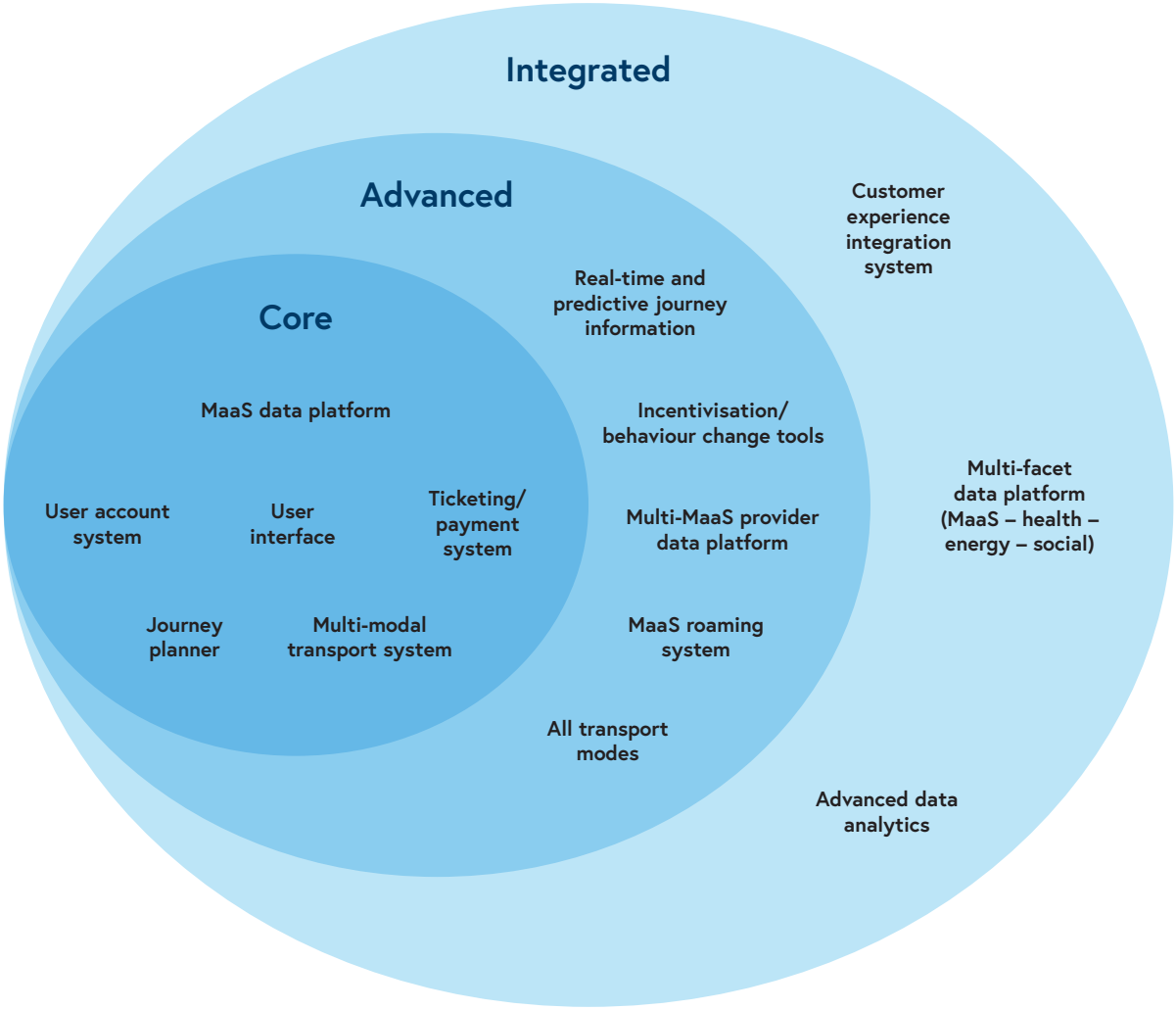


Figure 2: Components of the MaaS system

The Core MaaS components represent the essential elements required to provide a basic MaaS offering. The Advanced MaaS set of components lead to a comprehensive mobility offering, added services such as multi-region and multi-provider offerings, and advanced journey information tools. The Integrated MaaS offering goes beyond the transport system, aiming to integrate with other sectors (e.g. Health, Energy, Retail) to offer a holistic customer experience.

	MaaS Component	Description
Core	**MaaS data platform**	Data is a key enabler for MaaS. The platform is the underlying infrastructure required to aggregate and process multi-sourced data about the transport system (vehicles and infrastructure) and users.
	User account system	Handles MaaS users' information, preferences, usage and subscription options.
	Multi-modal transport system	The essential element of MaaS and refers to the transport modes offered, which can include public transport, taxis, car hire, etc.
	Ticketing/payment system	Includes the various methods used for paying for transport through MaaS, whether it is paper-based, through a smart card or contactless payment, or other payment systems.
	Journey planner	Supports MaaS users in identifying/optimising the travel mode, route and travel time, which can be optimised according to user preference (travel time, cost, special requirements, etc.).
	User interface	The customer-facing component of the MaaS system. This can be through a web-based or app-based digital interface or through a basic phone-operated service.
Advanced	**Real-time and predictive journey information**	An advanced version of the Journey Planner component and enables the provision of real-time transport information, as well as a predictive element providing near-future predictions about a journey. This is to support MaaS users to make in-journey decisions regarding mode, route and even the need to continue with a journey.
	All transport modes	Advanced MaaS aims to provide all the possible transport modes under its offering, including active transport.
	Incentivisation/ behaviour change tools	Aims to drive certain travel behaviour to achieve specific business or social objectives.
	MaaS roaming system	Akin to mobile communications systems, this component aims to enable MaaS customers to use their account to access mobility services from other providers and in different regions.
	Multi-MaaS provider data platform	This is an advanced version of the MaaS data platform component enabling MaaS providers to share data, including users' account information, to support additional services such as MaaS roaming.
Integrated	**Multi-facet data platform**	The integrated version the MaaS data platform component, which supports the aggregation of data from different sectors beyond transport.
	Advanced data analytics	Aims to develop more insights from the multi-sector data in order to deliver the objectives of the customer experience integration system.
	Customer experience integration system	Takes the customer experience focus from the transport journey and observes a wider context (e.g. why customers make the journey in the first place) and aims to support an integrated life experience as opposed to only a journey experience.

The MaaS value chain and stakeholders

The MaaS ecosystem covers a wide range of stakeholders[5] depending on the extent of the MaaS system and its maturity level (Core – Advanced – Integrated). MaaS stakeholders are categorised here into three tiers depending on the maturity of the MaaS system.

1st tier MaaS stakeholders

Essential for running a core MaaS system

- **MaaS operator:** Owns and provides the MaaS service and the customer interface. The operator is the new player in the transport market and integrates the offerings/services of the supply side and offers these as MaaS products to the demand side through a single interface.
- **MaaS customers:** Key players in the ecosystem. Based on the business model of the MaaS provider (Business to Customers, Business to Business, or Business to Business and Customers) the customers could be individuals, companies or both. MaaS customers could also cover freight in addition to passengers.
- **Transport service providers and operators:** One of the main suppliers in the ecosystem, providing capacity to the MaaS operator.
- **Digital infrastructure and service providers:** Could act as suppliers for the MaaS operator as well as to the transport service providers. Such infrastructure and services include the data platform, the ticketing/payment processing system, the user interface and account systems, as well as the journey planning service.

2nd tier MaaS stakeholders

Support the provision of the Advanced MaaS offering and help expand the geographic and service dimension

- **Mobility data providers:** Include road operators and mobile phone data providers as examples. As the MaaS concept relies heavily on the availability of interoperable data availability, the role of the data provider is of critical importance.
- **Data analytics providers:** Offer their capabilities to the MaaS provider and possibly to others in the ecosystem. They process, repackage and make the data available in interoperable formats. Most importantly, they could provide insights on the mobility system and MaaS users, as well as prediction information at different timeframes.
- **Other MaaS operators:** Could integrate their services across different geographies and service options (employer-based with personal-based services). Such stakeholders are essential when considering wider service provision (e.g. MaaS roaming).
- **Regulators and policymakers:** Could provide policy frameworks and recommendations for the sustainable development of the MaaS market, fair competition, financing, passenger rights, data openness and sharing, privacy and security, service quality standards, social inclusion and safety. It is assumed that the development of the MaaS market would be similar to the telecommunication market (i.e. global standards for GSM networks – global roaming). National policy frameworks should avoid different open standards across different regions that will hinder interoperability.
- **Investors:** Include both private investors, but also public funds that are currently used for public transport subsidies. This is especially given the potential financial opportunities predicted from providing a MaaS service.

3rd tier stakeholders

Take the service offering beyond transport/mobility to deliver a wider and integrated customer-oriented service and support the delivery of city/regional objectives

- **Health service providers:** Could deliver some of their objectives (e.g. active transport) through MaaS behaviour-changing tools and possibly integrate some of their data to improve mobility services to patients.
- **Retailers:** Could offer MaaS to their customers as part of integrated packages (e.g. unlimited grocery delivery as part of a MaaS package) and link MaaS rewards and behaviour change incentives to loyalty cards.
- **Smart city service providers:** Provide a wide range of services where mobility/transport plays a major role, and where a more integrated multi-sector offering is required.
- **Local and regional planners:** Could make use of and support the delivery of an integrated MaaS offering through land-use planning. This group includes housing planners, developers, and providers given the strong link between housing schemes and mobility with the current emphasis on sustainability.
- **Others:** Include a wide range of stakeholders who benefit and/or contribute to the MaaS ecosystem. These include insurance companies, local and national governmental organisations, universities and research institutes, and transport provider unions.

5 Kamargianni, M., and M. Matyas 2017. The Business Ecosystem of Mobility as a Service. Presented at the 96th Transportation Research Board Annual Meeting, Washington DC, 8-12 January 2017. Available at: https://docs.wixstatic.com/ugd/16813a_d0a82eecee84408c84e4a919b987396e.pdf

6. Development roadmap

The deployment and wide adoption of MaaS is reliant on a number of aspects relating to changes in data and technology systems; transport systems; social, environmental, and economic aspects impacting travel behaviour; as well as changes in governmental policies and legislations. This section evaluates such potential changes at a high level and provides a MaaS development roadmap that takes into account the anticipated changes in these areas.

Data and technology systems

Numerous advances are witnessed in the relevant fields of communications systems; data aggregation, processing and analysis; and ticketing and payments systems. The development and pervasiveness of mobile communications has changed the way we communicate, and with the arrival of the fifth generation (5G) mobile communications, we expect the rising use of the Internet of Things (IoT) and the support of vehicle connectivity and their associated applications. 5G is bringing advances in relation to higher speed, greater capacity/bandwidth; and support for device-to-device communications[6-7]. According to the European Commission 5G Action Plan[8], 5G implementation in major cities will start in 2019/20 with full coverage of major roads and train stations in Europe by 2025.

The advances in sensing, communications and computing technology has led to the generation of massive amounts of data, which attracted significant investments in data platforms and data processing systems. Machine learning and artificial intelligence will disrupt many industries and have significant impact on the economy and society. However, currently there is no general consensus on the nature and timeline of such disruptions[9].

Ticketing and payment systems are also being revolutionised through a number of technologies including contactless, mobile phone (e.g. Apple Pay and Android Pay) payments and the advent of blockchain[10]. Applications of blockchain have already been seen in the transport sector[11], including in logistics and flight and freight tracking, and this has the potential to support the implementation and adoption of MaaS.

Transport systems

The transport system is witnessing rapid advances in vehicular technology (with the advent of autonomous, electric, and connected vehicles) and the emergence of new transport modes such as ride hailing apps, electric scooters, drones, flying taxis, dock-less bikes, and the different forms of demand-responsive transport.

In terms of vehicular technology, it is expected that about 25% of traffic will constitute autonomous vehicles (AVs) by 2030, growing to around 75% by 2040[12]. Connected vehicles (CVs) are expected to have a wider and faster adoption rate compared to AVs. On the other hand, there are high levels of uncertainties in relation to the emerging new mobility modes, especially in terms of their financial sustainability as opposed to their technology soundness.

Social trends

There are a number of changes in social trends which are having an impact on the current transport market. An example is the move away from the ownership model for mobility among the young generation towards the shared mobility model[13]. This is witnessed in the UK and the US[14], as an example, by the decline and stagnation of the number of young adults applying for and obtaining full driving licenses[15]. Furthermore, there is currently more general awareness of the transport environmental impact and people are making more conscious decisions relating to their activities and their impact on the environment (emissions and air quality). Aspects relating to the population demography and land-use trends have a significant impact on the mobility needs.

Policies and legislations

Regional, national and local policies and legislations can have direct/indirect impact on the transport industry. While the main objectives of such policies are to deliver economic, social and environmental benefits, they can have a limiting impact on the operation and/or financial sustainability of the transport sector.

Aspect	Potential impact on MaaS	Comments
Data and technology systems	**High**	Technology developments will have a highly positive impact on MaaS deployment and adoption. Improvements in connectivity and data analytics will support a reliable MaaS offering and enable the delivery of 'intelligent' user-centric services. Developments in ticketing systems will allow a more integrated MaaS offering. Current familiarity with surge and real-time charging for air travel will facilitate public acceptance.
Transport systems	**Medium**	Advances in vehicular technologies (e.g. AVs and CVs) will enable better integration between transport modes (mass-transit with first-last mile solutions). The introduction of new transport modes will increase the MaaS options and offerings. However, the appearance and disappearance of such modes will not have a significant impact on MaaS as an integrated offering as, in most cases, there will likely be enough options to conveniently get customers from origin to destination.
Social trends	**High**	One of the potential benefits of MaaS is the reduction of vehicle ownership, which could then result in decreasing single-occupancy trips. This is attributed to changes in social trends such as the geographical dispersal of three-generational families and the move towards a service-oriented society. Future changes to such trends are likely to have a high impact on MaaS adoption. In terms of the demographics, and as the population ages, there will be a reluctance to drive or own individual cars and MaaS options, including AVs, will be increasingly attractive. In terms of land use, MaaS works best in dense urban areas, but the growth in recent planning permissions for housing and industrial development in suburban and rural areas will be hard to fit with the current MaaS business models.
Policies and legislations	**High**	Policies and legislations relating to technology, data sharing and use, promotions of specific behaviours, transport ticketing and transport operational models will have a significant impact on the level of MaaS adoption and overall success.

Table 1 assesses, at a very high level, the potential impact of the above aspects on the implementation and adoption of MaaS.

6 https://5g.co.uk/guides/what-is-5g/
7 https://link.springer.com/article/10.1007/s11036-017-0828-7
8 http://www.europarl.europa.eu/legislative-train/theme-connected-digital-single-market/file-5g-action-plan
9 Architects of Intelligence: The truth about AI from the people building it. A book by Martin Ford
10 Blockchain is a decentralised database that maintains a continuously growing ledger of digital transactions. A blockchain processes transactions on its database in a similar way to entries in a physical ledger, assembled into small groups, called blocks, like new pages in a physical ledge. New blocks are linked to older ones, forming a chain, hence the term blockchain.
11 https://blockchain-x.eu/wp-content/uploads/2018/02/flightchain-whitepaper.pdf
12 https://arup.sharepoint.com/teams/as-knowledge-base-greater-china/Knowledge%20Base/Autonomous,%20connected,%20electric%20and%20shared%20vehicles%20Reimagining%20transport%20to%20drive%20economic%20growth.pdf#search=connected%20shared%20transport
13 http://www.theitc.org.uk/wp-content/uploads/2015/07/ITC-ORR-Road-Rail-Attitudinal-Report-Final.pdf
14 https://www.ncbi.nlm.nih.gov/pubmed/24279960
15 https://www.racfoundation.org/research/mobility/young-adult-drivers-berrington-report

Figure 3 provides a high-level MaaS development roadmap for the 2020-2035 period, looking at the evolution of MaaS from Core to Advanced to Integrated offerings according to the definitions in Section 5. This roadmap is informed by the relevant aspects discussed above. It is important to note that technological, social and regulatory changes will have an impact on the MaaS evolution and the defined timeline in Figure 3. There are possible MaaS futures[18] with different optimism levels, which can result in variable timelines compared to Figure 3.

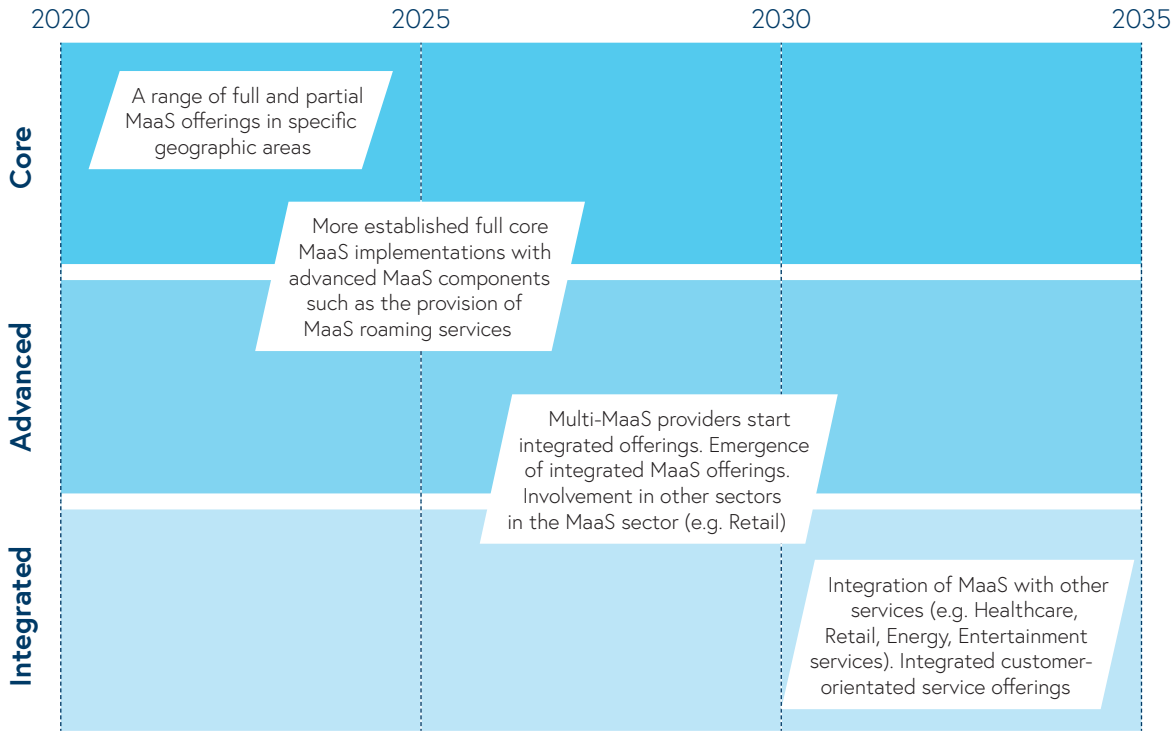


Figure 3: Potential High-level MaaS development time line

16 http://www.socresonline.org.uk/8/2/brannen.html
17 http://www.futurespacesfoundation.org/wp-content/uploads/2016/04/Vital-Cities-not-Garden-Cities-FSF-dps.pdf
18 UK Goverment Office for Science, A time of unprecedented change in the transport system - A time of unprecedented change in the transport systemThe Future of Mobility; January 2019. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/780868/future_of_mobility_final.pdf

7. Benefits, unintended consequences and challenges

MaaS has the potential to bring a wide range of benefits to the different members of its value chain. While there is strong focus in recent MaaS publications on the potential benefits, this section will also look into the possible unintended consequences of MaaS, as well as associated challenges.

Benefits

There is a strong body of literature about the potential benefits of MaaS, which is drawn from research, surveys, and outcomes of MaaS trials [19-20-21-22-23]. This subsection briefly discusses some of the MaaS potential benefits:

Improving the mobility experience of customers through:

- **The provision of a one-stop shop for travellers to access all their mobility needs**
- **The delivery of tailored transport services based on the customer needs (e.g. the provision of different types of hired vehicles to suit specific needs at specific times)**
- **Cost savings by potentially reducing the associated costs of owning a vehicle**
- **The provision of flexibility and more mobility choices**
- **Potentially enabling a defined mobility level of service that mitigates, to some extent, the impact of disruptions in the underlying infrastructure**

Enhancing the revenue for public transport providers through:

- **Increasing ridership by informing mobility users of public transport options and addressing the first and last mile challenges through integration with other transport modes**
- **Optimising public transport supply and improving its efficiency by better understanding the required demand through data capture and analysis**

Delivering economic, social and environmental benefits through:

- **Reduction of single-occupancy vehicle trips and encouraging the shift towards public, active and shared transport. This will effectively lead to a reduction in traffic congestion and its associated economic costs; improvement to air quality; reduction of road transport emissions; potential improvements to road safety; and potential release of road space**
- **Encouraging active transport within MaaS (e.g. through rewards/incentives) will lead to public health improvements**
- **Delivering mobility services tailored to user needs and characteristics has the potential to improve the mobility of the disabled and ageing population**
- **A potentially profitable proposition for MaaS mobility aggregators and mobility data platform operators**

19 Kamargianni, M., Matyas, M., Li, W., and Muscat, J. 2018. Londoners' attitudes towards car-ownership and Mobility-as-a-Service: Impact assessment and opportunities that lie ahead. MaaSLab - UCL Energy Institute Report, Prepared for Transport for London. Available at: https://docs.wixstatic.com/ugd/a2135d_33f08862a08148389c89de1e908ac8a0.pdf

20 https://s3-eu-west-1.amazonaws.com/media.ts.catapult/wp-content/uploads/2016/07/17113431/3426_MaaS-Report-Reprint_Web-new-17-Nov.pdf

21 https://www.arup.com/perspectives/publications/research/section/maas-the-value-proposition

22 http://www.sciencedirect.com/science/article/pii/S2352146516302794

23 https://www.its-australia.com.au/maasreport/

Supporting innovation in the transport and technology sectors through:

- **Providing a platform for new and emerging mobility modes to be integrated with existing modes/services and part of the mobility ecosystem**
- **Enabling the delivery of data-driven services through the integration of multi-sourced data about the transport system and its users**
- **Enabling the integration of mobility services with other sectors (Health, Insurance, Retail, etc.) which will potentially lead to innovative services and business models**

Unintended consequences

Despite the range of potential benefits MaaS could bring, its offering and operating model could also lead to unintended consequences such as:

Limited shift towards public and shared transport, which could be due to:

- Travellers resisting change to their travel patterns
- The underlying transport services not being attractive enough to support mode shift

Increased congestion on the road network due to:

- Increased popularity of ride sharing leading to additional road trips and an undesired shift from public transport
- Availability of taxi and car hire options, especially in an inclusive subscription package, leading to more taxi and car trips

Malfunctioning MaaS system due to commercial competitiveness issues as a result of:

- Insight from the data leading to commercial competitiveness issues. Data might identify a viable business case for a new bus route, resulting in reduced revenue for the taxi and car rental operators in the MaaS ecosystem, as an example
- Sharing travellers' data collected through the MaaS app among the different transport providers, leading to strong competitions within the MaaS ecosystem. The data could also be used in manipulation and secret marketing

Challenges

There are many barriers that could be faced on the way towards the wide deployment of MaaS, which are categorised here into **Technology/infrastructure, Users, Regulations, and Business barriers.**

Technology/infrastructure barriers

Enabling infrastructure

MaaS is reliant on both transport and communications infrastructure, and while this may not be an issue in major cities, it is in other areas. Although 5G mobile communications is progressing, and with a huge potential to improve connectivity and mobility services, there are still areas with only 2G coverage and struggling to build a business case for 3G and 4G technologies. In terms of the transport infrastructure, while there is a number of upcoming and innovative mobility modes (shared, autonomous, connected and electric), basic public transport is failing in some areas to provide reliable and continuous services, driving potential passengers into private vehicles. Realising the wider benefits of MaaS and having a wider geographic coverage requires a strong and reliable underlying infrastructure.

Access to required data sources

Delivering an integrated multi-modal mobility service through MaaS requires access to multi-sourced data which can be locked, hidden or in non-usable format. While there are several public sector data sources available as open data, the provision of open data from the private sector can be more challenging. These issues need to be addressed at the governmental level by ensuring that required data is open or shared through policies and legislations; at the organisational level where transport providers implement the right systems and processes to ensure the collection and sharing of required mobility data while preserving privacy regulations; and at the technological level by defining standardised technology, common data standards, platforms and APIs.

Integrated ticketing and user accounts

Delivering a single user account and an integrated payment service requires the MaaS provider to have access to different ticketing/booking backend systems for the different transport modes offered as part of the package. Furthermore, there are potential tax implications in the case of having a single user account for personal and business travel. Similar to the data access case, the integrated ticketing challenge needs to be addressed at the governmental, organisational and technological levels in a similar manner.

Regulation barriers

Regulation in relation to subsidies

Subsidised public transport could result in MaaS providers also being subsidised, which can raise competition regulation issues. One of the potential solutions to this issue is changes to the regulations around subsidies. An example could be to subsidise journeys (e.g. public transport journeys) for individuals. This is different to subsidising a specific route. In other words, a move to a user subsidy from the current supplier subsidy.

Regulation in relation to data privacy/security

Current regulations (e.g. the EU General Data Protection Regulation) can be perceived as a barrier to the opening and sharing of data, especially from the private sector. There is a need to define and address these perceived issues, particularly in relation to aggregated and anonymised mobility data.

Procurement

Transport services in the local and national levels are currently procured in a specific mode/route approach which can be a procurement challenge in a MaaS context. Changes in regulations would be required to enable procurement of "as a Service" approaches to mobility.

MaaS will be reliant on good communications infrastructure, and 5G promises huge potential benefits. However, some areas are still struggling to implement 3G/4G technology

User-related barriers

Ability to change travellers' behaviour

One of the potential MaaS benefits is to reduce car use and ownership. This requires significant behaviour change, especially for car owners where it is expected there will be significant resistance. MaaS needs to satisfy the daily, weekly, and seasonal mobility needs for car owners. It is also considered important to introduce this behaviour change in a staged approach where MaaS starts by offering additional mobility services to owning a car rather than offering it as a car replacement service. It is also important to avoid 'car ownership versus MaaS' or similar 'black and white' categorisations[24].

Digital exclusion

Digital exclusion can be defined as "the inability to access online products or services or to use simple forms of digital technology," which disproportionately affects vulnerable people, low-income groups, the ageing population and the more marginalised communities in society. On one hand, MaaS has the potential to improve the mobility of vulnerable and older people through mobility services tailored to their needs and circumstances; on the other hand, if MaaS is delivered exclusively through a digital interface (e.g. smartphone apps, web-based service) it will prevent some people from accessing the service. There needs to be a way to overcome the latter situation, such as offering MaaS through a telephone operator/service.

Business-related barriers

Position of public transport providers

Public transport is one of the essential components of MaaS. However, public transport providers could be reluctant to offer their services under a MaaS provider due to:

1. **Failure to see the benefits that a MaaS provider can bring. MaaS benefits such as having wider audience and improved utilisation, access to users' data to improve services, and predictable income may appeal more to small providers**
2. **Potential change of their business model (e.g. from a Business-to-Customer to a Business-to-Business model) and the associated inherent resistance to change**
3. **Risk of losing their identity and brand, and direct relationship with their customers**
4. **MaaS provides an additional transport service layer that needs to be paid for, and with tight profit margins across transport operators this is not seen as attractive**

There is an important role for both national and local governments to address these issues through the procurement process and contracting arrangements.

Realising a financially sustainable business model

While MaaS is an appealing concept to travellers (having all mobility needs from one provider), it needs to be financially attractive in comparison to procuring services from different suppliers. This could lead to challenges associated with the building of a financially sustainable business model for the MaaS operator that can provide competitive pricing while also supporting a defined level of service (e.g. in the case of transport service disruptions).

24 http://www.vtt.fi/sites/maasifie/PublishingImages/results/cedr_mobility_MAASiFiE_deliverable_2_revised_final.pdf

8. Use cases

MaaS is an emerging landscape and its deployment and wide adoption is expected to go through an evolutionary path over three dimensions (geographies, transport modes and service levels) as discussed in Section 5. A set of ten use cases are provided here to highlight some of the current MaaS developments around the world, as well as some of the benefits and deployment challenges faced by the use case providers in their own words.

The use cases provide either a single component of MaaS, multiple components or a full core MaaS offering, and are provided by organisations from across the MaaS value chain including MaaS providers, data platform providers, transport ticketing and user account technology and service providers, transport information service providers, national transport authorities, transport demand and service optimisation providers, and transport and technology consultancy organisations. The use cases include solutions currently deployed in countries such as Australia, Finland, France, Georgia, Germany, Italy, New Zealand, Spain, the UK and the USA.

The benefits reported in the use cases were mainly around the ability of the provided solutions (either full or partial MaaS) to drive a shift from single-occupancy vehicles to more public or shared transport modes. Some use cases also reported benefits in relation to:

- Cost savings for transport operators (through optimised service and increased ridership)
- Improved perception of public transport
- Improved decision making for transport operators and travellers through data
- Improved customer experience and mobility choices

A number of challenges and barriers were reported by the use case providers through their experience, including:

- MaaS providers' access to ticketing and booking engines of transport service providers and the lack of an agreed standard interface of ticketing
- The need to develop bespoke partnerships and commercial agreements with different transport service providers in different cities
- Different levels of understanding of open data principles, data ownership, sharing of competitive/business data, and processing and gaining insight from the data
- The need for the MaaS provider to support a robust and responsive service to disruptions in the underlying infrastructure
- Building an appropriate pricing structure and payment plan that is offering value-for-money to MaaS users and also ensures transport service providers get a fair revenue share
- Inclusiveness for the non-tech affine population, which is addressed by some use case providers through the introduction of mobility call centres
- Mobile communication coverage, which is addressed in some use cases by enabling the relevant application to work offline where possible

8.1 Atkins

Background

Transport for Greater Manchester (TfGM) and SNC-Lavalin's Atkins business worked in collaboration with 13 other partners (including local authorities, transport operators, service providers, local residents, businesses and communities) to investigate whether Mobility as a Service (MaaS) could improve the future of mobility in Greater Manchester (GM). This led to first-of-its-kind trials taking place with a definition and model of a MaaS system specific to GM being created, which would allow us to test and explore its desirability, feasibility and viability. This model was tested by a practical trial in early 2018, which provided deep insights from passengers, commuters and residents on whether MaaS could satisfy their current and future transport needs of integrated and seamless transport. The work also involved building a commercial and financial model enabling MaaS in Greater Manchester and ensuring all stakeholders benefit from MaaS with increased revenues, increased patronage, improved asset utilisation and increased reputation. With the continuous development of the case for MaaS in GM, TfGM are now well positioned to continue with more complex and ambitious plans to further transform mobility across GM.

First use of technology

Rather than invest in an expensive or unwanted technological solution, the starting point of the project was getting to know the customer. Residents were invited to take part in gathering insights on current travel patterns and how they could potentially benefit from MaaS. 230 people signed up to take part in the study with 39 participants taking part in the live trial.

A central control room was set up and managed by a team from TfGM and Atkins, which was the 'go-to' point for personalised journey management, live updates and disruption re-routing for passengers taking part in the trial. Immersive research, involving in-depth interviews with passengers, provided insights into the key issues being faced on day-to-day travel. Based on this information, along with the needs, wants, location and characteristics of passengers, two personas, to represent different user types, were selected. Personalised journey plans based on individual participant profiles were provided covering seven modes of travel including: buses, trams, carshare, taxi, bike share, on-demand shared transport and walking. All these were available to participants through a single ticketing option and real-time travel updates were provided along with re-routing during travel disruptions.

Extensive stakeholder engagement was conducted with transport operators, local councils, third party companies and other relevant stakeholders who would play a critical role in MaaS delivery in Greater Manchester. This has helped to identify barriers and drivers which ensured the MaaS scheme development was inclusive to everyone.

Application of technology

The project attracted high interest, especially considering the short organisational timeframe. Incentives, including a free travel pass and a personalised travel planner offered to participants proved popular. Over a four-week period, 626 personalised journeys were delivered, linking six modes of transport including buses, trams, car clubs, taxis, bikeshares and walking. A single-ticket approach was deployed, and 110 real-time updates were sent, helping to plan and re-route journeys. 14 participants were re-routed when there were disruptions on the route they were travelling on.

Based on the personal profile preference, the participants were 'nudged' to change their travel behaviour by trying out new modes of travel. A total of 40 behavioural 'nudges' were sent, of which 11 were accepted by the participants.

Benefits

The trial was a great success with a number of benefits including:

- 73% of the journeys provided during the proof of concept were multi-modal (i.e. included the participants travelling on more than one mode for their commute).
- 21% of participants were more willing to use active travel modes of cycling and walking after taking part in the study. During a re-engagement with the participants six months after the trial, c. 20% of participants have started using active travel modes for their commute.

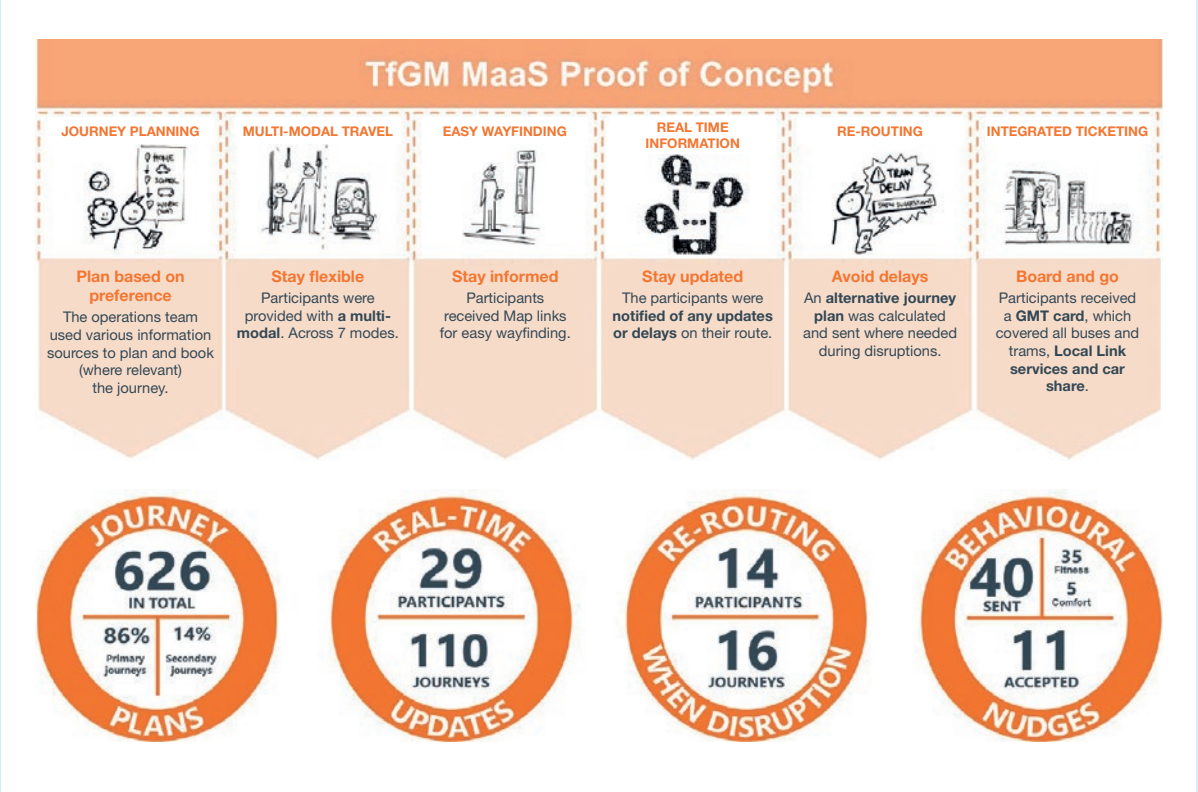
- 26% of the participants were more willing to use public transport modes, indicating that MaaS has the potential to shift travel behaviours to more sustainable modes, which could help address the challenges faced by most of the urban city areas in the country.
- A 27% positive increase in user perception of public transport by providing them with multi-modal travel, an integrated ticket for their journey and real-time information throughout their journey. This again shows the potential MaaS has in changing perception towards public transport modes and increasing patronage.
- A mini MaaS ecosystem has been developed in Greater Manchester including transport operators, technology companies, local businesses and local districts.
- The early development of a MaaS commercial and financial model for Greater Manchester, identifying the role of each stakeholder in the MaaS ecosystem and the value flows from one party to another.

Relation to a MaaS ecosystem

The proof of concept was an early intervention to understand the user behaviour and perception towards MaaS. The aim was to bring together a number of stakeholders, namely the local transport authority, transport operators, technology companies and local councils to start building a MaaS solution specific to Greater Manchester needs. The knowledge gained from the proof of concept supported the commercial ecosystem for MaaS unique to Greater Manchester's characteristics, ensuring maximum benefit for the region.

Barriers/challenges/lessons learnt

- The multiple sign-up processes for users to use different modes such as carshare, car hire, taxi etc. can be lengthy and needs to be transformed into a seamless experience for effective MaaS deployment.
- Contractual agreements and data sharing agreements are a barrier to providing real-time information and gathering insights.
- Ease of usage and communication between the participants and trial operations team was key to the success of the trial. This needs to be considered during the development of a MaaS scheme.
- The trials were free for the participants, but extensive research needs to be done to build an appropriate pricing structure and payment plan for the MaaS scheme as transport users are highly price sensitive, especially if they are going to be 'nudged' to decrease private car usage.
- Enabling multiple operators to work and provide services on a single platform and agreeing commercial agreements is a big challenge.
- MaaS requires individually-priced services to be bundled into a single offering, but at the same time offering value for money for the customers. Revenue sharing agreements are required to ensure each operator gets a fair share of the user-generated revenue.



8.2 Conduent

Background

The purpose of the Conduent Seamless Transportation System is to provide an efficient and affordable mobility service to travellers using a smartphone. Furthermore, it puts users at the heart of the transport network, offering tailor-made travel services influenced by preferences. Based on the Mobility-as-a-Service (MaaS) model, public transport operators can now offer their customers the convenience of paying for multi-modal, end-to-end travel via smartphone. After becoming Conduent clients, operators simply install dual-technology (Near-Field Communication (NFC)/Bluetooth Low Energy (BLE)) tags on their network. Seamless comprises a payment service and a back-office processing platform.

It provides a fully managed account-based, post-pay payment system. Billing is processed automatically at the end of the month, based on the trips completed on the participating modes of transport. Customers are billed by direct debit or credit card payment. Passengers no longer need to buy tickets in advance or wait in queues at counters or ticket vending machines.

First use of technology

Seamless' first commercial implementation began in September 2017 in Valence, France. It permits use of the city's 147-bus network. It has been followed by a second implementation in the city of Saint Malo, France. It is available for use with Bluetooth-enabled Apple iPhones. It is compatible with all mobile phone operators.

Application of technology

The traveller downloads the Seamless app onto their NFC or BLE-enabled smartphone and registers with Seamless to activate their account. Customers use the service by presenting the mobile phone to a Seamless tag affixed near the entrance of the transport mode (bus entry, access control gate, etc.). Travellers simply tap their smartphone on any Seamless tag. During the tap the tag creates and stores an encrypted transaction and relays it to the smartphone. Constant network connection is not required – transactions are sent to the Seamless server once the traveller's phone is connected to the network.

Conduent's Mobility Companion app can also be downloaded, offering travellers door-to-door trip planning. The app collects data and analytical insights that help transportation planners understand their city flow as well as citizens' mobility needs.

Benefits

- It is universal. Seamless is designed independently of SIM cards and is compatible with all mobile phone operators (in fact a SIM is not even required, so any smart device can be utilised – provided the user logs on to the Internet periodically to upload any taps to the Seamless back-office). Wherever the Seamless service operates the user can tap their phone, knowing that they will only pay the prevailing fare wherever they are travelling, without needing to understand the nuances of the local transit-payment market.

For public transport operators:

- Financial risk reduction. The implementation of an account-based method decreases the amounts of cash handled by operators.
- The operator (or transit authority) can upload their specific fare regime(s) in a wide variety of profiles, including capping and best price, as well as special fares for senior citizens, the disabled, children and students.
- The multi-operator/multi-modal environment is easily serviced, with each operator's data remaining private to them.
- Increased customer usage, and therefore, revenues.
- Lower capital costs. Installing Seamless dual-technology tags is less expensive than the infrastructure investments required when modernising a ticketing system.

For passengers:

- Data security. Data remains encrypted throughout the transaction process, and the process does not require customers to share personal information.
- Itinerary planning through Conduent's Mobility Companion app.

Relation to a MaaS ecosystem

Seamless provides a full MaaS solution, as it is multi-modal and capable of enabling end-to-end transport. All forms of transport, including car and bicycle sharing, can be integrated into the system.

8.3 Cubic

Background

Cubic Transportation Systems, a leading integrator of payment and information solutions for intelligent travel applications, has been involved in traffic management in Sydney since 1997, when the company developed and deployed its Incident Management System technology to manage traffic conditions for the Sydney 2000 Olympic and Paralympic Games.

Furthermore, working closely with Transport for New South Wales (TfNSW), the local transit authority, Cubic has been providing ongoing maintenance and operation support of Sydney Transport Management Centre (TMC), a central computer system for managing traffic throughout the New South Wales road network, since 2015.

In August 2018, Cubic won a contract to deliver its next-generation, fully multi-modal Transport Management Platform to TfNSW, with an aim of providing Sydney with one of the most advanced transport management systems in the world. The platform enhances monitoring and management of road networks, making it easier to coordinate the public transport network across all modes, improve the management of clearways, planning of major events and incident clearance times, while also providing real-time information and advice to the public about disruptions. The solution will be delivered by Cubic and its partners, including WSP, PTV Group, Mentz and Microsoft.

First use of technology

The platform will be delivered over a period of 18 months, through a phased transitioning of new and improved operational capability into the existing TMC, transforming it into a true multi-modal operation centre for addressing congestion, improving safety and increasing public transport usage across the entire New South Wales transport network.

The legacy system will then be decommissioned and a five-year support service will commence immediately after the first deployment goes live.

This is the first deployment in the world of Cubic's brand new multimodal transport management system and it will position Sydney as a global leader in this field.

Application of technology

Sydney has long struggled with congestion and traffic. Having recognised this, one of the key objectives of the Cubic Transport Management platform is to provide TfNSW with situational awareness and coordination across all modes of transport. This will make it easier to predict when things may go wrong, thus helping to proactively prevent city gridlock, as well as react quickly to traffic issues as they develop, helping commuters adjust their journeys.

The platform is designed to be open and extensible to help TfNSW deal with an ever-more complex transport network and leverage the technology disruptions that might appear in the coming years.

Benefits

Cubic's solution will provide TfNSW and Sydney residents with numerous benefits. The new platform, hosted in the cloud, will offer a common operating picture to the TMC operators, giving them improved situational awareness across the entire transport network and providing them with decision support and automation of current manual processes. This will help manage incidents better and faster when things go wrong (e.g. crashes, breakdowns in tunnels), inform the public of any knock-on impacts (e.g. buses affected by road closures) and propose alternative routes, greatly improving overall capacity and efficiency of the road network.

Sydney's commuters will benefit from a much-improved and tailored dissipation of information regarding traffic conditions and potential disruptions, allowing them to plan more efficient journeys, make better travel choices and spend less time stuck in traffic.

Relation to a MaaS ecosystem

Cubic's platform will integrate the operational management systems for all modes of transportation in the Sydney area. This, coupled with the provision of most up-to-date data, statistics and intelligence on transport operations, will allow the local transit authority to manage the city network in a holistic, integrated and coordinated way – a common denominator of all Mobility as a Service solutions.

Barriers/challenges/lessons learnt

Cubic works closely in partnership with the New South Wales Government and TfNSW on the introduction of groundbreaking new technologies designed to improve the transport experience for commuters and to increase the use of public transport. While some challenges will inevitably appear during the deployment period, Cubic's extensive experience in delivering large and complex transport technology projects around the world will ensure any barriers are overcome efficiently and in a timely manner.

8.4 MaaS Global

Background

MaaS Global have launched the world's first commercially scalable MaaS app – Whim – bringing together a wide range of transport and mobility services together in one mobile phone application. Whim gives customers access to public transport, taxi, car hire, bike share and car share. Whim aims to be a real alternative to owning your own car, giving customers the same level of freedom and easy access to mobility – the dream that was sold to consumers by the auto manufacturers. By providing this level of freedom without car ownership, MaaS Global also believes that it can encourage the use of more sustainable modes of transport for some journeys that customers currently make by single-occupancy car. This in turn will provide economic, environmental and societal benefits, through reduced congestion and reduced emissions, and help to make public and shared transport more sustainable.

First use of technology

The Whim application was first trialled in Beta in Helsinki in 2016, in order to demonstrate that there was a customer demand for this type of service, and also to gain evidence concerning behaviour change amongst customers that chose to use the Whim service. The evidence gained from this Beta allowed a further development of the product to be introduced during mid-2017, building up to a full-scale commercial launch of Whim in Helsinki in December 2017. Whim launched a public Beta service in Birmingham in April 2018, and also launched in Antwerp (Belgium).

Application of technology

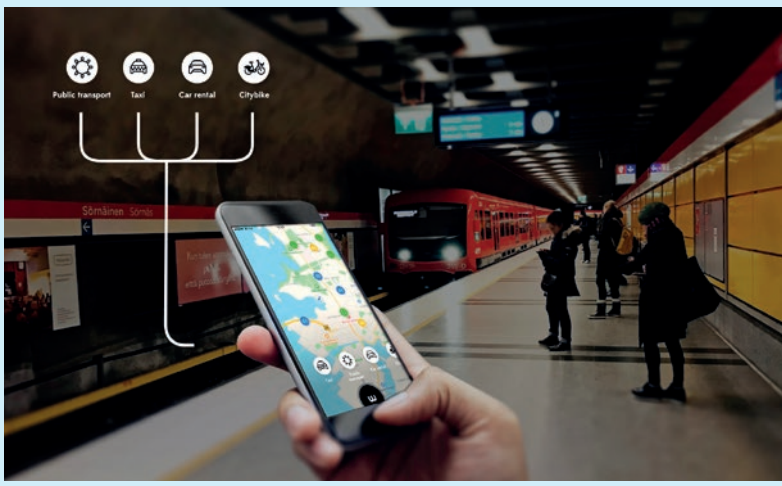
Whim has been launched on a fully commercial basis in the cities where it is live. The service requires commercial agreements to be in place with key Transport Service Providers (TSPs), and then access to their ticketing/ booking engines via APIs. Whilst in Helsinki, the newly-introduced Finnish Transport code requires TSPs to provide open access to APIs – no such regulations exist elsewhere in Europe. This required MaaS Global to develop partnerships and commercial agreements in its expansion cities. There are also no API standards for the technical integration of TSP services into a MaaS application – therefore MaaS Global has developed and published standards which it is encouraging the industry to adopt – these can be found at www.maas-api.org.

Benefits

Whim is a true MaaS application, allowing subscribers to have the freedom of mobility without the hassle and need of owning your own personal car. The original Whim Beta collected data from participants about their use of various transport modes, before and after they became Whim customers. This data showed a significant increase in public transport use from 48% of all trips made to 74% of all trips made. There was also a smaller increase in the proposition of journeys undertaken by taxi, but there was a significant drop in the use of private car, from 40% of all trips undertaken to just 20%. Following the successful commercial launch in Helsinki, further studies of customer behaviour will be undertaken. Monitoring customer behaviour is also a key outcome following the launch of Whim in Birmingham and Antwerp.

Relation to a MaaS ecosystem

Whim is a full MaaS solution, giving customers the opportunity to plan journeys and choose between fastest and green journeys. It also enables the appropriate purchase of tickets, either on a pay-as-you-go basis or as part of a full MaaS subscription. Whim will also offer roaming abilities between different geographies, in the same manner as mobile phone airtime.



8.5 Mott MacDonald

Background

Osprey: Inform operates as a standalone module from Mott MacDonald's Osprey Urban Traffic Management Control (UTMC[25]) solution. It can provide the information component within the MaaS ecosystem, supporting MaaS operations by disseminating network status, travel times and transport disruption information to both the public and service providers.

Information is made available via the following:

- **Open Data Service (ODS):** Allows authorised users (e.g. MaaS operators) to access data to use for their own purposes.
- **Web:** The Osprey: Inform travel information website (TIW) and its associated tools provide a rich content-managed portal, delivering essential travel and disruption information from different data sources, ensuring the latest travel data is made available to MaaS operators and the public. The TIW can incorporate additional widgets, such as Twitter feeds and journey planners.
- **Smartphone Apps:** Allow easy access to information for the public while on the move using real-time data from different sources.
- **Display Screens:** Osprey distributes real-time travel information to publicly-viewable screens, configurable to display a rolling list of pages, each with travel information sourced from the Osprey: Inform module. Sources of live information include journey times, traffic disruptions and rail/bus routes and departures.

First use of technology

UTMC applications have been around since 2000 and are continuously evolving to meet operator requirements. The Osprey: Inform module, its travel information website, open data tools and display screen application have been available since 2011.

The display screen application was used in the lead up to a major sporting event in London in 2012 to inform venue construction workers of their travel options.

Application of technology

Osprey: Inform is being used as an open data platform by many local transport authorities. One client utilised Osprey: Inform to create a trial journey time alert service for commuting drivers. Drivers pre-registered their regular driving routes in and around the city and received automated alerts when planned events or incidents are reported on routes and travel time is predicted to or exceeds predefined thresholds. The trial sought to influence traveller behaviour to avoid congested time and to utilise alternative travel options.

Benefits

The use of Osprey: Inform in a MaaS context enables the distribution of event, disruption and route travel time information to MaaS operators.

The Osprey Inform: Operation Dashboard is a web-based tool providing authenticated MaaS operators with access to create user-defined dashboards to monitor individual areas of interest, such as a particular road junction, and see multiple feeds of information in a single clear view. MaaS operators can select the dashboard area tool and draw a polygon on the map to define the area. Osprey then searches inside the drawn shape and displays a list of all transport assets found on any of the map layers. The system then allows MaaS operators to select the assets of interest and save the selection as a dashboard. Dashboards can contain a summary map, feeds from CCTV or Variable Message Signs (VMS) and strategies set in the area.

25 UTMC is a UK-based initiative which provides traffic managers with open technical specifications, supporting an innovative competitive marketplace and helping systems interwork effectively.

Relation to a MaaS ecosystem

Osprey: Inform is part of the MaaS ecosystem, enabling MaaS operators to access network status, travel times and transport disruption information. This allows MaaS operators to offer the most appropriate travel option to a customer on any given day. Osprey: Inform provides a secure, open and accessible mechanism for operators to access disruption and real-time journey time information.

Barriers/challenges/lessons learnt

MaaS operators need to be able to offer a transport service which is robust and responsive to disruptions in the underlying infrastructure, both the physical road or rail and the operational services. To achieve this, they need to understand the pricing and timetable of all the services which could fulfil their clients' needs and the current incidents which are affecting the available transport options. Osprey: Inform has been designed to help facilitate this and continues to integrate new sources of travel and traffic information as required.

8.6 NZTA

Background

The New Zealand Transport Agency's (NZTA) MobilityOS programme is a leading-edge development of the Mobility as a Service concept on a national scale. Using real-time data, it aims to provide customers with all their transport options in one place online, giving them the ability to view, compare and book their preferred mode of transport using their mobile phone. The aim of this programme is to roll out the real-time platform that enables this concept using open data principles in order to proliferate applications and services that increase customer choice in how they navigate the transport network, and in doing so, to assist with the reduction of single passenger vehicles on the road. The MobilityOS programme has been designed to ensure that no personal customer data is stored on the real-time platform and where possible, customer information that needs to be stored, is stored on users' devices. Any data that is captured by the real-time platform is "stateless" and is lost if not captured, and the data that is captured is non-personalised metadata. For example, showing the number of people on a specific bus, but not who specifically is on that bus, or the number of taxi trips taken over a certain period of time.

First use of technology

The MobilityOS programme started as a pilot when NZTA launched its first app, Choice, in Queenstown in August 2017. This was quickly followed up by the launch of RideMate in Auckland in December 2017, focusing on the Auckland region.

NZTA partnered with MachineZone, using their Satori platform to drive the real-time data, and partnered with Coherent Solutions to develop the apps. The user experience and design of the apps was undertaken by NZTA staff. As the pilot moves into full programme mode, both the platform and app design has been brought in house and fully designed and developed by NZTA staff as they transition into national roll-out.

Application of technology

The backbone of the technology is the use of a cloud platform to integrate and consume real-time data from transport providers and points of interest, and presenting this to customers in a user-friendly and easy-to-access way (i.e. their mobile phone). By surfacing real-time data in relation to transport modes (such as taxis, buses, trains, ferries and rideshare and bikeshare operators), customers are provided with increased choice in how they navigate the transport system, and can make decisions based on the values and motivators that are important to them (i.e. cost, sustainability, comfort, time etc.).

Transport providers get the benefit of participating in an open and online 'marketplace' where customers are seeking the best transport option that suits their needs.

Benefits

Customers benefit from an improved customer experience and choice in how they travel and navigate the transport network. For all participating transport providers, customers are able to see at a glance: cost; estimated time of arrival; price differences between public transport and other modes; as well as real-time information for popular destinations such as the ski fields in Queenstown.

In the future, additional information such as wheelchair accessibility will also be added. Other benefits are greater visibility for public transport options, reduced congestion and maximising use of physical infrastructure as well as greater economic opportunities for transport providers and businesses.

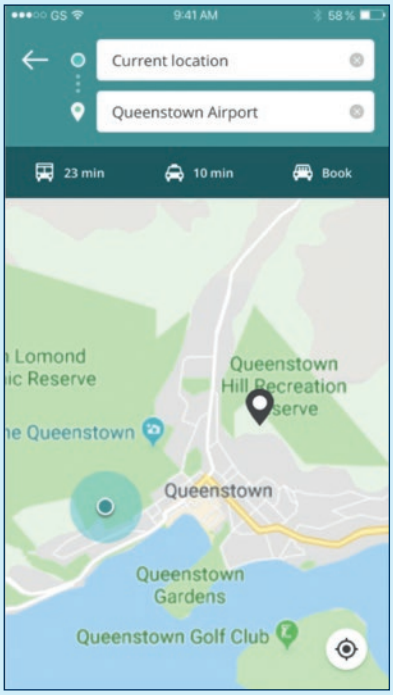
Relation to a MaaS ecosystem

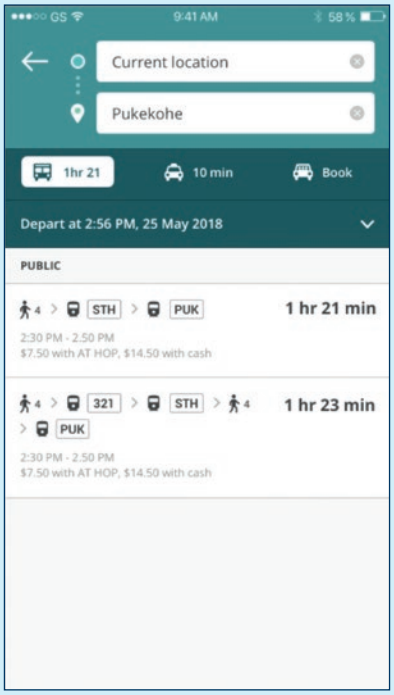
The solution developed by NZTA is a full MaaS concept and includes journey planning, the ability to view and compare transport modes based on cost, time and user preference, and the ability to track your chosen mode of transport as it picks you up and as you embark on your journey.

In 2019, MobilityOS will include the ability to pay for your transport choices using an online wallet/payment system, allowing you to book and pay for multiple modes of transport through one single payment via your mobile phone.

Barriers/challenges/lessons learnt

The biggest barrier initially was the different levels of understanding of open data principles and helping transport providers understand what signing an open data contract meant. In some cases it was unclear who actually owned the data and in others, transport providers were wary that they were signing away their competitive/business data. Additionally, NZTA had to answer the question as to whether or not this kind of ambitious programme was the role of a government agency. It has taken the view that in order to unlock the potential of the intersection of digital technology and the transport system in New Zealand, it had to play a role in ensuring a free and open marketplace where transport providers and customers could come together to create greater value, without making it less accessible by adding in private sector margins or preferred supplier arrangements.





8.7 Padam

Background

Padam provides a Software as a Service (SaaS) turnkey solution to bus operators and cities to develop optimised on-demand services. The Padam end-to-end digital solution allows corporate customers to simulate and operate optimised on-demand road services. The solution relies on algorithms and data analysis for optimisation and includes user and driver apps and back-office for operators.

Padam sells its technology through two products:

- **Padam Lab**: the simulation platform that does data analysis and modelling for any Demand Responsive Transport (DRT) service in any territory.
- **Padam Live**: the operating platform that is used by clients to book rides, and drivers and bus operators to run the service.

Padam's solutions are well fitted for van-pooling and paratransit services in high-density areas, as well as for use cases such as first and last mile, low density areas, off-peaks hours in low to medium density areas.

First use of technology

Padam trialled its own private service in Paris, first for night travellers, then for commuters. This experience helped the Padam team build strong algorithms and scalable technology. Padam provides the technology that enabled the design and operation of the Flexigo Gally Mauldre on-demand service. Branded and subsidised by IDF Mobility (Paris transport authority), the service is often pointed out as the first of its kind.

Application of technology

Padam was founded on the idea that fixed routes are well fitted for high-density areas but are not economically sustainable in low to medium-density areas. Padam activity is focused on every use case in low to medium-density areas.

Projects usually start with DRT simulations on Padam Lab that are aimed at validating the relevance of DRT in the area and defining the DRT parameters. Simulations provide the bus operators with accurate outputs and tell whether the territory is fit for DRT and which configuration is the best.

Once the simulations are satisfactory, the bus operator can switch easily to Padam Live and start running the DRT service. Padam's offer also includes some high-density use cases such as commuting, paratransit and airport shuttles.

Benefits

Padam use cases include converting fixed bus routes into DRT services in low to medium-density areas. In these cases, its experience shows important costs savings. For example, Padam simulated a DRT service in a Paris suburb to compare with fixed routes. The results showed 35% cost savings, which was achieved by decreasing the number of vehicles needed and raising the ridership. This service has now been launched.

A similar use case was simulated on higher volumes – the results showed 29% cost savings and a more than 40% increase in ridership.

Another use of Padam is to replace software in existing DRT services. In Orléans, where a DRT service already existed, Padam replaced a market reference operating software. Padam showed strong results with doubling ridership after only six weeks. The user experience provided by Padam, the possibilities and the optimisation know-how contributed to this excellent result.

Relation to a MaaS ecosystem

Padam products are particularly fit for medium and low-density areas, where the first and last mile is a common issue. DRT services are a good solution for these use cases, but they need to be integrated into the existing network: train stations, transportation hubs, etc. Padam Live APIs can be opened to integrate DRT services into a global MaaS ecosystem, and Padam models enable bus operators to fit within the existing network.

8.8 Shotl

Background

Shotl is an app-based platform for shared and flexible on-demand transportation that matches different passengers heading in the same direction with a vehicle moved by a professional driver. Shotl pursues a strict Business-to-Business (B2B) policy where it offers its technology to other businesses or institutions such as operators, transport agencies, cities or major employers. Support activities include (a) technical support for service operator staff (drivers and operation managers), (b) high-level consultancy support by recommending routing, area of service and operational hours and evaluating expected levels of service with the available configuration, and (c) creating periodic service reports based on system and user feedback information.

In the second half of 2017, it was implemented in Can Barata (wider Barcelona area) on an existing suburban mini-bus route to improve its operational efficiency and increase its appeal to passengers.

First use of technology

Shotl's technology was successfully tested in spring 2017 on a large-scale trial with 15 vehicles connecting Polytechnic University of Catalonia's (UPC) university campus in the outer Barcelona area with the city centre. This trial was sponsored by UPC, the car manufacturer SEAT, RACC and CARNET (Volkswagen's innovation hub). This trial combined both real and virtual petitions with the goal of a stress test of the system and a check on users' and drivers' interaction with the platform. Shotl defined the pilot's use cases, trained the drivers and led the post-pilot feedback-gathering sessions with users. The service offered was considered a good alternative to current options, especially for travellers without an attractive combination of regular bus routes. Technically, the IT platform proved successfully its robustness in an area with 200 virtual stops.

Since then it has been commercially implemented in various locations in Spain, France, and Germany and has confirmed upcoming deployments in the USA, Finland, Italy, and Switzerland. It is now implemented in both urban and rural contexts as an integrated part of the public transportation network as well as with major private employers that need to provide attractive mobility options for their workers to move between their different sites.

Application of technology

Shotl's technology consists of three elements: the User App, the Driver App and a Central Management Console. The Driver App gives dynamic turn-by-turn navigation instructions between virtual stops and an overview of the passengers to be picked up and dropped off. These instructions are connected through the Central Engine with the requests that passengers send through the User App in which they can reserve trips in real-time or in advance through a pre-booking feature, either fully dynamically or as an enhanced flag-stop on an established corridor/bus route. The main challenge for the whole system that Shotl faced in Can Barata had to do with holes in mobile network connectivity. It solved this issue by stabilising the communication between the different parts of the system even if there is no direct contact. In addition, it complemented the company's solution for reservations via the phone in order to make the service accessible for users without a smartphone.

Benefits

The trial in Can Barata has led to the following promising results for implementing a technology-driven demand-responsive mode of transportation on certain routes:

- After six months, the average number of passengers was multiplied by factor 2.63, attracting demographic groups that before relied on being transported by car, (e.g. the young, domestic workers)
- In peak times, up to four times more passengers were transported than before the pilot
- Despite increasing mileage from 90 to 130 kilometres per day, the ratio of passengers transported per kilometre has doubled with flexible on-demand routing
- Simulations on the basis of these results on other routes have shown that we are likely to keep this increase in performance with similar overall operating hours and mileage per route

Relation to a MaaS ecosystem

The business model of Shotl consists of providing the technology to add shared on-demand flexible transportation to areas where they enhance the overall functioning of the mobility network, (e.g. unconnected residential areas, different sites within a campus or business park, feeders to major capacity public transportation routes). As such it provides a crucial part to enhancing mobility that any MaaS platform will require to provide different transportation options to increased numbers of people in more areas.

Barriers/challenges/lessons learnt

Three major challenges have been resolved:

- **Inclusiveness for non-tech-affine population:** Together with the local operator, a hotline has been installed to attend reservations that have come in by phone from passengers without a smartphone. This has been crucial to include groups like the ageing population and making the service also available to them
- **Communication:** This new kind of service required an extensive communication effort for passengers to understand the functioning of the service and use it accordingly. These efforts have carried its fruit in that user demand has improved significantly
- **Driver training:** Drivers require continuous training on their app in order to use it accordingly and also integrate their knowledge of the local traffic, street conditions and passenger behaviour so as to complement the suggestions of the system and take corresponding measures in case of eventualities (congestion, early drop-offs, etc.)

8.9 Streamr

Background

Streamr, (www.streamr.com) the blockchain-powered data platform, collaborated with decentralised location data market Fysical (www.fysical.com) to use aggregated location data as the basis for a matrix of vehicle movements for the country of Georgia. This data is leveraged from mobile apps on 10 million phones to enable the development of new and improved information compared with traditional data collection efforts, which rely on traffic surveys. The project demonstrates how data can be collected, modelled and used to improve the delivery of transport planning services.

First use of technology

Streamr's founders have been together since 2011. With a background in developing algorithmic platforms for trading, tools such as the Streamr Engine and Editor have been developed over these years. They enable the processing, analysis and visualisation of real-time data streams. Over 10,000 subscribers use the tools to prototype, visualise and analyse data. More recently it is also used to set up streams as data products in the Streamr Data Marketplace, launched in May 2018. When buyers subscribe to the streams they can also use the Editor to view and analyse the streams before importing into any other in-house systems.

Application of technology

Streamr worked with Bold Native Advisors, a global multidisciplinary consulting firm, to build a traffic model matrix of Georgia using aggregated location data obtained from phone apps. The pilot involves processing a large amount of raw data and building a new vehicle demand matrix for the country. Georgia was selected due to the fact that in 2017 Native built a model there on behalf of the World Bank using traditional datasets and roadside interviews. This existing data source was used to check the location data and the 2017 model was used to complete a number of comparison exercises with the new model matrix created from location data.

The dataset supplied through Streamr's Marketplace is comparatively large by transport planning standards, comprising more than 25 million records and it was necessary to apply a series of 'rules' within a statistical analysis package to render this data into more recognisable Origin-Destination (OD) data and split this data further into different modes and vehicle classes. Streamr is removing roadblocks to efficiently developing traffic models, enabling transport authorities to use vast amounts of traffic-related data, which were previously difficult to access.

Streamr and Fysical allow consumers to monetise the real-time data being generated about them from hundreds of mobile apps and other devices, and are realising the potential of a global data economy.

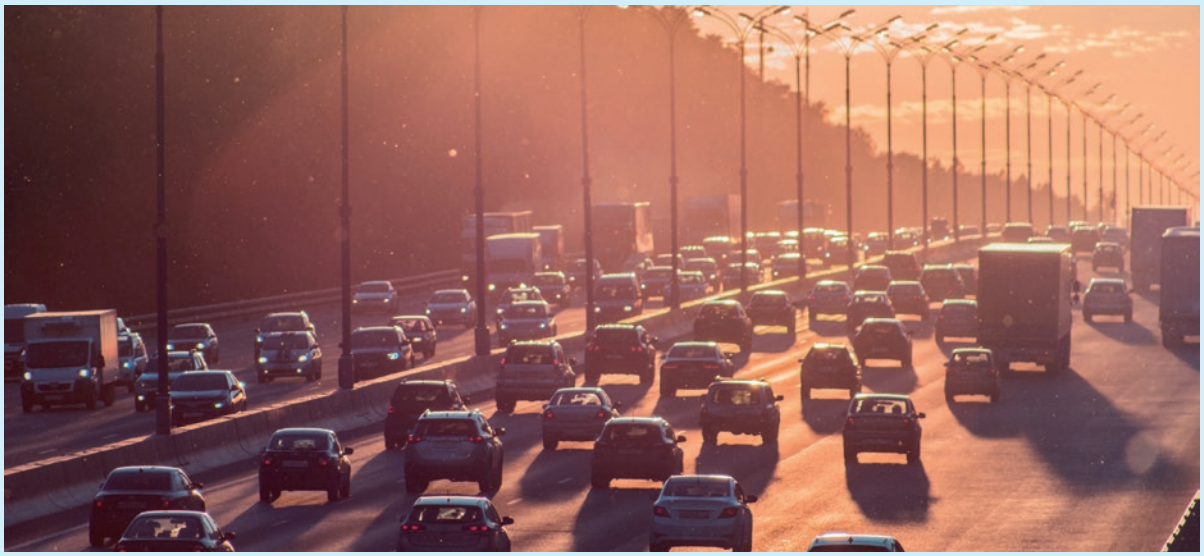


Photo: Alexander Popov

Benefits

Streamr's Marketplace is breaking down the barriers between data producers and users. Streamr takes no transaction fee. Traffic model developers have traditionally spent significant amounts on roadside interviews, household surveys and mobile phone data to develop traffic models, which can be costly and in the case of OD surveys often provides a limited sample of observed movements.

There were significant savings in terms of both time and money as a result of using location data when compared with a full traffic survey programme. Two months of continuous location data from Fysical was made available almost immediately, whereas the traffic survey programme took more than two months to plan and then there was a further 6-8 weeks wait whilst the surveys were implemented and the OD data was coded, checked and processed.

The Marketplace enables mixing of datasets and refinement through additional technologies such as machine learning. Streamr is developing projects for councils, which also add the capability of its Trackr location data gathering app on a mobile phone to be an additional new source of data. Individuals can share in the financial rewards when a data product is sold having their data aggregated, anonymised and potentially combined with datasets from other organisations. This community product functionality will enable problems to be solved by crowdsourcing data far beyond what has traditionally been possible whilst facilitating monetisation at a granular level. This provides incentivised collaboration, stimulating a data economy.

Relation to a MaaS ecosystem

The case study here applies to traffic models. The ability to crowdsource data across multiple new sources and to facilitate monetisation down to the level of the individual could enable more efficient combination of data across multiple modes of transport to derive more insight and help planning. It could also be used to help inform real-time decisions on the transport network.

Barriers/challenges/lessons learnt

The largest challenge faced was the processing of the dataset. There was significant debugging and revision of the 'rules' process needed to produce a sensible trip matrix. The process was also iterative and if initial assignments of the matrix showed trip patterns which did not make sense or were too different from the 2017 model the raw data was revisited.

8.10 URBI

Background

URBI is a mobility aggregator. Through its mobile app, URBI offers to its users different means of transportation such as car sharing, public transportation and taxis.

First use of technology

URBI was first developed and launched in Berlin in 2014. Nowadays it is present in two continents (North America and Europe), aggregating more than 50 services and serving several hundreds of users. The main markets, at the moment, are: Milan, Berlin, Madrid and Barcelona.

Application of technology

The final goal of URBI is to build an efficient and effective MaaS option, offering to users a solution which can substitute the use of private cars. In this sense, the main issues are related to involving in the projects the different mobility players (such as car sharing companies) who are sometimes not willing to collaborate and share data/info/APIs.

Benefits

Through the use of URBI the users can avoid having a car as their property. In this sense, there is already a saving. Moreover, in the long term, the potential benefits can impact the city as a whole, decreasing traffic and pollution.

Relation to a MaaS ecosystem

At the moment, URBI is developing a MaaS solution, pending legal and commercial agreements with various mobility operators in the various focal cities. In this sense, the platform is ready to be used for MaaS as it currently showcases various mobility services, offering the possibility, for some, to reserve, book, use and pay via the URBI app.

Barriers/challenges/lessons learnt

The main challenges that URBI faces are related to commercial/legislative factors. In this sense, considering the current strategies of various mobility operators, it is difficult to build an efficient MaaS comprehensive of various services. These issues are even greater when considering the necessity of scale in order to sustain the business. In fact, each city has different rules, as also each mobility operator applies different strategies based on the specific geography. For this reason, each city/area needs to be addressed and developed as a different case.

9. Final remarks

Mobility as a Service promises a transformational change to the customer offering and a significant step forward on improving transport's societal, economic and environmental outcomes. Whilst the concept of optimised transport has been around for more than 50 years, recent advances in connectivity and data technologies coupled with a more customer-focused approach to delivering services were the key enablers for the MaaS concept. A prerequisite for a sustainable MaaS system to exist is seen as an appropriate and reliable underlying transport and digital infrastructure to deliver the services and access to relevant transport data.

The provision of multiple mobility and transport options into a single integrated MaaS offering, along with its potential benefits and commercial opportunity have led to a large number of pilots and trials as well as fully implemented commercial solutions around the world. These clearly demonstrate the technical feasibility of delivering MaaS and highlight some of its benefits with captured evidence. They have also shown that fully integrated transport for all travellers is not always necessary and the Implementation Scenarios (defined in this document) have shown that segmentation could mean that optimum benefits from MaaS can be realised if it focused on specific user groups and in specific geographies – transport authorities may not need to 'boil the ocean' to achieve a sustainable benefit from MaaS deployments. Transport authorities could also look to the use cases to identify where a MaaS component or collection of MaaS components could deliver their desired outcomes.

It is important to note that the implementation and wide deployment of MaaS could face a myriad challenges and could also lead to unintended consequences. The various levels of technology/ infrastructure availability between regions and across rural and urban areas could mean that deployed MaaS solutions for urban and rural areas need to be carefully planned to suit the landscape. MaaS is then expected to organically expand across three dimensions (Geographies – Transport modes – Service levels). It is important to ensure that MaaS caters for the different users (including the digitally challenged) and provide incentives to change travellers' behaviour, especially if the MaaS objective is to reduce car ownership and single-occupancy vehicle use.

The MaaS landscape is very complex with first, second and third tier stakeholders all part of the ecosystem. Understanding the complexity and interaction within this multi-sided business model is critical to understanding how the service can be sustainably operated. This multi-sided business model is something far more complicated than the traditional transport operator delivering public transport services to passengers through a combination of user payments and government subsidies. Whilst remaining technology hurdles can be overcome it appears that the greatest challenges to sustainable MaaS – and where effort is most required – are the institutional and commercial hurdles.

MaaS is still in its infancy and there is strong need for collaboration among public and private sector organisations to remove the barriers to innovation, realise its full potential and bring about its expected benefits. MaaS needs to be recognised as more than a collection of systems, or system of systems; it is the delivery of services involving real people. It needs to be treated through a service management approach where people, processes, products and partners are at the forefront and silos are dissolved through a federated approach to connectivity. There is a need to build on lessons learnt from other "as a Service" industries and where complex multi-sided business models have been successful (e.g. online marketplaces). Finally, it is important to note that there is no one-size-fits-all when it comes to MaaS and that various versions of MaaS are likely to prevail in various contexts and in relation to specific user types.

10. Acknowledgements

The IET would like to thank our MaaS Working Group for contributing to this report. We also wish to acknowledge the organisations featured in Section 8 for their time and effort spent providing their valuable case studies.

Lead author:

Khalid Nur, *Arup*

Contributors and Working Group members:

Kristine Beuret, *Social Research Associates*

Darren Capes, *Department for Transport*

Marcus Enoch, *Loughborough University*

Tim Gammons *(Working Group Chair)*, *Arup*

George Hazel, *George Hazel Consultancy*

Karla Jakeman, *Innovate UK*

Maria Kamargianni, *UCL MaaSLab*

Chris Lane, *Transport for West Midlands*

Vivi Michalaki, *Highways England*

Andrew Pickford, *Transport Technology Consultants*

Tracy Savill, *Transport Systems Catapult*

Andy Taylor, *Cubic*

Ella Taylor, *CCAV*

Richard Westgarth, *BMT*

The Institution of Engineering and Technology

Our offices

London, UK
T +44 (0)20 7344 8460

Stevenage, UK
T +44 (0)1438 313311

Beijing, China
T +86 10 6566 4687

Hong Kong
T +852 2521 2140

Bangalore, India
T +91 80 4089 2222

New Jersey, USA
T +1 (732) 321 5575

@TheIET

theiet.org