





D3.1 – Report on major "needs" (Initial Version)

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A status is associated to each step of the document lifecycle:

- Draft: this version is under development by one or several partner(s);
- Under review: this version has been sent for review;
- Issued: this version of the document has been submitted to EC.
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- PU: Public
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EXECUTIVE SUMMARY

This document addresses major mobility distresses in the market to serve as a basis for the activities in work package 3 of the COHESIVE project.

The scope of this document is to identify and characterise major mobility 'needs', among passengers, transport service providers, and local authorities, to be addressed through the COHESIVE project. This 'Initial Version' provides a preliminary analysis, which will be augmented for the 'Final Version' of the report (D3.2). In addition, this document provides the basis for the companion report, D3.3, in which we prepare user profiles and define and describe use cases for use within the project.

This report first outlines key trends in the mobility sector in Europe, split by social trends, regulatory trends, and technology trends. Doing so demonstrates that the IP4 programme is well-placed to respond to emerging trends in the mobility landscape and indicates some key areas where the project can add value, thereby helping to guide the development of the IP4 solution.

The remainder of the report draws on desktop research and engagement with relevant stakeholders to delineate key challenges or needs of travellers, transport service providers, and local authorities, and goes on to map these to the aims of the project. These identified needs will directly inform the use case development in D3.3.

The document targets the following stakeholders:

- COHESIVE WP leaders;
- IP4 CFM projects coordinators;
- Shift2Rail Joint Undertaking;
- European Commission
- Reference for IP4 OC.

Some portions of this document may on occasion be shared with other stakeholder whose input/approval into the use case execution may be needed.



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INTRODUCTION

1.

1.1 Purpose

This initial version of major needs to address within the scope of the COHESIVE project identifies and characterises major distresses, paint points, or 'needs' felt on multimodal transportation environments with a focus on rail. It does so through reviewing relevant literature and by engaging with a variety of stakeholders (e.g. local authorities and mobility providers), all of which will serve as background for the final version of this report (D3.2) as well. Analysis in this report aims at clearly identifying and describing the ecosystem requirements and serves as a basis for the development of user profiles and use cases presented in deliverable D3.3 in order to overcome these obstacles. This will drive the use case execution and the testing of the IP4 releases. Use case documents from other relevant IP4 projects (CO-ACTIVE and ATTRACkTIVE) have been consulted in informing the report, as they illustrate the relationship between the user, travel brokerage service (if applicable) and TSPs, and the timeline of this with regards to trip progress, trip tracking, selection of ancillary services, etc.

The insights regarding passengers are based on reviewing relevant literature. Those for Transport Service Providers (TSPs) are based primarily on a series of engagement activities, including a survey of Train Operating Companies (TOCs) and Route Infrastructure Managers, a meeting with the Rail Delivery Group, and further consultation with project partners at the mid-term conference of the CO-ACTIVE and ATTRACkTIVE projects. Further consultation was then carried out in May and June 2020 through two interviews with TSPs and a survey issued to members of the project Advisory Board (with 5 responses). For the sections on local authorities, insights come from the project team's own knowledge, consultation with the Advisory Board, and additional literature. Consultations with three local authorities across Europe are planned and will be included in D3.2.

This report is structured as follows. Chapter 2 provides a discussion of key social, regulatory, and technological trends shaping and driving the mobility sector in Europe, demonstrating how the IP4 programme is well placed to offer appropriate solutions. In Chapter 3, we outline the main challenges in multimodal mobility facing passengers, transport providers, and local authorities. This discussion serves as a basis for identifying pressing areas of focus for IP4 activities. Chapter 4 then goes on to show how IP4 will address these challenges or needs, describing the added value it will offer the three groups of stakeholders. Finally, in the conclusion, we structure the findings, summarising how IP4 activities will match up with the identified needs, and thus setting up the work delivered in D3.3. We also explain how this work feeds into the remainder of Work Package 3.

1.2 Covid-19

This document mostly pre-dates the global Covid-19 crisis. As such, the findings are primarily related to the pre-Covid-19 situation. It is only now that initial signs of how stakeholders will adapt are emerging. Covid-19 will likely continue to have a major impact on passengers, TSPs, and local authorities for the foreseeable future. This can be considered in the updated version of this report (D3.2), although it will be too early for any firm conclusions to be drawn.





1.3 COHESIVE project overview

The COHESIVE project aims to guarantee technical consistency and homogeneity throughout the different IP4 CFM projects to support the successful and meaningful integration of the modules coming from those projects, thus supporting the seamless multimodal (air, rail, coach and urban) traveller experience across Europe. Shift2Rail IP4 aims to deliver a complete multimodal travel solution door-to-door connecting the first and last mile to long distance journeys combining air, rail, coach and other services. This initiative includes a semantic interoperability framework, business analytics platforms, a one-stop shop where customers can search, plan, shop, book and ticket multimodal travel itineraries, an European scale trip tracker, multiple inventory, booking and ticketing systems having interoperability with related 'orchestrator' modules attached to the one-stop-shop (covering air, rail, coach and urban) and invoked by a customer centric application to be used on customer devices. These intentions will be demonstrated in different occasions through the COHESIVE project lifetime via a set of functionally incremental technical releases. Figure 1 - IP4 (Technical Demonstrators (TD) structure depicts the technical demonstrator packages composing the ecosystem and the main interactions between them.



Figure 1 - IP4 (Technical Demonstrators (TD) structure

Acrony	n	Description	า					
EC		European Commission						
GA	GA Grant Agreement							
GDPR	GDPR General Data Protection Regulation							
ICT	ICT Information and Communications Technology							
IT		Information T	echnology					
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1.4 List of acronyms





IP	Innovation Programme
IP4	Innovation Programme 4
JU	Joint Undertaking
LBS	Location Based Services
MaaS	Mobility as a Service
ORR	Office of Rail and Road
TOC	Train Operating Company
PTO	Public Transport Operator
SIRI	Service Interface for Real Time Information
TAP TSI	Technical Specification for Interoperability relating to Telematics Applications for Passenger Services
TD	Technical Demonstrator
TSP	Transport Service Provider
V2V	Vehicle to Vehicle
WP	Work Package

Table 1 - List of acronyms

1.5 Terms and definitions

Term/Definition	Description
Big Data	Large, complex data sets which often cannot be managed by traditional data processing software
Cloud Infrastructure	The hardware and software components that are needed to support cloud computing requirements
Decarbonisation	Reducing carbon dioxide emissions
Decentralisation	The movement away from a single centre to other locations
Interoperability	Ability of a system to work with or use the parts or equipment of another system
Life Cycle Cost	The sum of all costs over the full life span or a specified period of a good, service, structure etc.
Technical Enabler	Technical items which support the development of business
Urbanisation	The process of making an area more urban

Table 2 - List of terms and definitions

The complete list of terms and definitions is on the Project Glossary of Terms and Definitions [R3].



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1.6 Reference documents

Reference	Name	Code
[R1]	COHESIVE Grant Agreement - N° 777599	-
[R2]	COHESIVE Consortium Agreement	-
[R3]	MAASIVE GLOSSARY	MASSIV-WP11-T-THP-005-06
[R4]	COACTIVE Use Case	COA UC_TD4.2
[R5]	ATTRACkTIVE Use Case 1	ATT UC_TD4.4
[R6]	ATTRACkTIVE Use Case 2	ATT UC_TD4.5

Table 3 - Reference documents





2. MAIN TRENDS AND DRIVERS FOR MOBILITY

A range of current trends and drivers are shaping the mobility landscape and patterns of mobility demand across Europe. In this section, based on a review of the relevant literature, we outline the most prominent social, regulatory, and technological trends and include some further insights from relevant stakeholders. The discussion will show how the current mobility landscape is a favourable ground for the successful implementation and exploitation of Shift2Rail IP4 COHESIVE solutions.

2.1 Social trends

Several well-documented social trends are shaping how people in Europe are travelling. The most significant from the perspective of the IP4 programme are elaborated below and include: (1) urbanisation and related changes in residence patterns; (2) an ageing population; (3) decarbonisation and concern for the environment; (4) the rise of the 'sharing' economy; and (5) ever-growing digitisation. It must be remembered that these trends do not play out evenly across the continent. While we have made some comment on regional differences, we focus primarily on overall trends.

2.1.1 Urbanisation / Changing residence patterns

The long-term trend of increasing urbanisation in Europe continues. UN figures indicate that around 75% of Europe's population currently reside in urban areas, and project that by 2050 this figure will be almost 84% (United Nations 2018). While there are significant differences in urbanisation levels between and within European countries (e.g. in 2018, the UK urban population stood at 83%, Portugal at 65%, and Belgium at 98%), the UN projections consistently point to increasing urbanisation in the coming decades.

In order to meet the demand needs from this trend (i.e. growing urban populations), cities are required not only to invest in infrastructure but also to ensure efficient, safe, and cost-effective urban transport systems and mobility of goods and people. This will further improve cities' competitiveness as economic hubs at the national and international level.

However, it is important to remember that the overall trend towards urbanisation is not uniformly distributed. Some cities in Europe are seeing a declining population while some rural areas are successfully attracting new residents (EPRS 2019). Furthermore, the implications of increasing urbanisation impact all regions. While cities deal with growing numbers of inhabitants, more rural areas may suffer from depopulation, which can put different strains on transport services.

The changing geographical residence patterns in Europe and the consequent implications for transport networks and service providers mean innovative solutions are needed to ensure changing mobility needs can be met.

2.1.2 Ageing population

Europe's population is ageing. In 2018, nearly 19.7% of the EU's population was aged 65 or over, already a 2.6% increase since 2008. The increasing proportion of older people is a trend across all EU countries, but with differences between countries (and within countries). For example, while Finland saw a 4.9% increase between 2008 and 2018, the equivalent figure for Austria and Belgium was only 1.6% (Eurostat 2019b). The European Commission projects the old-age dependency ratio





(the ratio of people aged 65 and over to those aged 15-64) to increase from 29.6% in 2016 to 51.2% by 2070 (European Commission 2018b: 4).

An ageing society brings many challenges around transport that operators need to respond to. A straightforward implication is that increasing numbers of older people will result in overall increased demand from this age group, with the related needs and pain points of people in this group. (These are further explored in the D3.3 deliverable). In relation to the IP4 programme, for example, a Transport Systems Catapult report on older travellers highlights that, despite increasing smartphone uptake, older travellers face several technology related barriers to travel, falling into three categories: 1) Features of technology design and ergonomics; 2) Cognitive and perceptual abilities, including decline in; and 3) Psychological issues (Transport Systems Catapult 2017).

However, Li and Voege suggest that older travellers will be among the first adopters of MaaS. They point out that older people take more longer trips than younger people, and that "MaaS covering home cities as well as overseas destinations would be welcome to elderly travellers who frequently travel abroad" (2017:103).

Nonetheless, older people should not be seen as a homogenous group. Based on a systematic comparison of relevant literature across Europe, Haustein and Siren (2015) point out that the older population is increasingly diverse. They identify four primary segments: an active car-oriented segment; a car-dependent segment, restricted in mobility; a mobile multi-modal segment; and a segment depending on public transport.

From the above, it is clear that the growing older population presents an opportunity for multimodal travel options, while recognising that any such solutions must ensure they meet the distinct and diverse needs and wants of older travellers to offer an attractive and viable option.

2.1.3 Decarbonisation / Environmental concern

Decarbonisation of mobility has risen to be a social and political priority. The growing prominence of climate-conscious social movements, including the Fridays for Future strikes led by school students, Extinction Rebellion, and schemes to promote flying less all point to an increasing concern in society for the environment. However, it is unclear what effect such initiatives will have on mobility demand and behaviour. A recent Eurobarometer survey of over 27,000 Europeans indicates that although 77% think climate change is a 'very serious problem', the proportion of people who say that protecting the environment is very important to them personally in fact declined between 2007 (64%) and 2019 (53%) (Eurobarometer 2020: 12, 8).

Still, social movements can be powerful influences on behaviour. The 'flight shaming' campaign in Sweden has been credited with contributing to a 4% decline in passengers through Swedish airports, and a 9% reduction in domestic air travel (Reuters 2020). A survey published by Swedish Railways in 2019 found a range of indicators suggesting concern for the climate has increased rail patronage in the country (SJ 2019).

Even so, as will be discussed further later, a growing political imperative (in many ways driven by these social movements) across European counties to decarbonise transport and the wider economies does suggest that this will be a key factor shaping future mobility.





2.1.4 The sharing economy

The sharing economy has seen significant growth in recent years, and in the mobility sector it has had a profound impact. The sharing economy can be described as "the sharing of consumption through online platforms that are challenging conventional business models" (Standing, Standing & Biermann 2019: 4). Standing, Standing, and Biermann (2019) divide the sharing economy in transport into four categories: ride-sharing (e.g. Uber), freight-sharing, car-pooling (e.g. Uber Pool, BlaBlaCar), and car-sharing (e.g. car clubs, but could also apply to bike or scooter sharing schemes). Uber demand continues to grow. In the fourth quarter of 2019, the company increased global trips by 28% to 1.9 billion (The New York Times 2020). Bike sharing schemes (docked, dockless, and increasingly e-bikes) as well as, more recently, e-scooter sharing schemes, have proliferated in European towns and cities over the past decade.

Closely related to the sharing economy is Demand Responsive Transport, straddling the line between public and private transport, and offering flexible shared transport aimed at meeting the needs of user groups. They can provide social benefits as well as environmental benefits, through facilitating use of other public transport modes (Interreg Europe 2018: 2).

For the rail sector, where the sharing economy will likely continue to have an impact is in the proliferation of mobility options that can contribute to more options and more seamless journeys for travellers. allowing them to be less dependent upon private cars. A deal between the French national rail operator SNCF and car-pooling specialist BlaBlaCar already alludes to the potential benefits of such link-ups (Railway Gazette 2018).

2.1.5 Digitisation

A fifth key social trend is what could be termed digitisation. Multifaceted and complex, we include this heading to refer broadly to the ever-growing impact of digital technologies on our lives. For example, internet use across Europe continues to rise. In 2018, 89% of EU households had internet access, an increase of 10% in five years (Eurostat 2019a). Further, GSMA (2019) have reported that 86% of Europe's population subscribe to mobile services, and 76% of these are smartphones – a figure they project to rise to 83% by 2025 (GSMA 2018: 6). In transport, Euromonitor International predicts that by 2024, 52% of travel sales will be online, and 25% will be through mobile (2019: 1). In the UK, the Rail Delivery Group reported that 22% of rail journeys in 2018 were made using tickets bought online, an increase from 7% in 2013 (2019).

Technology developments are discussed in greater depth in section 2.3, including how 'smart cities' can harness technology to overcome societal challenges such as urbanisation and decarbonisation, however the IP4 programme seems well placed to harness the social trend towards digitisation.

2.1.6 Other social trends

Some further social trends are in evidence, including:

• Rail passenger transport **demand** continues to rise in Europe as a whole and in most EU countries (Eurostat 2019c).



• A McKinsey article in 2019 argues that **personalisation** will the 'the prime driver of marketing success within five years' (Boudet et al. 2019). As will be seen in section 3.1, passengers are beginning to seek a degree of personalisation in their travel experience.

2.2 Regulatory drivers

High quality rail services and the protection of users' rights are essential to fulfilling the objective to increase the share of rail transport in comparison to other modes of transport. The European Commission has, through four 'railway packages' been working over the course of decades to reform the European rail transport market, with a focus on three main areas: (1) opening the rail transport market to competition, (2) improving the interoperability and safety of national networks and, (3) developing rail transport infrastructure (European Commission 2020b). The Fourth railway package of 2016 aimed to complete the Single European Railway Area, a single market for rail services (European Commission 2020c). A further area of work has been on improving legislation for passenger rights (European Commission 2020a). Further, EU and national regulatory priorities are continuing to shift towards clean mobility. The sections below outline the key regulatory drivers relevant to the IP4 programme.

2.2.1 Interoperability

A key tenet of the regulatory approach has been to improve the 'interoperability' of the EU rail system. The conditions to achieve this aim are set out primarily in the railway interoperability Directive 2016/797, covering both technical compatibility of assets as well as professional qualifications and health and safety conditions (EUR-Lex 2016).

EU legislation further aims to harmonise safety requirements across the Union (European Commission 2020d).

2.2.2 Passenger rights

In terms of passenger rights, the EU in 2011 set out a vision for passenger rights across all modes. The 'Communication on Passenger Rights in all transport modes' outlines three key principles: nondiscrimination; accurate, timely and accessible information; and immediate and proportionate assistance (European Commission 2011: 3). Ten specific rights flow from these principles (European Commission 2011: 3-4).

- Right to non-discrimination in access to transport
- Right to mobility: accessibility and assistance at no additional cost for disabled passengers and passengers with reduced mobility (PRM)
- Right to information before purchase and at the various stages of travel, notably in case of disruption
- Right to renounce travelling (reimbursement of the full cost of the ticket) when the trip is not carried out as planned
- Right to the fulfilment of the transport contract in case of disruption (rerouting and rebooking)
- Right to get assistance in case of long delay at departure or at connecting points
- Right to compensation under certain circumstances

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- Right to carrier liability towards passengers and their baggage
- Right to a quick and accessible system of complaint handling
- Right to full application and effective enforcement of EU law

In rail, these rights are codified in Regulation (EC) No 1371/2007, which 'aims at establishing rights and obligations for rail passengers in order to protect them particularly when travel is disrupted, and to improve the efficiency and attractiveness of rail passenger services' (EUR-Lex 2020b). A European Commission proposal in 2017 sought to update these rules in five main areas detailed below (European Commission 2017b). At the time of writing, the proposal was at a First Reading stage with the Council of the European Union (EUR-Lex 2020a).

- **'Uniform application of the rules:** long distance domestic and cross-border urban, suburban and regional services can no longer be exempted from the application of passenger rights rules.'
- **'Information and non-discrimination:** improved provision of information about passenger rights, e.g. by printing it on the ticket. Passengers who use connected services with separate tickets must be informed on whether their rights apply to the whole journey or only to the different segments.'
- 'Better rights for persons with disabilities or reduced mobility: mandatory right to assistance on all services and full compensation for loss or repair of mobility equipment. Relevant information has to be given in accessible formats and rail staff must receive disability awareness training.'
- **'Enforcement, complaint-handling procedures and sanctioning:** clear deadlines and procedures for complaint handling and clear responsibilities and competencies of national authorities responsible for the application and enforcement of passenger rights.'
- **'Proportionality and legal fairness:** a "force majeure" clause will exempt rail companies from having to pay compensation in the event of delays caused by natural catastrophes, which they could neither foresee nor prevent. Under the current rules, rail companies have to pay compensation even when faced with such events.'

The ongoing efforts to codify and harmonise passenger rights, particularly across modes, will help ensure the success of the IP4 activities.

2.2.3 Passenger security

In 2018, the European Commission put forward an action plan to improve the security of rail passengers and staff by establishing a new cooperation and coordination framework with the aim of preventing and responding to possible terrorist attacks on rail services. One intention is to develop an EU Rail Passenger Security Platform which will provide a medium to enhance pan-EU information sharing and ensure collaborative decision making (European Commission 2018a). Such efforts to harmonise aspects of rail travel across the continent will support programmes like the IP4.

2.2.4 **Towards sustainable mobility**

In late 2019, the European Commission unveiled its plans for the European Green Deal, which Commission President, Ursula von der Leyen, described as 'Europe's man on the moon moment' (Euractive 2019). This roadmap aims to make the EU climate neutral by 2050 and promises a European Climate Law to turn the aims in law. Sustainable mobility is a key area of the Green Deal,



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with an aim to reduce transport emissions by 90% by 2050 (European Commission 2019). Two priorities will be helping boost different modes of transport and developing smart applications and mobility as a service solutions.

A previous agenda, 'Europe on the move' (European Commission 2017a) sought, through a comprehensive package of regulatory and support measures, to contribute to competitive, connected and clean mobility for all Europeans, by making traffic safer, encouraging smart road charging, reducing CO2 emissions, air pollution, and congestion.

2.3 Technological trends

The current trend in smart cities is to provide a common platform, on which many intelligent services can be delivered. The following are eight fundamental technological trends that act as enablers for the seamless multimodal passenger journey.

2.3.1 Mobile applications and services

Mobile apps are gaining much traction as part of the digital ecosystem and marked investment in the mobile app development industry by many tech giants has been witnessed in the past few years.

Mobile apps help organisations create brand awareness, deliver personalised content, boost customer engagement, and increase sales. The popularity of mobile apps can be made out by the fact that 1.96 million apps are featured in the App Store and 2.46 million apps are available on Google Play (as of the second quarter of 2019) (Smart Insights 2020).

The mobile app development industry has been greatly impacted by the advent of advanced technologies – the Internet of Things, Chatbots, Artificial Intelligence, Machine Learning, Blockchain, Augmented and Virtual Reality, etc, some of which will be explored further below.

2.3.2 Vehicle to Vehicle (V2V)

Vehicular communication systems are computer networks in which vehicles and roadside units are the communicating nodes, providing each other with information, such as safety warnings and traffic information (Wikipedia – Vehicular Communications Systems 2020). Indeed, V2V communications are used to reduce traffic accidents and increase overall safety.

V2V communication has a longer capability range (300 meters) than ultrasonic sensors, cameras, and radars, and can therefore alert drivers of dangerous situations earlier and more effectively. Moreover, V2V can be combined with radars and cameras to achieve even greater safety (Engineering.com 2020).



Figure 2 - Overview of V2X technologies

Companies actively working with V2V services include:

The 5G Automotive Association (5GAA): a global, cross-industry organisation of companies from the automotive, technology, and telecommunications industries (ICT), working together to develop end-to-end solutions for future mobility and transportation services.

CAR 2 CAR Communication Consortium: leading European vehicles manufacturers, equipment suppliers and research institutions join forces for the deployment of cooperative Intelligent Transport Systems and Services (C-ITS). The main objective of the CAR 2 CAR Communication Consortium is the development, testing and deployment of cooperative Systems in Europe based on inter-vehicle, vehicle to roadside and vehicle to other road user equipment short-range communication for improving road safety and road efficiency.

3rd Generation Partnership Project (3GPP): a standards organisation which develops protocols for mobile telephony.

The GSM Association (Global System for Mobile Communications): represents the interests of mobile operators worldwide (CPC document 'V2X Communication Technology').

2.3.3 Internet of Things (IoT)

The number of devices connected to the internet now exceeds the number of people on the planet (The Telegraph 2020). IoT enables the integration of communication, control and information processing across the transportation systems and thus allowing real-time interactions.

Vodafone highlights that today more than a third of organisations use IoT solutions for optimising processes, reducing operating costs, improving data collection, creating new revenue streams, or increasing revenue from existing ones (LORIOT 2020).





In order to introduce more legal regulations around the rapidly growing field of IoT, in 2019 the UK government drafted a new law, focusing on three requirements for the manufacture and sale of connected objects in the UK:

- 1. Devices must have unique passwords and no 'factory reset' option
- 2. Reporting functions for vulnerabilities must be created by all manufacturers
- 3. Consumers must be made aware of the minimum length of time security updates will be received for the products at the point of sale (GOV.UK 2020).

2.3.4 Big data

The rise of big data technology in the recent years due to rise in data generated by sensors, mobile devices, ICT and other sources allowed for continuous real-time analysis of data flow which is a fundamental element for transport operators and authorities by taking advantage of this data in their decision-making process related to optimizing services provisions and making informed decisions. In the ubiquitous smart city vision, big data analytics providers will have a fundamental role in the future of mobility since their solutions will guide decision-making at every level.

In big data environments, scalable cloud concepts eliminate the limiting local IT infrastructures of companies. A theme of "Wide Data" means that IT is increasingly looking at the fragmented, widely distributed data structures created by inconsistent or incorrectly formatted data and data silos.

In the past five years, the number of databases that exist for a wide variety of data types has more than doubled from around 160 to 340. The companies that will benefit most are those that manage to bring data together in a meaningful synthesis in the future (Medium 2020). Cloud facilities certainly help with this, as discussed more below.

2.3.5 Cloud computing and business services

Providers of services over the Cloud are becoming more agile with connectivity emergence to deliver connected transportation systems and integrated platform used for urban planning, security and safety purposes. Cloud infrastructure – public, hosted private and on-premises – is increasingly less siloed, allowing workloads to be more portable and data streams more mobile. Many emerging Cloud computing trends stem from the industry entering a phase of standardisation and increased compatibility (Tsidulko 2020).

Passenger Cloud was designed with the explicit aim of making digital services easier to manage, with a particular focus in the early days on simplifying transport data.

It does that by bringing together multiple customer touchpoints, for example apps, websites and kiosks, via an accessible all-in-one administration platform. This *Create Once Publish Everywhere* mantra unites networking planning teams, customer support agents and front-line marketers – often based in different geographical locations – behind the same source of information (Passenger 2020).

2.3.6 Digital twins

The concept of a digital twin is that of creating an entirely digital version of a site, complete with realtime data feeds.



In Los Angeles, one central city data management system was created as a digital twin of the entire city's transportation network. This central hub was then transformed into a compliance standard for technology companies. This meant that all road closures, construction data, and/or accident data were compiled into one "digital twin" system for the city (English 2020).

This improves the ability of the city to understand what's occurring on its streets day to day, and welcomes technological advancement e.g. delivery robots and autonomous vehicles with ease.

2.3.7 Location-based services (LBS)

LBS can be defined as information services provided by devices that are able to use device's location to modify the information they provide accordingly. LBS was valued at USD 36.2 billion in 2019, and it is expected to reach USD 126.4 billion by 2025 (Finance.yahoo.com 2020). Location data is a vital part of the mobile experience and enables some of the most widely used mobile apps, which can be used for many applications such as travel, navigation, searches, geo-social networking, mobile marketing, retail and advertising. Mobile users are increasingly expecting personalised access to information and services from their mobile devices anytime and anywhere. Continued growth is forecast in navigation, social location networking, local search/local advertising, fleet and asset management, and field-force automation, among other markets. Indoor positioning and navigation of travellers and communication with their devices in all situations are also of the highest importance in this context.

With the increase in the number of smartphone users, location-based technologies are emerging at a faster pace, and hence, diversifying its business providing various applications on location base data. This technology will enable new forms of location-based experiences aiming to make travels more engaging and attractive as well as homogeneous and innovative multimodal user interfaces enabling travellers to ubiquitously access heterogeneous services such as Travel Shopping and Ticketing.

Opti-Trans is a project proposed by the GSA (European Global Navigation Satellite Systems Agency), to create Optimised Transport System for Mobile Location Based Services.

The OPTI-TRANS GNSS-enabled mobile application will incorporate an innovative profile manager, allowing the user to create several desired profiles containing preferences pertaining to preferred mass transport means, vehicle availability etc.

This platform will be based on the automated taxi-on-demand system which currently incorporates the optimum matching of taxis to commuters, by extending the platform to mass public transport routing and timetable information, as well as car-pooling services, to provide the user with the optimum multi-modal journey planning.

The OPTI-TRANS server will interface with public transport authorities' databases and provide upto-date and reliable information on public transport routes and timetables, as well as cancellations and abnormal traffic conditions (Gsa.europa.eu 2020).

This increased ability to collect and manage data is improving mobility solutions for the entire world. Mobility has shifted from an analogue space focused on getting from point to point, to a highly digital space that focuses on saving lives, eco-friendliness, using as little fuel as possible, and maximising human efficiency and well-being (English 2020).





MULTIMODAL MOBILITY CHALLENGES 3.

Multimodal travel faces many challenges to successful operation. In this section, we examine the key challenges from the perspectives of passengers, Transport Service Providers (TSPs), and local authorities.

3.1 Passenger perspective

The challenges passengers face in taking multimodal journeys are numerous and vary greatly across individuals and journey types or purposes - i.e. the challenges are context-dependent. These specificities will be teased-out in deliverable D3.3 through the development of personas and the medium of user journeys. More details on the specific needs and pain-points of specific groups are also available in the Transport Systems Catapult literature review 'Major Needs and Pain-Points experienced on Multimodal Journeys', which complements the current report.¹ Furthermore, the 'heatmap' appendix to D3.3 provides a graphical overview of passenger needs and wants across a variety of segments.² In what follows, however, based on the findings of this literature review and some further research to identify more Europe-wide applicable sources, we discuss in more general terms the most common and significant cross-cutting challenges facing passengers making multimodal journeys.

The categories below emerged from the literature and match up with those in the heatmap. It is important to present a holistic picture of the passenger experience; however, it is not the aim of IP4 to address all these categories but rather to provide IT services to improve the traveller experience. We outline in subsequent chapters the opportunities for where IP4 activities can contribute to addressing identified needs.

3.1.1 Overall experience

Overall, travellers seek to reduce the complexity of their journeys. When passengers consider switching to a new mode of transport, the new experience must offer equal or greater levels of flexibility and convenience. Multimodal transport presents extra challenges in reducing this complexity for the traveller. In fact, the Transport Systems Catapult's Traveller Needs study identified that public transport is associated with 'twice as many pain-points' as travelling by car and that 'each additional transport mode in the journey, the number of pain-points experienced by the traveller increases' (Transport Systems Catapult 2015: 18). While some level of standardisation (e.g. ticket times, optimisation of interchanges) may exist across operators within a given mode, such interoperability is rarer across modes. This leads to a marketplace where passengers have to manage the search and purchase of their itineraries themselves, by interacting with very different interfaces covering only partial elements of their trip because of the lack of end to end, one stop shop experience.

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Issued

¹ Transport Systems Catapult (2018). 'Major Needs and Pain-Points experienced on Multimodal Journeys. Literature Review Cohesive WP3, T3.1.1'. (Unpublished).

² Appendix 5.1 to D3.3. 'User Journey Heatmap'





3.1.2 **Planning the journey**

Exploring when and how to travel.

Passengers often find journey planning to be complicated and confusing and seek to reduce the complexity of their trips (Transport Systems Catapult 2015: 3). For some, embarking on a journey, particularly one that may be unfamiliar, can be a daunting experience. The problem can be particularly acute for visitors or tourists trying to understand how a local public transport system operates (Li and Voege 2017). Backing this up, a 2018 Eurobarometer survey of over 25,000 travellers across Europe found that 92% said that "the provision of quality information about timetables and platforms is important", with 69% saying it is very important (2018: 62).

Scope for IP4 activity in this area: <u>Yes – Planning the journey can be complicated, confusing, or</u> <u>daunting.</u>

3.1.3 Pricing

Cost of journey.

The cost of rail travel is a frequent concern for passengers (ORR 2015a, Transport Systems Catapult 2015), particularly for some groups such as young people (Campaign for Better Transport 2013, Transport for London 2012).

In addition, it must be remembered that other costs associated with travel also have a bearing on passengers' experiences. For example, the ORR highlights the costs of station toilets and refreshments as pain points to rail travel (2015), and the Transport Systems Catapult raises a similar point about car parking (2015).

An important point is that travellers seek to better understand pricing and when and how to travel most affordably (Transport Systems Catapult 2015).

In D3.2, we will look into research on innovative pricing mechanisms, such as multi-modal pricing, MaaS packages, or group travel pricing.

Scope for IP4 activity in this area: <u>Yes – Pricing (and best value) can be unclear. Non-ticket expenses</u> are also important.

3.1.4 Offerings

Availability of routes and times, as well as other facilities such as shops/toilets.

The availability of suitable routes and times is an important factor in the desirability of rail, and by extension, multi-modal travel. Relevant considerations include whether public transport routes reach desired destinations (Campaign for Better Transport 2013), the frequency of services on a given route (ORR 2015a), and the relative lack of flexibility afforded by public transport schedules (Transport Systems Catapult 2015).

Furthermore, some groups in particular (leisure travellers and visitors or tourists), highlight the importance of the selection of shops and restaurants at stations, especially during delays (ORR 2015a, Transport Systems Catapult 2016). On the train, business customers value access to high





quality refreshments, while leisure customers also desire this but are more concerned that refreshments are affordable (ORR 2015a).

Scope for IP4 activity in this area: <u>Partial – By providing information and easy access to purchases</u> or deals.

3.1.5 Booking

When journey booking is possible, and facility to book seats.

Most needs and pain points around journey booking relate to the ease of doing so. The process should be easy and straightforward, and with the ability to pre-book seats (ORR 2015a).

Many leisure travellers, in particular, desire the ability to book further in advance (ORR 2015a).

Scope for IP4 activity in this area: Yes - Booking travel can be complicated/not straightforward.

3.1.6 Purchasing

Availability and ease of suitable means of purchasing tickets.

As with booking, purchasing tickets should be as easy and understandable as possible, with a variety of payment options, and with the option to download tickets onto one's phone (ORR 2015a). One group that can find ticket purchasing particularly challenging is visitors or tourists (Li and Voege 2017). In the Eurobarometer study, 92% of respondents said that the easiness of buying tickets is important (2018:67), while 75% said they are satisfied with this (81% among rail travellers only) (2018: 41). This survey gives further details, showing that 86% of rail travellers say the importance of through tickets are important to them (2018: 69), while 84% say the same for tickets covering several modes of a journey (2018: 71).

Scope for IP4 activity in this area: Yes - Purchasing ticket is not always as easy as it might be.

3.1.7 Negotiating travel

Ease of making the journey, including wayfinding and access.

Many travellers find navigating train stations difficult, and this is particularly the case for people with mental or physical impairments, for visitors or tourists, or during busy periods. Specific difficulties can come in access to assistance, intuitive wayfinding, clear signage, and overcrowding (Oliveira et al. 2017a; Transport Systems Catapult 2016). For passengers with various forms of disability, problems can be exacerbated in terms of accessing and negotiating platforms (ORR 2015b) or comprehending the implicit information in the station or understanding where/when to get off the train (Mackett 2017).

Scope for IP4 activity in this area: <u>Yes – It is not always easy to understand how to undertake a</u> journey – e.g. wayfinding, connections, accessibility.



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3.1.8 Communications

Availability of information in appropriate media during journey.

Across the reviewed literature the availability and suitability of communication comes up regularly as both a traveller need and a pain point. For example, according to Eurobarometer, 86% of travellers (and 90% of rail travellers) report that the 'provision of quality information on connecting services with other modes of transport' is important (2018: 62).

The most prevalent issue identified by customers during the journey is easy access to relevant information and assistance, such as regarding service disruption or up-to-date status on the subsequent legs of their planned trip (Oliveira et al. 2017a, ORR 2015a, Transport Systems Catapult 2016). For some, this should include present, visible, and helpful staff on the train (Oliveira et al. 2017b). For some groups, such as visitors, tourists, or young people, relevant accessible information includes guidance on how to use the local public transport (Transport for London 2012).

Related to the previous point, passengers require information to be available in a suitable format or medium – this is especially important for older travellers, or those with disabilities or impairments (Mackett 2017, ORR 2015b, Transport Systems Catapult 2016). Problems can include, for example, difficulty in seeing or hearing announcements, or reading digital information (ORR 2015b). Where passengers are making journeys with multiple modes or operators, the problem may be exacerbated by having multiple platforms giving the information.

Further, customers desire context-specific information – that is, information customised to their current situation (ORR 2015, Sochor et al. 2014). This personalisation can extend to allow communication in the other direction, for example to inform staff of specific needs (ORR 2015b).

Finally, many passengers would like up-to-date information to facilitate the progress of their journey, such as on seat availability or carriage occupancy levels (Oliveira et al. 2017b, Transport Systems Catapult 2016).

Scope for IP4 activity in this area: <u>Yes – Relevant communication is not always timely, available, or</u> in the best format/medium.

3.1.9 Help

Availability and quality of assistance during journey.

The Office for Rail Regulation highlights the lack of access to assistance at stations as being a common problem for those who need it. In particular, their study notes the desire to speak to a real person for help (while recognising that 'un-helpful' staff can be a common complaint) (ORR 2015a).

Scope for IP4 activity in this area: Partial (if able to provide access to virtual support)

3.1.10 Comfort and space

Personal comfort and cleanliness of transport and facilities.

Across the reviewed literature and the different passenger segments, issues around the comfort and ease of the travel experience rose commonly. The main concerns include seat availability (ORR





2015) and the challenges of overcrowding and being forced to stand (ORR 2015a, Oliveira et al. 2017a, 2017b, Transport for London 2012, Transport Systems Catapult 2016). Eurobarometer data suggests around seven in ten across Europe are satisfied with seat availability (2018: 117). Another area of concern is in the facilities for desired activities, such as space to work (Oliveira et al. 2017b) or the availability of a power socket (ORR 2015a). And the ORR note the need for suitable luggage space (2015a) while the Transport Systems Catapult highlight the capacity to effectively move luggage (2016).

Finally, across Europe, 94% of travellers say that the cleanliness and good maintenance of stations is important (2018: 77), while only 56% respond that they are satisfied with the cleanliness and good maintenance of rail carriages (2018: 113).

Scope for IP4 activity in this area: <u>Partial – Could provide information on carriage occupancy, luggage</u> racks, etc.

3.1.11 Wi-fi

Availability and quality.

A frequent challenge for passengers is lack of or insufficient data connectivity, particularly when ticketing or relevant information relies on this (ORR 2015a, Transport Systems Catapult 2015). The Eurobarometer survey indicated that across Europe, only 41% are satisfied with the availability of Wi-Fi on trains (2018: 107).

Scope for IP4 activity in this area: No

3.1.12 Efficacy of mode

Primarily related to reliability. Trains run as scheduled and connections efficient

It is important to passengers that their chosen mode is punctual (ORR 2015a, Transport Systems Catapult 2015), reliable (Sochor et al. 2014, ORR 2014), and not too time consuming (ORR 2015a, Transport Systems Catapult 2015), that connections between modes are efficient (Transport Focus 2018). The Eurobarometer data shows that just 59% of respondents across Europe are satisfied with the punctuality and reliability of rail travel (2018: 4).

Scope for IP4 activity in this area: No

3.1.13 Security and safety

Do travellers feel safe and secure?

Several studies note the crucial importance for travellers of feeling safe and secure during their journeys. Concerns are travelling (or waiting) alone (Campaign for Better Transport 2013; Mackett 2017) and relatedly travelling after dark (Campaign for Better Transport 2013; Transport for London 2012). Oliveira et al. note that safety concerns can particularly affect older travellers (2017b).

Scope for IP4 activity in this area: No (although could potentially offer advice on routes/safety.)





3.1.14 **Compensations**

Information around compensation rights/process when things go wrong. Ease of securing compensation.

Travellers want to easily understand their rights to compensation and the processes for claiming this; desire appropriate remedial services for disruption (such as replacement coach or taxi services; and display a preference for receiving cash rather than vouchers as compensation (ORR 2015a).

Scope for IP4 activity in this area: Yes - The compensation process needs to be clear and easy.

3.1.15 **Complaints**

Information around complaints procedures and ease of doing so.

Research from the Office for Rail Regulation indicates passenger frustration with complaints procedures being time consuming and not customer-centric (ORR 2015a). In the Eurobarometer study, 81% of rail travellers (and 79% of respondents overall) say that easy and accessible complaints-handling is important (2018: 74). Only 40% (38% overall) are satisfied in this regard (2018: 52).

Scope for IP4 activity in this area: Yes - The complaints process needs to be clear and easy.

3.1.16 Reconciling tickets

The ability to use the ticket as evidence to adjust travel or claim expenses.

The Office for Rail Regulation report notes that passengers desire an easy way to use their tickets for activities such as expense claims, ideally through a website (ORR 20515).

Scope for IP4 activity in this area: <u>Yes – Using tickets for activities like expense claims should be easy.</u>

3.1.17 Summary of passenger challenges and scope for IP4 activity

Table 4, below, summarises the main challenges identified for passengers and outlines scope for IP4 activity.

Торіс	Scope for IP4 activity	Торіс	Scope for IP4 activity
Planning the Journey Planning the journey can be complicated, confusing, or daunting.	Yes	Comfort and Space It's not always easy to find seats/luggage space	Partial
Pricing Pricing (and best value) can be unclear. Non-ticket expenses are also important.	Yes	Wi-fi	No
Offerings	Partial	Efficacy of Mode	No

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Knowledge of available			
amenities/facilities not always			
clear.			
Booking Booking troublean be		Security and Safety	
complicated/not	Yes		No
straightforward.			
Purchasing		Compensations	
Purchasing ticket is not always	Yes	The compensation process	Yes
as easy as it might be.		needs to be clear and easy.	
Negotiating Travel		Complaints	
It is not always easy to		The complaints process needs	
understand how to undertake	Yes	to be clear and easy.	Yes
a journey – e.g. wayfinding,			
connections, accessibility.			
Communications		Reconciling Tickets	
Relevant communication is not	Voc	Using tickets for activities like	Voc
always available, or in the best	165	expense claims should be	165
format/medium.		easy.	
Help			
Access to assistance is not	Partial		
always simple.			

Table 4 - Passenger challenges and scope for IP4 activity

3.2 Travel Service Provider (TSP) perspective

The insights for public transport operators are based on a series of engagement activities, including a survey of Train Operating Companies (TOCs) and IMs, a meeting with the Rail Delivery Group, and further consultation with project partners at the mid-term conference of Co-Active and ATTRACkTIVE. These initial findings have been added to in June 2020 through in-depth interviews with two TSPs (one of whom is based in Portugal and the other in Italy) and a survey sent to the COHESIVE Advisory Board, which consists of a number of high profile TSPs and travel authorities. We contacted 10 representatives from the Advisory Board and received 5 responses. The combined insights from all these activities are summarised below.

3.2.1 Data governance in MaaS

Data ownership and the willingness of TSPs to share data within a MaaS ecosystem such as that in IP4 are amongst the main challenges for using the data operated by the MaaS platform. TSPs connected to the MaaS system may be reluctant to share information that has a high commercial value (e.g. for a vehicle sharing service provider, the locations where users are typically taking the vehicles, users' preferences, etc.). There are data governance models that can ensure the appropriate balance between protecting individual data ownership and enabling data access and usage by MaaS providers, and these would be key to promote MaaS operation and development.

Scope for IP4 activity in this area: <u>Yes – Data ownership and usage can be explored</u>





3.2.2 Data protection and cybersecurity

TSPs with interconnected data systems flowing throughout the value chain are particularly vulnerable and face the possibility of a cyber-attack interrupting physical networks and causing significant disruption. With a multimodal ICT system, public operators and TSPs, particularly, have to ensure a guaranteed resilience towards these attacks. The security challenge also exists in booking and ticketing processes where financial data are managed.

It is important to consider security for Intelligent Public Transport to protect the operators, the economy and the life and safety of citizens. However, TSPs face several challenges in this direction: there is currently no EU policy on cyber security for transport, the awareness level is low, and it is difficult for operators to dedicate budget to this specific objective of cyber security.

Scope for IP4 activity in this area: Yes - Data protection can be explored

3.2.3 Data access and interoperability

Data is a key component of transport innovation and making better use of travel data has the potential to positively impact planning, creating an efficient travel ecosystem, and opening-up business opportunities. However, TSPs stated that data is often expensive to collect and integrate and sometimes private operators are unwilling to share. Therefore, one of the main challenges in the marketplace for public operators is the access to data; timetables, prices, links with other modes, specific information related to traveller preferences, real-time information on the journey, etc.

More technically, they stated that data standardisation can be challenging, especially for integrating different modes of transportation. Even though data standards already exist in the rail sector: TAP, TSI, SIRI (Service Interface for Real Time Information), amongst others, it is different for other sectors such as air. Some of the fundamental obstacles currently impeding the deployment of true multimodal ICT systems include:

- The multitude of data formats across modes and services
- The absence of connectivity standards for ICT systems across modes and actors
- Low availability of good quality data, including real-time data
- High integration costs due to non-interoperable ICT systems
- Reluctance to sharing data and services from actors benefiting from the current fragmentation

Scope for IP4 activity in this area: Yes - these are key factors

3.2.4 Regulation

Respondents stated that regulation should have the intention to facilitate, but that in their experience it is more of a hindrance. When it impedes certain technology it can slow innovation. Regulations are enforced, for example, with regards to distributing timetables in rail, which companies need to comply with.

Distinct approaches exist to open source data for EU countries. Regulation at EU level on data accessibility is recommended, for example, the MMTIS Regulation (2016/1926) is an important step in this direction. The implementation of National Access Points now needs to be monitored, and possibly the rules on data sharing will have to be revised (to include more dynamic travel information





and more information on fares to enable not only multimodal travel information but also booking/ticketing). Finland was perceived by a respondent as being advanced in this respect, as they have introduced the obligation for mobility service providers to provide third parties (e.g. MaaS operators) access to their APIs for booking and ticketing. The data should be available as much as possible as open data according to the 'Open Data Directive' (Directive (EU) 2019/1024).

Scope for IP4 activity in this area: No

3.2.5 **Technology disruption and new business models**

When considering the IP4 solution, a combination of transit, shared mobility, non-motorised and other modes of transportation has the potential to generate a tipping point and become more attractive than vehicle ownership. New business models are merging from the MaaS concept, such as total mobility providers and mobility aggregators. The availability of data generated from personal and other sources is impacting the mobility industry where public transport services should be based on meeting the needs of users. This data can help operators understand the who, why, where and what the needs of passengers are.

There are lots of apps now that offer integrated information to passengers, making information more uniform and easier to search as there is no longer the need to search in different places for how to get from point to point.

One respondent was of the opinion that customers are customers of public transport rather than being customers of particular operators. One of the marked changes in the transport sector is a trend towards less captive users, i.e. someone who uses a particular mode for the majority of the trip. More and more people now try to combine modes, and the way society has been evolving is leading to a change in travel patterns that tend to become more complex. In the past, the typical commuter would go from home to work in the morning and back in the evening. Nowadays there is increased prevalence of alternative working patterns like remote working, working from home, etc. which complicates understanding of travel patterns.

There is a desire from some TSPS to be an operating system of mobility, i.e. own the hardware and through digitalisation enable others to create mobility services. The focus is not just on selling tickets to individuals – rather it is also on providing new services to different stakeholders, e.g. for a museum to attract visitors and organise an expedition. Rather than trying to intuit what passenger needs are, as they interact with a system the TSP can understand what they are doing. For example, if buying a ticket to a station, the station is not their desired destination – the passenger's real purpose of travel will be to go to work, visit a friend and more. But this picture isn't clear from just seeing what tickets they buy from one station to the next.

Scope for IP4 activity in this area: Potentially - new business models may become apparent

3.2.6 Decentralisation and sprawling cities

Continued urbanisation and growth of cities leads to both residential and commercial real estate moving further away from the centre i.e. decentralisation. One of the main issues for TSPs is fixity of their rail and subway systems and this decentralisation leads to increasing complexity in the transit system with long commutes and drive-time traffic woes. Transit agencies could work towards a smart





and comprehensive set of options for its users that include multiple modes of transportation to speed commutes.

Scope for IP4 activity in this area: No

3.2.7 Large fleets, larger costs

TSPs in growing urban areas are managing larger fleets of vehicles over time, and therefore more employees, which leads to increasing maintenance costs as well as costs related to attracting, training, and retaining skilled workforce that contribute to increased safety and fewer lost-time accidents. The adoption of technology systems becomes crucial for better route scheduling, maintenance tracking and employee scheduling, and can reduce costs and downtime as can the implementation of better tracking, mapping and communications systems on the vehicles themselves.

Scope for IP4 activity in this area: No

3.2.8 Economics

There will be likely changes to the work pattern, which may see TSP business models challenged. For example, the rise of the Tuesday, Wednesday and Thursday commuter; increased flexible working (particularly as a result of remote working patterns changing with Covid-19) and the erosion of the standard 'peak' travel times.

Scope for IP4 activity in this area: Yes – this is a key factor

3.2.9 Scaling the geographic coverage of MaaS offerings

The extent of application is an important success factor for MaaS: not only in terms of modes covered but also in terms of geographic scale: city – region – country – or even international. Mobility and mobility needs do not stop at the borders.

Most MaaS schemes are currently limited to the local (at most, regional) level. At the moment, MaaS implementation is scattered. Open standards and interoperability are needed to ensure scalability and 'roaming' across borders.

Most trips are not cross-border, so the local level is really important for daily mobility. However, MaaSlike cross-border systems are also crucial to make longer distance travel across Europe more sustainable (and encourage a shift to rail from road and air transport).

There are multiple solutions being offered by companies such as Uber to use integrated services across geographies. One TSP stated that a regional MaaS solution is relatively easy to implement inside Germany or other western European countries. However multistate or across countries would mean a wide range of stakeholders that need to convene, which also means an agreement to use a singular MaaS service model, and agreement about who the user-data belongs to.

Scope for IP4 activity in this area: Yes

3.2.10 Summary of TSP challenges and scope for IP4 activity





Table 5, below, summarises the main challenges identified for TSPs and outlines scope for IP4 activity.

Торіс	Scope for IP4 activity
Data Governance in Maas	
Data ownership and the willingness of TSPs to share data within a	Mar
MaaS ecosystem such as that in IP4 are amongst the main	res
challenges for using the data operated by the MaaS platform.	
Data Protection and Cybersecurity	
With a multimodal ICT system, transport service providers have to	Yes
ensure a guaranteed resilience towards data and cyber attacks.	
Data Access and Interoperability	
Access to travel data has a huge impact on planning, creating an	
efficient travel ecosystem, and opening-up business opportunities.	Yes
Data standardisation can be challenging, particularly across	
different modes of transport.	
Regulation	No
Technology disruption and new business models	
Technology disruption is leading to rapid maturing and turnover of	
technology. New business models are merging from the mobility-	Potentially
as-a-service concept, such as total mobility providers and mobility	
aggregators.	
Decentralisation and sprawling cities	No
Large fleets, larger costs	No
Economics	
Changing working patterns, flexible and remote working	Yes
arrangements may impact the mobility landscape.	
Scaling the geographic coverage of MaaS offerings	
The extent of application also applies to geographic scale: city –	Yes
region – country – or even international.	

Table 5 - TSP challenges and scope for IP4 activity

3.3 Local Authorities perspective

Cities and other local authorities play a major role in fostering a sustainable and efficient transport systems. Some of the most pressing factors currently facing local authorities across Europe are described below. These can be seen as their mobility 'needs'. These issues are not discussed here in great depth, as each is well-documented elsewhere. Instead, we briefly highlight the relevance of the issue to the IP4 programme. Further engagement with three local authorities across Europe is planned for inclusion in D3.2.

3.3.1 Traffic congestion

Traffic congestion is a major problem across Europe's towns and cities, estimated to cost around 1% of the continent's annual GDP (European Commission 2020e). Large numbers of vehicles carry only a single occupant. INRIX data indicates that in 2019, per driver, the "number of hours lost in congestion during peak commute periods compared to free-flow conditions" was 149 in London, 140 in Brussels, and 71 in Madrid (INRIX 2019). Congestion is exacerbated by the ever-growing numbers





of couriers driven by expanded use of online shopping. This congestion contributes to negative environmental, economic, health, and social impacts. Local authorities can offer some mitigation through infrastructure improvements, however real change can only come through reducing the numbers of vehicles on the roads. Creating and investing in multimodal mobility initiatives to enhance public transportation services can contribute to this challenge.

Scope for IP4 activity in this area: Indirectly, through driving increased use of public transport

3.3.2 Environmental challenge

Directly related to the issue of congestion, decarbonisation is a major priority for growing numbers of cities. Air quality and noise pollution constitute important challenges for local authorities, contributing to damaging quality of life and the health of urban populations. Local authorities are reacting. More and more local authorities are establishing car-free areas (Wikipedia – List of car-free places 2020), introducing forms of low-emissions zones (urbanaccessregulations.eu 2020, Wikipedia – Low-emission zone), or declaring 'climate emergencies' (Covenant of Mayors for Climate & Energy 2019).

Promoting public transport and active travel are necessary measures to help local authorities address environmental challenges. This will require taking action to improve the efficacy of multimodal transport.

Scope for IP4 activity in this area: Indirectly, through driving increased use of public transport

3.3.3 Land use

Interlinked with the problem of congestion and the challenge of decarbonisation, local authorities, particularly those in cities, face complex, competing demands for land. The scale of transport infrastructure, particularly the road network and parking infrastructure, contributes greatly to the problem. Innovative, customer-oriented mobility services have the potential to reduce the need for people to own a personal vehicle which may, in turn, result in decreased parking demand and road space needs. This can free up valuable urban land to be used for development, greenspace, public space, or active travel infrastructure.

Scope for IP4 activity in this area: Indirectly, through driving increased use of public transport

3.3.4 Barriers to innovation

Lack of finance and outdated legacy infrastructure are major barriers to the introduction of innovative transport technology and business models. This leads to a lack of innovative SMEs due to high upfront investment costs and complex contractual setup.

Scope for IP4 activity in this area: No

3.3.5 Summary of Local Authority challenges and scope for IP4 activity

Table 6, below, summarises the main challenges identified for local authorities and outlines scope for IP4 activity.





Торіс	Scope for IP4 activity
Traffic Congestion	Indiractly
Need for attractive options to drive use of public transport network.	maneetry
Environmental Challenge	Indirectly
Need for attractive options to drive use of public transport network.	maneetry
Land Use	Indiractly
Need for attractive options to drive use of public transport network.	munectly
Barriers to Innovation	No

Table 6 - Local Authority challenges and scope for IP4 activity





4. STAKEHOLDERS OPPORTUNITIES

4.1 **IP4 ecosystem added value/advantages**

The objective of the IP4 COHESIVE project is to answer the challenges detailed in Chapter 3 by providing more innovative, attractive and end-user-oriented rail services, and by providing a general framework for multimodal transport. In particular, IP4 will lead to a dramatic increase in the attractiveness of rail travel, generating sufficient growth in demand to support a major shift to rail through:

- A seamless travel experience a complete multimodal travel offer, connecting the first and last mile to long distance journeys, combining air, rail, coach, and other modes of transport or services.
- Seamless access to all travel services the travel experience will be totally enhanced through the integration of a wealth of travel services supported by innovative digital technologies.

Figure 3**Error! Reference source not found.** below gives an overview of the seamless travel experience with access to all services within the journey.



Figure 3 - IP4 seamless travel experience

This core objective of extended seamlessness will be answered though the introduction of a groundbreaking 'Technical Enabler' driven by two key concepts:

- The travel experience becomes a 'product', with the traveller placed at the very centre. This user-centric shift ensures that multimodal travel services mask the complexity of the transport system and offer a whole new door-to-door travelling experience with strong appeal, simplified access and trusted reliability.
- An open published framework will allow unprecedented service interoperability whilst limiting impacts on existing systems, without prerequisites for further centralised standardisation.

The 'Interoperability Framework' should provide technical interoperability by enabling the creation of an open 'Web of Transportation', a shared distributed database of transportation data built according to internet technologies. Linked data principles and supported by semantic web will be considered, besides ultimate advances in big data technology for the multi-formats data management. It aims to provide a shared, fully described and machine-readable abstraction (ontologies) of transportation



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data and services provided and consumed by information systems independently from their internal organisation and representation.

Rather than developing a 'one size fits all' solution, the IP4 programme will provide a 'Market Place' that enables participation by market players and new entrants alike, and where all transport stakeholders will find an open-ended world of data and service resources, which can be combined for improved services. Furthermore, IP4 will be completely distributed (no centralisation of data) and modular while providing the mechanism to access, interpret, orchestrate and process data in any standard by the interoperability framework.

Table 7 summarises the main objectives of IP4 and provides an overview of some of the expected concrete deliverables.





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Objective	Result	Practical
	Provide a 'one-stop shop' to the customer (able to handle any mobility query) and give visibility to all accessible trips	'Travel Shopping' will propose specifications and reference implementation designed to be scalable to all transport modes, all operators and supports shopping over all types of distribution channel (direct indirect online, offline, etc.)
Enhance the capacity/ user demand of the European Rail System	Provide a unified access to ticketing services for all transport modes, regardless of their location, access method or format, validation process Provide a personal 'guardian angel' which gives access to all information, additional services, and simplify the user travel experience	(direct, indirect, online, online etc.) 'Booking & Ticketing' will provide specifications and reference implementation covering 100% 'standard' entitlements (air, train, long- distance bus, daily/weekly passes, Origin-destination/zonal, etc.) Reference implementation of a 'Travel companion' with innovative human-machine interfaces
	Better adaptation between supply and demand	'Business analytic' will provide all the tools to refine the supply of the operators and better satisfy the users
Consolidate the reliability/ quality of services	Increase the resilience of the rail system for the passengers	The 'Trip tracker' will provide real-time information on the current trip legs, including any mean to adapt the journey and re-accommodate part of the trip if needed
Improve on Life Cycle Costs /Competitiveness	Foster an extended competitive market of advanced applications and interoperability products and services	Open specifications, detailed open interfaces, and access to the open interoperability framework will offer to any European travel industry player the tools to develop competitive and smart services, based on the framework defined in IP4. Amount and heterogeneity of data and improved 'Business analytics' process allow more efficient operations and use of resources

Table 7 - IP4 objectives and deliverables

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4.2 Added value for passengers

Passengers are the end-users who will benefit from the IP4 solutions. However, it is important to note that end-users belong to different groups with different requirements, perceptions and attitudes that can affect modal choice in a multimodal transport environment.

In terms of added value to passengers, an integrated planning, booking, payment, ticketing, routing and validation solution across all transportation modes is an improvement in quality, as it enables enhanced ease of use, flexible mode choice and easier interchange, as well as saving time and money. This is particularly true for existing public transport end-users, who can immediately understand the added value. However, supporting this with further quality improvements designed to not only increase reliability, speed, and frequency but also provide in-trip assistance and location-based services and recommendations will play a decisive role as well to attract more car users. Therefore, the IP4 solution (combining seamless multimodal travel offer with access to travel services and a personal assistant) could also be a very attractive result for non-frequent public transport users.

IP4 is putting the traveller back at the centre of the transport infrastructure which will improve passenger experience and satisfaction through offering the following added value to the user's journey:

- One-stop-shop: convenient multimodal travel with comparison and wide choice from completely exhaustive list of services of all mobility providers.
- Stress-free switching from one mode to another.
- Transparent traveling information with accurate real-time re-routing solution in case of travel disruption (traffic jam, weather, rebate, incidents, etc.)
- Single authorisation that makes usage of all mobility services possible
- One-click planning, booking and payment
- Customised individual mobility packages and personalised offerings: Offer of tailor-made solutions considering customer profile, preferences, lifestyle, budget.
- Attractive prices and bonus programs within the mobility wallet.
- Travellers have one trusted door-to-door mobility provider.

4.3 Added value for Transport Service Providers

Public transport providers are an important stakeholder in the multimodal mobility ecosystem and could gain huge benefits from the IP4 solution. For operators, it is no longer simply enough to provide train, tram or bus services. They need to diversify their offer, which will help them gain market leadership by providing a wider range of services which are relevant to both transport and mobility platforms. The added value of a seamless multimodal travel experience and access to all services are significant for transport service providers and can be summarised as follows:

4.3.1 Economic

- IP4 solution could reduce administrative costs (e.g. fewer cashiers needed) and reduce fare processing times. This would allow a better throughput of passengers.
- The interoperability framework will reduce or even eliminate development and integration costs of legacy systems and new systems/actors.





- Optimisation through keeping track of time and duration of service usage, and whether your service is combined with other transport offerings, enables operators to continuously improve their service and optimise asset utilisation and energy savings.
- Easy monetisation: Monetising with additional sales channels through partners (merchant near train stations and advertising partners) and through passengers with increased ticket sales given improved passenger experience, marketing of targeted offers and special deals combinations of different services.
- Connecting data sources through the interoperability framework can lead to an enhanced offer for customers.
- Reduced payment of compensation to customers by increasing the number of customers delivered to their destination within the service agreements.

4.3.2 Strategic

- Cooperation: becoming more open and willing to cooperate with other transport service providers to offer new services and become an integral part of the local urban transport system. There will also be means to improve interchanges so that customers can more readily access alternative modes of transport from the one they were travelling on.
- Open new business opportunities, by enabling better integration of alternative services into the scheme, making it more attractive for customers to use it.
- Growth: becoming a provider of an integrated mobility solution would increase revenue and passenger traffic through benefiting from a wide audience and stronger presence and visibility on the local mobility market.
- Deliver best value to end-users with a better price differentiation strategy and easier access to customers via different channels.
- Passenger data analysis holds enormous potential for better understanding of customers' needs and preferences; including traveller profiles, journeys as well as travel behaviour, spending habits and preferred places to be or points of interest. TSPs can use this data not only to understand the ecosystem and how small changes, several miles away, can have an influence but also save money understanding passenger flow which also improve safety and security at stations. Furthermore, this information can be used to better exploit the network's capacity, to offer personalized advertising, create targeted value creating offers such as entertainment and catering or services relating to family or business needs along with loyalty and bonus programs also.
- Public Relations: improved customer service and better experience for passengers with restricted mobility.
- Increased efficiency: better contracting of services (you know what services people use, and which they don't).
- Enhancements: One barrier many TSPs face is that they cannot justify and quantify the benefits of enhancements to the infrastructure. Better data can help them understand the potential benefits of a project and quantifying the benefits post project completion.
- A further potential benefit is the ability to offer MaaS packages and integrate with bike sharing, scooter sharing, etc. Also, cross discounts with some mobility partners in the city – e.g. if users have a monthly card, they can get a complimentary mile on the bike sharing, or if they park their car outside the city, they gain a discount on public transport.





• Another possibility is that as part of multimodal offerings people have information about the associated environmental implications via different options, which also has competitive appeal for tourists.

4.3.3 Technical

- Semantic approach and respect of standards through the interoperability framework will guarantee technical interoperability and removal of open points.
- Improved control over transaction tracking which will limit fare evasion and fraud but also improve cyber security system in place.
- Algorithms to predict and anticipate impact on traffic would allow better responsiveness to incidents and crisis and a more efficient operations during large scale events.
- Support for GDPR compliance; security features of the IP4 interoperability framework meet the GDPR requirements.

4.3.4 New markets

- Modelling future opportunities for new/emerging transport types. The big data environment could enable more accurate modelling of new transport types. This reduces the barrier to entry of these types of transport and could help create a step change in mass mobility
- New travel-related services: there is a potential need to insure journeys (such as the need to guarantee the risk of a bus failing to deliver people to their flights, so missing it). This means that there could be a new marketplace where organizations sell "MaaS insurance". It also could challenge the model of reimbursement and compensation in the transport sector. In fact, complex deals between train operators and the rail infrastructure (especially in UK) that see money pass from one to the other; train delays caused by infrastructure failure, and train delays caused by train crew issues could be replaced by a paid-for service by both sides to insure against the risk.
- Potentials for expanding service offer into complementary market segments (e.g. tourism, access to public services, etc.), opportunities for enhancing support to Public Authorities in understanding mobility demand and improving policies.

4.4 Added value for Local Authorities

Having identified in the previous chapter a series of challenges local authorities are facing related to delivering mobility services, we outline here how the IP4 programme can provide opportunities or deliver added value for these bodies. Local authorities can have a facilitating role in implementing IP4 solutions and in coordinating the different mobility service providers and the efficient use of infrastructure. We foresee benefits for local authorities from the IP4 programme falling under four main categories: governance, value capture, environmental benefits, and security and safety.

4.4.1 Governance

- Vision on and continuous understanding of transport flows
- Improved urban mobility planning and understanding of mobility needs
- Coverage of additional number of mobility modes
- Improve rural and suburban travel and offer enhanced mobility opportunities for rural/suburban dwellers





4.4.2 Value capture

- Capture/ preserve the share of transport value
- Generation of revenue through 3rd party integration and through other revenue streams such as advertising
- Optimized utilisation of transport infrastructure
- Attractive city with increased economic competitiveness
- Furthermore, the tourism sector is one of the most important employers in many European cities, making it particularly necessary for the cities to secure their market shares

4.4.3 Environmental benefits

- Increase public transport usage at the expense of car usage
- Compliance with emissions regulations

4.4.4 Security and safety

- Monitoring and registering of all transport-related information, such as identities, journey patterns, price, etc.
- Real-time information regarding driver/passenger glocalization
- Increased control of traffic management
- Communication with the travelling public





5. CONCLUSIONS

The analysis carried out in this document delivers the initial research for WP3 activities and will be used to clearly identify end-to-end use cases for the execution of the innovative functionalities of IP4 solution and identify their strategic and business potential impact.

In this report, we have discussed the main trends and drivers of mobility (social, regulatory, and technological), and identified major mobility needs for each stakeholder group – passengers, TSPs, and local authorities. Each of these stakeholders have different pain points or challenges that correspond to the benefits and added value offered by the IP4 solution, as is summarised in

Table 8 below. This table draws together the challenges identified in Chapter 3 and the corresponding opportunities outlined in Chapter 4.

The work in this report lays the ground for the remaining deliverables in the Work Package:

- Deliverable D3.2 will build on this document, adding further stakeholder engagement. It will also include expansion of some of the sections herein.
- Deliverable D3.3 will follow directly and logically from this report. The needs and pain
 points identified here will be used to inform the development of user profiles and to map
 corresponding use cases or user journeys (for passengers and TSPs). The process for
 doing this will be described in more detail in D3.3. In short, we will:
 - Identify and outline user/traveller profiles, which represent key groups of travellers (e.g. older travellers, business travellers, disabled travellers). These will draw on and incorporate both the social trends identified in this report and the traveller challenges uncovered through the literature review.
 - Identify several personas. These are reliable and realistic representations of key segments, allowing the project team to more fully understand and appreciate the users' needs, experiences, behaviour and goals. Individual personas can fit into more than one traveller profile (e.g. older traveller AND leisure traveller).
 - By combining the traveller profiles and the personas, we create use cases or user journeys. These represent realistic scenarios to demonstrate how travellers may engage with and make use of the IP4 solution.

These profiles, personas, and use cases will help the project team develop demonstrators which will serve to effectively communicate to travellers, services retailers and transport operators the benefits of the IP4 solution.

As a precursor to the work in D3.3, in the matrices below (Table 9, Table 10), we have mapped the trends identified in this report with the issues and challenges uncovered for passengers and TSPs. The purpose of this exercise is to indicate – with * – those challenges/needs where emerging trends are likely to have particular relevance or impact. Further, we have identified – with (*) – those areas most relevant for the IP4 solution, and which we recommend are covered in the user journeys in D3.3.

In summary:

• For passengers, the travel companion will give easy access to IT services adapted to passengers' 'profile', exposed by their preferences. Thanks to the connection between the preferences and the geo-localisation of the person, many innovative IT solutions can be developed covering all aspects of the social life (culture, merchandising, etc.).



• The market of transport services (shopping, ticketing but also services related to guidance) will be opened thanks to the interoperability framework. The fact that the heterogeneity of the transport market is now masked by the interoperability layer will decrease the investment costs for advanced IT solutions and will open a new competitive market.

Finally, aligned to the stakeholder analysis in this report, major needs identified in the mobility market represent a starting point for the actual positioning of the IP4 solution or set of solutions. At this stage, it emerges that no existing solution covers all IP4 innovative aspects. IP4 will target the intersection of several market sectors and, in particular, the innovation of IP4 solution is related to supporting full semantic interoperability of interchangeable and loosely coupled tools, data and services, within a distributed "web of transportation". Multiple concurrent implementations can be developed independently by specialist suppliers and co-exist competitively. This will apply downward market pressure to the cost of sourcing tools and technologies for travellers, retailers and operators, while allowing them to retain full control of the choice of business models through which to consume or provide value.



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5.1 Summary of stakeholders' challenges and IP4 benefits (Table 8)

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Stakeholders	Issues and challenges	IP4 solution and benefits
Stakeholders	 Issues and challenges Planning the journey Planning the journey can be complicated, confusing, or daunting. Pricing Pricing (and best value) can be unclear. Non- ticket expenses are also important. Offerings Knowledge of available amenities/facilities not always clear. Booking Booking travel can be complicated/not straightforward. Purchasing Purchasing ticket is not always as easy as it might be. Negotiating travel It is not always easy to understand how to undertake a journey – e.g. wayfinding, connections, accessibility. Communications Relevant communication is not always available, or in the best format/medium. Help Access to assistance is not always simple. Comfort and Space It's not always easy to find seats/luggage space 	 IP4 solution and benefits One-stop-shop: convenient multimodal travel with comparison and wide choice from completely exhaustive list of services of all mobility providers. Stress-free switching from one mode to another. Transparent traveling information with accurate real-time re- routing solution in case of travel disruption (traffic jam, weather, rebate, incidents, etc). Single authorisation that makes usage of all mobility services possible. One-click planning, booking and payment. Customised individual mobility packages and personalized offerings: Offer of tailor-made solutions considering customer profile, preferences, lifestyle, budget. Attractive prices and bonus programs within the mobility wallet.

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	The compensation process needs to be clear and easy.	
	Complaints The complaints process needs to be clear and easy.	
	 Reconciling tickets Using tickets for activities like expense claims should be easy. 	
Transport Service Providers	 Data governance in MaaS Data ownership and the willingness of TSPs to share data within a MaaS ecosystem such as that in IP4 are amongst the main challenges for using the data operated by the MaaS platform. Data protection and cybersecurity With a multimodal ICT system, transport service providers have to ensure a guaranteed resilience towards data and cyber attacks. Data access and interoperability Access to travel data has a huge impact on planning, creating an efficient travel ecosystem, and opening-up business opportunities. Data standardisation can be challenging, particularly across different modes of transport. Technology disruption and new business models Technology disruption is leading to rapid maturing and turnover of technology. New business models are merging from the mobility-as-a-service concept, such as total mobility providers and mobility aggregators. 	 Economic IP4 solution could reduce administrative costs (e.g. fewer cashiers needed) and reduce fare processing times. This would allow a better throughput of passengers. The interoperability framework will reduce or even eliminate development and integration costs of legacy systems and new systems/actors. Optimisation through keeping track of time and duration of service usage, and whether your service is combined with other transport offerings, enables operators to continuously improve their service and optimise asset utilisation and energy savings. Easy monetisation: Monetising with additional sales channels through partners (merchant near train stations and advertising partners) and through passengers with increased ticket sales given improved passenger experience, marketing of targeted offers and special deals combinations of different services. Connecting data sources through the interoperability framework can lead to an enhanced offer for customers. Reduced payment of compensation to customers by increasing the number of customers delivered to their destination within the service agreements.





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Changing working patterns, flexible and remote working arrangements may impact the mobility landscape • Scaling the geographic covering of MaaS offerings The extent of application also applies to geographic scale: city – region – country – or even international.	 become an integral part of the local urban transport system. There will also be means to improve interchanges so that customers can more readily access alternative modes of transport from the one they were travelling on. Open new business opportunities, by enabling better integration of alternative services into the scheme, making it more attractive for customers to use it. Growth: becoming a provider of an integrated mobility solution would increase revenue and passenger traffic through benefiting from a wide audience and stronger presence and visibility on the local mobility market. Deliver best value to end-users with a better price differentiation strategy and easier access to customers via different channels. Passenger data analysis holds enormous potential for better understanding of customers' needs and preferences; including traveller profiles, journeys as well as travel behaviour, spending habits and preferred places to be or points of interest. TSPs can use this data not only to understand the ecosystem and how small changes, several miles away, can have an influence but also save money understanding passenger flow which also improve safety and security at stations. Furthermore, this information can be used to better exploit the network's capacity, to offer personalized advertising, create targeted value creating offers such as entertainment and catering or services relating to family or business needs along with loyalty and bonus programs also.
	 Public Relations: improved customer service and better experience for passengers with restricted mobility. Increased efficiency: better contracting of services (you know what services people use, and which they don't).
	• Enhancements: One barrier many TSPs face is that they cannot justify and quantify the benefits of enhancements to the infrastructure. Better data can help them understand the

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 potential benefits of a project and quantifying the benefits post project completion. A further potential benefit is the ability to offer MaaS packages and integrate with bike sharing, scooter sharing, etc. Also, cross discounts with some mobility partners in the city – e.g. if users have a monthly card, they can get a complimentary mile on the bike sharing, or if they park their car outside the city, they gain a discount on public transport. Another possibility is that as part of multimodal offerings people have information about the associated environmental implications via different options, which also has competitive appeal for tourists.
 Technical Semantic approach and respect of standards through the interoperability framework will guarantee technical interoperability and removal of open points. Improved control over transaction tracking which will limit fare evasion and fraud but also improve cyber security system in place. Algorithms to predict and anticipate impact on traffic would allow better responsiveness to incidents and crisis and a more efficient operations during large scale events. Support for GDPR compliance; security features of the IP4 interoperability framework meet the GDPR requirements.
 New markets Modelling future opportunities for new/emerging transport types. The big data environment could enable more accurate modelling of new transport types. This reduces the barrier to entry of these types of transport and could help create a step change in mass mobility New travel-related services: there is a potential need to insure journeys (such as the need to guarantee the risk of a bus failing

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		 to deliver people to their flights, so missing it). This means that there could be a new marketplace where organizations sell "MaaS insurance". It also could challenge the model of reimbursement and compensation in the transport sector. In fact, complex deals between train operators and the rail infrastructure (especially in UK) that see money pass from one to the other; train delays caused by infrastructure failure, and train delays caused by train crew issues could be replaced by a paid-for service by both sides to insure against the risk. Potentials for expanding service offer into complementary market segments (e.g. tourism, access to public services, etc.), opportunities for enhancing support to Public Authorities in understanding mobility demand and improving policies.
Local Authorities	 Traffic congestion Need for attractive options to drive use of public transport network. Environmental challenge Need for attractive options to drive use of public transport network. Land use Need for attractive options to drive use of public transport network. 	 Governance Vision on and continuous understanding of transport flows Improved urban mobility planning and understanding of mobility needs Coverage of additional number of mobility modes Improve rural and suburban travel and offer enhanced mobility opportunities for rural/suburban dwellers Value capture Capture/ preserve the share of transport value Generation of revenue through 3rd party integration and through other revenue streams such as advertising Optimized utilisation of transport infrastructure Attractive city with increased economic competitiveness Furthermore, the tourism sector is one of the most important employers in many European cities, making it particularly necessary for the cities to secure their market shares Environmental benefits Increase public transport usage at the expense of car usage

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	Compliance with emissions regulations
	Security and safety
	 Monitoring and registering of all transport-related information, such as identities, journey patterns, price, etc.
	Real-time information regarding driver/passenger glocalization
	 Increased control of traffic management
	Communication with the travelling public

Table 8 - Summary of stakeholders' challenges and IP4 benefits





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5.2 Mapping key trends and passenger needs (Table 9)

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				Issues and challenges for passengers (identified as offering scope for IP4 work)										
 * = Identified trend likely to impact identified challenge () = Suggested for coverage in user journey development 			Planning the journey	Pricing	Offerings	Booking	Purchasing	Negotiating travel	Communications	Help	Comfort and Space	Compensations	Complaints	Reconciling tickets
	Social	Urbanisation / Changing residence patterns			*			*						
		Ageing population	(*)			(*)	(*)	(*)	(*)	(*)	*			
ers		Decarbonisation / Environmental concern	(*)	(*)			*							
riv		The sharing economy	*	*	*									
р		Digitisation	(*)	(*)		(*)	(*)	(*)	(*)	(*)		(*)	(*)	(*)
an	tory	Interoperability	*	*	*	*		*	*					
spu		Passenger rights						*		*	*	*	*	*
rer	Jula	Passenger security	*						*	*				
1ain 1	Reg	Towards sustainable mobility	*	*				*			*			
ility N	Technological	Mobile applications and services	*	*		*	*	*	*	*		*	*	*
lob		Vehicle to Vehicle												
2		Internet of Things						*	*					
		Big data	*	*				*						
		Cloud computing and business services					*					*		*
		Digital twins						*						
		Location-based services						*						

Table 9 - Mapping key trends and passenger needs

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5.3 Mapping key trends and TSP needs (Table 10)

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			Issues and challenges for TSPs (identified as offering scope for IP4 work)								
 * = Identified trend likely to impact identified challenge () = Suggested for coverage in user journey development 			Data Governance	Data Protection and Cybersecurity	Data Access and Interoperability	Technology disruption and new business models	Economics	Scaling the geographic coverings of MaaS offerings			
		Urbanisation / Changing residence patterns				*					
	a	Ageing population				*					
ers	Soci	Decarbonisation / Environmental concern				(*)					
)riv		The sharing economy				*	*				
р		Digitisation				*					
an	Ż	Interoperability	*	*	*						
spu	ator	Passenger rights	(*)	(*)	(*)						
Irei	Jula	Passenger security	*	*	*						
Main ⁻	Reç	Towards sustainable mobility				*					
oility N	cal	Mobile applications and services	*	*	*	*	*	*			
lob		Vehicle to Vehicle	*	*	*	*					
2	ogic	Internet of Things	*	*	*	*					
	plot	Big data	*	*	*						
	Techi	Cloud computing and business services	*	*	*	*	*				
	-	Digital twins						*			
		Location-based services		(*)		*	*	*			

Table 10 - Mapping key trends and TSP needs

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