Interreg Europe Project

PriMaaS

Prioritizing low carbon mobility services for improving accessibility of citizens

Characterization of European regional mobility ecosystems towards sustainable MaaS

PriMaaS
Interreg Europe

European Union
European Regional
Development Fund

universidade de aveiro
theoria poiesis praxis

PriMaaS

Prioritizing low carbon mobility services for improving accessibility of citizens

Characterization of European regional mobility ecosystems towards sustainable MaaS

PriMaaS Project Index Number: PGI05830, funded by the Interreg Europe Programme
Project Coordinator: Jorge Bandeira
PriMaaS Lead Partner: University of Aveiro (PP1), Portugal
PriMaaS Advisory Partner: Stockholm University (PP8), Sweden
PriMaaS Project Partners: University of Aveiro (PP1), Portugal; Intermunicipal Community of Coimbra Region, Portugal (PP2); TTS Italia National Italian Intelligent Transport Systems (ITS) Association, Italy (PP3); Intelligent Transport Systems Romania (PP4), Romania; University of Applied Sciences Erfurt, Germany (PP5); Timisoara Municipality, Romania (PP6); Liguria Region, Italy (PP7); eGovlab - Stockholm University, Sweden (PP8); Council of Tampere Region, Finland (PP9); South East of Scotland Transport Partnership, United Kingdom (PP10).

Authors: Eloísa Macedo, João Teixeira, Jorge Bandeira
Collaborators: Ana Faria, Nuno Pomar, Gennaro Ciccarelli, Mihai Niculescu, Niklas Fischer, Matthias Gather, Claudia Hille, Mihaela Dalca, Erika Ferrera, Raffaele Cattani, Myrsini Glinos, Marja-Riitta Mattila-Nurmi, Julie Vinders

Publisher: UA Editora - Universidade de Aveiro
1st Edition – February 2022
ISBN: 978-972-789-739-1
DOI: https://doi.org/10.48528/v94h-xn48

Acknowledgements: Authors would like to thank all PriMaaS partners for their cooperation and assistance in gathering and providing valuable information for the conduction of the analyses and preparation of this report.
The final version of the document is available on the PriMaaS website:
https://www.interregeurope.eu/primaas/

Contents

Project Summary 7

Executive Summary 9

Introduction 11

PriMaaS Regions Characterization 13

- Context 13
- Population 15
- Density 15
- Gross Domestic Product 15
- Climate Change and Energy Vulnerability 17
- Transport Externalities 20
  - Congestion 20
  - Air Pollution 27
  - Noise Pollution 29
  - Climate Change 30
- Digital Agenda Scoreboard 31

Integration of Transport Modes and Pricing Options 37

- What is MaaS? 37
- MaaS Initiatives 37
- MaaS Levels differentiation 38
- Public sector MaaS governance pathway 41

Current Integration of Transport Modes and Pricing Options in the PriMaaS regions 43

- Relevant factors behind a MaaS scheme under the PriMaaS Partnership 43
- PriMaaS Multidimensional Indicator concept 46
- Comparing New MaaS Multidimensional Indicator with Sochor et al. levels 52

Good Practices on Innovative Mobility Solutions 55

- Public Transport App with Check-In/-Out System 55
- On-Demand Bus 55
- The Act on Transport Services 56
- Strategic Innovation Program for sustainable mobility solutions 56
- NaaSMaaS hobby pick-up service for school children 57

Stockholm Public Transport offer a multimodal ticket 57
SIT FLEXI Intermunicipal demand responsive transport solution 58
Good Practices related to COVID-19 and Public Transport 59
Public Transport and Mobility Trends in the Post-pandemic Era 63
Stakeholder View on MaaS 75
MaaS main topics or long-term impacts 75
National vision and legislation framework 76
Business Uncertainty 78
MaaS Design and Sustainability 81
Who Should lead MaaS structures? 82
Stakeholders' perspectives: open-ended questions 83
MaaS Readiness Indicator 89
Overall Conclusions and Lessons Learned 95
References 97
Annexes 99
Coimbra (Centro Region) 99
Liguria 101
Timisoara 103
Thüringen 105
Stockholm 107
Tampere Region 110
South East Scotland 112

Project Summary

The Mobility-as-a-Service (MaaS) is a recent concept whose main objective is to change the way people travel and pay for mobility services. The provision of transport services is one of the key pillars of strategic importance for regional authorities. Therefore, regional policy instruments can play a valuable role in supporting the introduction of MaaS and simultaneously ensuring these new platforms will contribute to low carbon transport policy-goals, social inclusion and increased levels of accessibility.

The main vision of PriMaaS is to promote the integration of traditional collective transport modes with personal and innovative ones by creating equitable mobility services truly focused on citizens' needs. Regional and national policy instruments should be adapted to promote a fully integrated intermodal approach between all transport services, namely by using data provided and gathered in real-time about both travel demand and travel supply. At the same time, multiscale policy instruments should ensure that the more comfortable and affordable travel options for any individual to get from A to B has also minimum carbon levels.

PriMaaS aims at increasing inter-organizational collaboration and building trust among key stakeholders (transport authorities, operators, providers of mobility services and consumers protection organizations). This will be achieved by promoting the thematic regional and interregional exchange of experience events.

By collaborating with the policy learning platform, PriMaaS will feed a knowledge hub focused on increasing accessibility levels based on the MaaS concept, therefore contributing to unravelling the full potential of regional transport networks and maximizing their efficiency. At the end of the 1st phase, 4 policy briefings, 1 Agenda and 6 action plans will be available to support policymakers and prepare regional policy instruments to a new arising paradigm in the transport sector.

Executive Summary

Transport is a very specific area of social and economic life. It creates countless opportunities and allows to fulfill the need for mobility. There is a current trend in transport growth, emerging mobility services, and increased citizen's needs. Multi-level approaches are needed to face the social, economic, and environmental impacts of specific mobility services.

Planning ahead can help cities and regions facing different challenges in what concerns urban mobility, making use of the technological advances and new transport services and studying economic, environmental, and social effects. The present baseline assessment report (BAR) examines and evaluates the status regarding innovative, sustainable and efficient mobility solutions, with a special focus on digital platforms integrating trip planning, ticketing, and payment services of all transport modes, including a wide range of public and private transport options.

Specifically, the BAR is aimed at:

1. Exploring the current integration of transport modes and pricing options in each region;
2. Providing a characterization of existing or predicted digital platforms through which the end-users can access mobility services;
3. Analysing the stakeholders perspectives on MaaS implementation barriers and enablers based on a survey: demanders of mobility (e.g., private or business customers), supplier of mobility services, and platform owners (MaaS agents);
4. Identifying the relevant features for a MaaS scheme and providing a characterization of the MaaS schemes through different topologies;
5. Providing a description of the existing technology infrastructure (network connectivity, GPS, e-ticketing and e-payment systems); tailor-made demand-responsive mobility solutions; and strategies, policy frameworks, socio-political awareness and MaaS readiness levels.

The BAR will also include a set of good practices identified across the PriMaaS partnership and shared in the PLP. This will be crucial to fostering the knowledge at the individual and organizational levels (1 and 2).

The information provided in BAR will allow scoring the regions advances and critically assessing their own status for future progress based on more user-centered mobility solutions.

The specific objectives of the present baseline assessment are to:

- Provide an overview of the current state of PriMaaS areas in terms of sustainable mobility development, implementation of measures, and application of MaaS;
- Explore relevant factors behind a MaaS scheme;
- Develop a Multidimensional Indicator of MaaS platforms performance;
- Survey the institutional barriers and enablers for sustainable MaaS across Europe;
- Identify good practices across the PriMaaS partnership;
- Offer inputs and guidance in terms of good practices, particularly to which extent they can be transferred to other cities and regions with different scales and specificities.

Introduction

The rapid rise of digital technologies can pave the way for improving regional development, playing a key role to make EU an innovation and environmentally-friendly society and economy. In particular, the EU key investment priorities involve:

• smarter Europe, through innovation, digitalisation, economic transformation and support to small and medium-sized businesses;

• a greener, carbon-free Europe, implementing the Paris Agreement and investing in energy transition, renewables and the fight against climate change;

• a more connected Europe, with strategic transport and digital networks;

• a more social Europe, delivering on the European Pillar of Social Rights and supporting quality

employment, education, skills, social inclusion and equal access to healthcare;

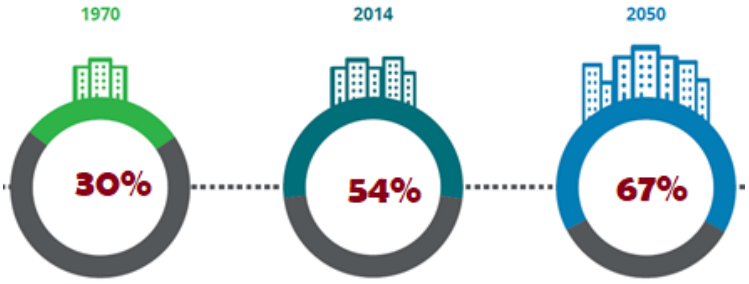
• a Europe closer to citizens, by supporting locallyled development strategies and sustainable urban development across the EU.

The key drivers of research and innovation are most effectively addressed at the regional level. European policymaking is inherently multidimensional: on the one hand, it has to encompass a broad framework providing objectives for the EU as a whole, while on the other it needs to acknowledge the often specific needs of national and subnational territories (Eurostat 2021). The global shift towards low-carbon economy involves responding to the increasing mobility needs of people and goods. Thus, the EC's low-emission mobility strategy sets clear and fair guiding principles to Member States to prepare for the future, but its core idea lies on the interregional cooperation as a solution for reaching the EU’s low-carbon objectives.

PriMaaS Regions Characterization

Context

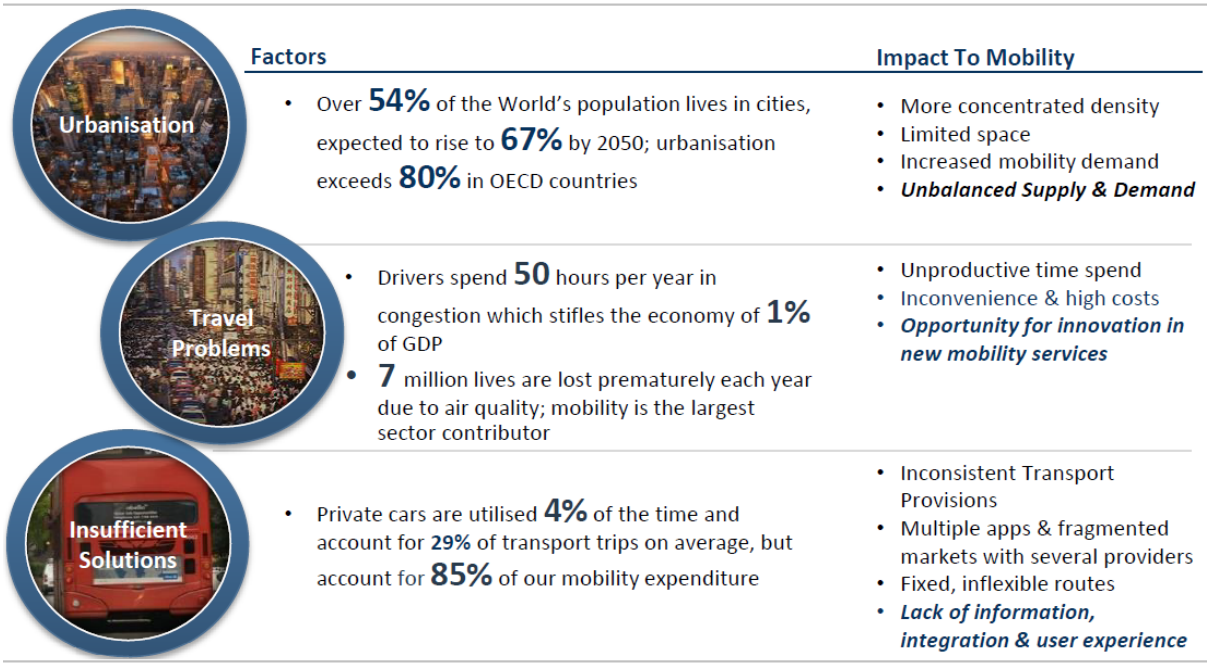
It is estimated that by 2050 almost 70% of the population will live in urban areas. Faced with such a radical change in the lifestyle of the world population, fundamental changes will also be necessary in terms of mobility.



Source: United Nations, Department of Economic and Social Affairs, Population Division, *World urbanization prospects: The 2014 revision, highlights* (ST/ESA/SER.A/352), 2014, https://esa.un.org/ unpd/wup/Publications/Files/WUP2014-Highlights.pdf

Figure 1 Global urbanization trends: Percent of population living in urban areas

Numerous factors reinforce that changing of urban demographics is leading to mobility issues that current mobility services are not able to solve and new types of mobility services are needed.



Source: *World Bank, World Health Organisation, Inrix, European Commission, Eurostat*

Figure 2 Different impacts on mobility reinforcing the need for new mobility services

As urban density grows, the new concept of mobility-as-a-service (MaaS) has emerged as a potentially disruptive way of addressing citizens' accessibility. It can be considered as an alternative way to move in a faster, cleaner, and less expensive way, transforming the transport system into one consumer-centric model.

To accommodate and be prepared for the MaaS innovation, regions need to adapt their laws to address these transport services and work out scenarios regarding how MaaS could affect local and regional trips and how these new services could be a major tool to achieve global goals such as decarbonization.

Following this understanding, some international partners with recognized experience on the topic were invited to take part in the PriMaaS IE Project, e.g., TTS Italia (PP3), SEStran (PP10), or SU (PP8). Such apps have experience in implementing and successfully demonstrating how citizens might benefit from such services. They have the key role of transferring knowledge to PPs, policymakers, and regional stakeholders. Based on this solid set of expert institutions (with experience in other funding programs (H2020)), it was sought to find partners committed to improving current knowledge, enhancing citizens' everyday mobility, and implementing the project's learning at the regional level. In this context, the Coimbra Region Intermunicipal Community (PP2), Liguria Region (PP7), Timisoara Municipality (PP6), Tampere Region (PP9), and SEStran (PP10) joined PriMaaS.

To enhance the effectiveness of learning and facilitate the dissemination of knowledge, the composition of the partnership also took into account the factors:

- experience of each partner in INTERREG projects in each country;
- geographic dispersion to disseminate information in various areas of Europe;
- heterogeneity of the PPs regions regarding the economic development and the awareness/implementation of the MaaS concept;
- complementarity of profiles (regions, inter-municipal communities, universities, non-profit associations).

PriMaaS consortium comprises several regions from seven different countries: Coimbra (Portugal), Thüringen (Germany), Timisoara (Romania), Liguria (Italy), Stockholm (Sweden), Tampere (Finland), South East Scotland (United Kingdom).

The transition to integrated mobility is not an easy step, and the pace and extent of change in each region depend on intrinsic factors such as population density, Gross Domestic Product (GDP), economic structure, digital scoreboard, modal share, road fleet composition, public investment, the existence of infrastructures, pollution and congestion levels, climate and environmental vulnerability, and externalities valuation, and local governance capabilities.

The next chapters will be devoted to describing the heterogeneous characteristics of the PriMaaS regions.

Figure 3 PriMaaS Project areas overview

Population

Within the studied areas, the population also presents significant differences. The most populous area in Stockholm is 2,308,143 inhabitants, while the population of the Tampere Region (2018) is 512,081.

Table 1 Population within the PriMaaS consortium

Region	Partners	Number of inhabitants
Liguria	Liguria Region and TTS Italia	1,556,981
Timisoara	Timisoara Municipality and ITS Romania	1,784,522
Thüringen	University of applied Sciences Erfurt	2,151,205
Stockholm county	eGovlab	2,308,143
Tampere Region	Council of Tampere Region	512,081
South East Scotland	South East of Scotland Transport Partnership	1,575,590
Coimbra	Intermunicipal Community of the Coimbra Region and University of Aveiro	436,948

Density

PriMaaS consortium regions also present a broad range of population densities. Stockholm County presents the most densely populated area with more than 350 inhab/km^2, while the region of Tampere is the least densely populated area with almost 41 inh/km^2.

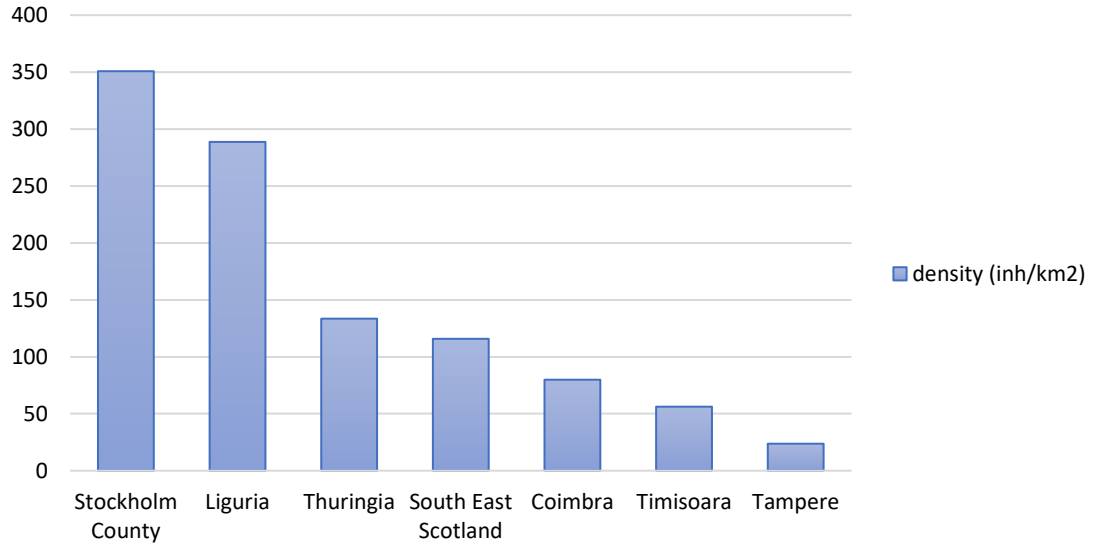


Figure 4 Density of PriMaaS Project areas (2019) (Eurostat, 2019)

Gross Domestic Product

Gross Domestic Product (GDP) is the broadest quantitative measure of a country or region's total economic activity. It measures the total value of all final goods and services produced within the geographic boundaries of a country or region. In particular, GDP per capita is widely used to compare living standards or to monitor the process of convergence across the EU. Expressing GDP per capita in Purchasing Power Standards (PPS) concerning the EU-27 enables cross-country comparisons and is the key variable for determining the eligibility of NUTS 2 regions in the framework of the EU's structural policy (Eurostat, 2016f). The following figure highlights the considerable differences between EU regions in terms of their economic performance.

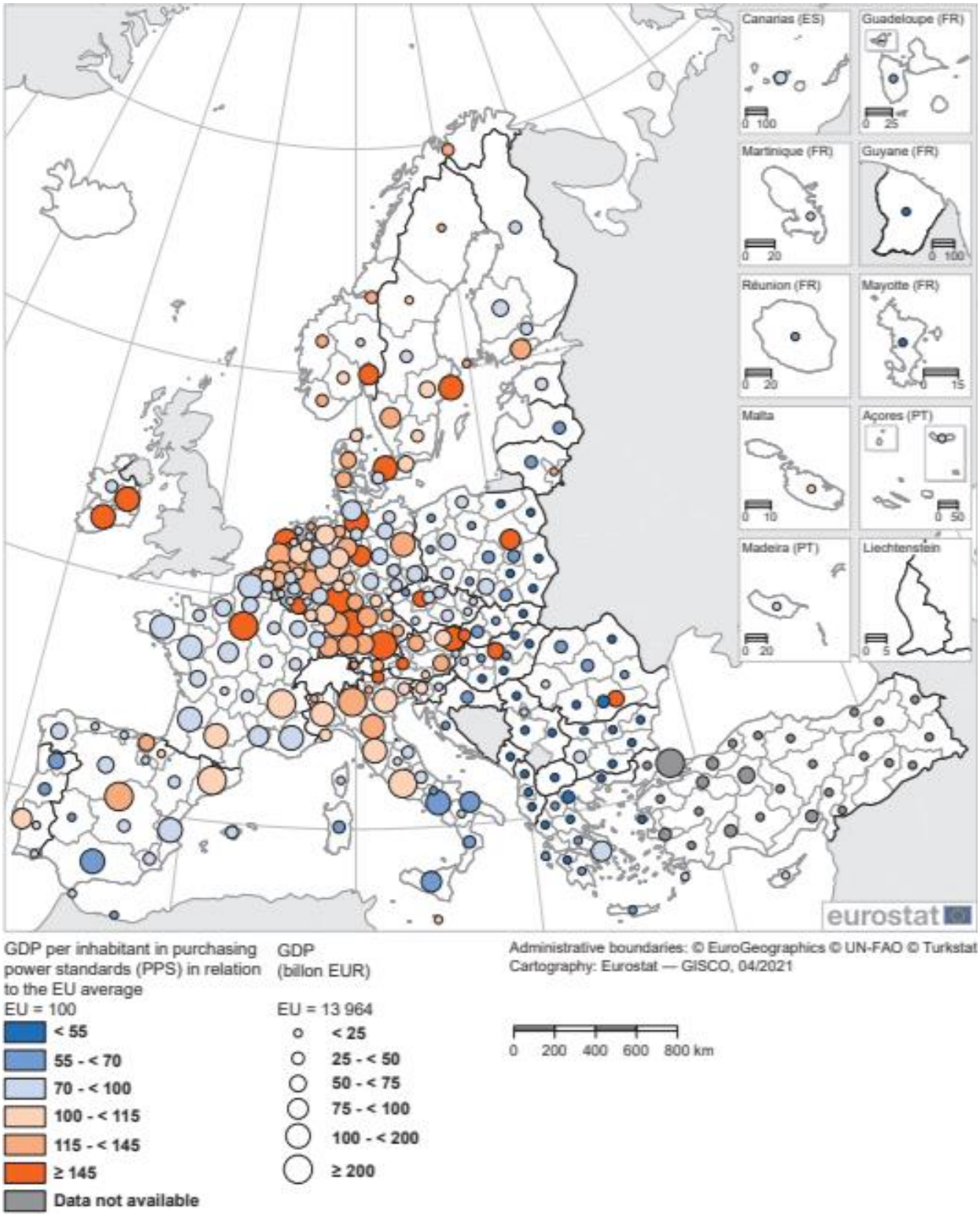


Figure 5 GDP and GDP per inhabitant, 2019 (Eurostat 2021)

It can be observed that Luxembourg had the highest regional GDP per inhabitant in 2019; its level of economic output was almost 3 times as high as the EU average, while regions where GDP per inhabitant was less than 70 % of the EU average include the southern regions of Spain and parts of Portugal.
GDP per capita in PPS in PriMaaS areas ranges from €20,000 to €49,700 for 2019. It can be referred that the richest PriMaas region is Stockholm (Sweden), which represents a GDP per capita in PPS in relation to the EU-27 average of 186 %. For the same year, the poorest areas within the PriMaaS consortium are Timisoara (Romania) and Coimbra-Centro Region (Portugal), presenting respectively, almost 20 % and 10 % of the national GDP generated.

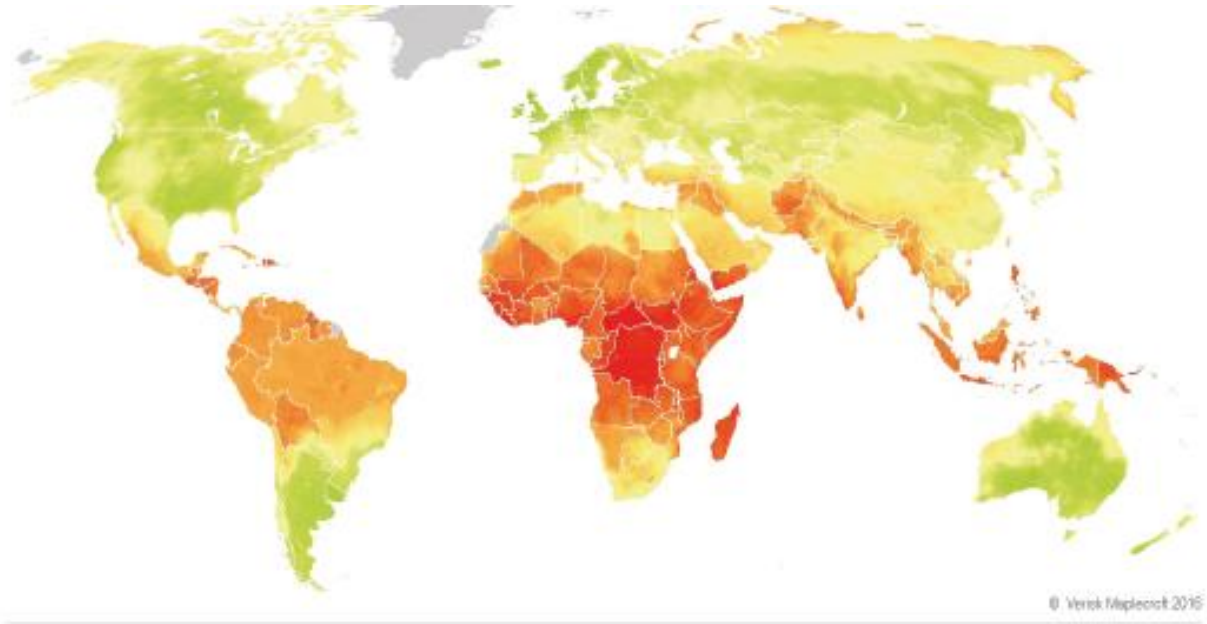
Table 2 GDP of PriMaaS Project areas (2017)

PriMaaS Area	GDP (PPS per capita)	GDP (million Euro)	% of the EU (27) average (PPS per capita)	% of national GDP generated in region
Coimbra (Centro Region)	20,000	36,755	67	18.9
Liguria	32,000	49,314	107	2.9
Timisoara	20,000	18,212	67	9.7
Thüringen	27,000	62,198	90	1.9
Stockholm	49,700	148,157	186	31.2
Tampere Region	36,000	18,300	100,5	8,5
South East Scotland	32,500	71,976	108	3.1

Source: Eurostat regional yearbook 2021 (Eurostat 2021) and own calculations for % of national GDP generated in the region.

Climate Change and Energy Vulnerability

Climate change is real, and it is expected to intensify extreme weather events that threaten human security, having potential economic impacts. Vulnerability to the adverse effects of climate change is a central issue in climate change research and policy.
The climate change vulnerability index was developed to assess the extent to which regions will be affected by the consequences of climate change (e.g., flooding, coastal erosion, land degradation, desertification, and potential drought hazard). Regions under threat of these underlying processes are already facing social, environmental, and economic issues. According to the Commission Staff Working Document "REGIONS 2020: an Assessment of Future Challenges for EU Regions (EU, 2008), regions subject to the highest pressure are generally located in the South and East of Europe, where most of the PriMaaS regions are located. The pressures from climate change would be greater in regions with low GDP per capita, thus having a lower capacity for adaptation to climate change.
The energy vulnerability index combines three main elements: i) energy import dependency, ii) energy consumption by households and industry, and finally, iii) carbon emissions (EU, 2008). According to the Commission's document, peripheral regions located mainly in Eastern and Southern Member States appear particularly vulnerable, while regions generally located in Northern and Western Europe show a greater capacity to adapt (for instance, Sweden). The following figure shows a map with the climate change vulnerability index from 2017, developed by Verisk Maplecroft 2016. It can be observed that UK and EU northern countries seem to be under the best performing countries group.



The five worst performing countries

Rank	Country	Region	Score	Category
1	Central African Republic	Africa	0.01	Extreme
2	DR Congo	Africa	0.20	Extreme
3	Haiti	Caribbean	0.24	Extreme
4	Liberia	Africa	0.25	Extreme
5	South Sudan	Africa	0.41	Extreme

The five best performing countries

Rank	Country	Region	Score	Category
191	Denmark	Europe	10.00	Low
190	United Kingdom	Europe	9.96	Low
189	Uruguay	S.America	9.95	Low
188	Iceland	Europe	9.85	Low
187	Ireland	Europe	9.83	Low

Figure 6 GDP and GDP per inhabitant, 2019 (Eurostat 2021)

Climate change and energy vulnerability in the PriMaaS regions are diverse, as verified through the index scores reported in the following table. Scores for each index range between 0 and 100, with zero representing the least vulnerable and 100 the most vulnerable one. On the one hand, Centro Region and Timisoara show the highest climate vulnerability, while Tampere and South East Scotland present the lowest. On the other hand, Centro Region, Liguria, and Thüringen have the highest energy vulnerability, while Stockholm and South East Scotland present the lowest.

Table 3 Climate Change and Energy Vulnerability Index of PriMaaS project areas (2008)

PriMaaS Area	Climate Change Vulnerability Index (0-100)	Energy Vulnerability Index (0-100)
Coimbra (Centro Region)	>=52.35	47-52
Liguria	30.33-37.11	>52
Timisoara	37.11-52.35	37-45
Thüringen	30.33-37.11	47-52
Stockholm	25.76-30.33	<15
Tampere Region	<21.41	45-47
South East Scotland	<21.41	<15

Source: Regions 2020. An Assessment of Future Challenges for EU Regions (EU, 2008).

Another index, the Global Climate Risk Index (CRI) developed by Germanwatch analyses, quantified the impacts of extreme weather events – both in terms of the fatalities as well as the economic losses that occurred and contributes to explaining countries' exposure and vulnerability

to climate-related risks. Concretely, for the examination of the CRI, the following indicators are considered in the CRI analysis:

1. number of deaths,
2. number of deaths per 100 000 inhabitants,
3. the sum of losses in US$ in purchasing power parity (PPP) as well as
4. losses per unit of gross domestic product (GDP).

The CRI for 2019 for the countries within the PriMaaS consortium is: Italy 43.50, Portugal 48.33, Germany 61.33, UK 90.83, Finland 97.83, Sweden 100.50, and Romania 104.50. But considering a more overall approach, the Global Climate Risk Index for 2000–2019 raises some concerns, since Germany, for instance, was revealed to be at a significant risk status in Europe, as the following figure shows.

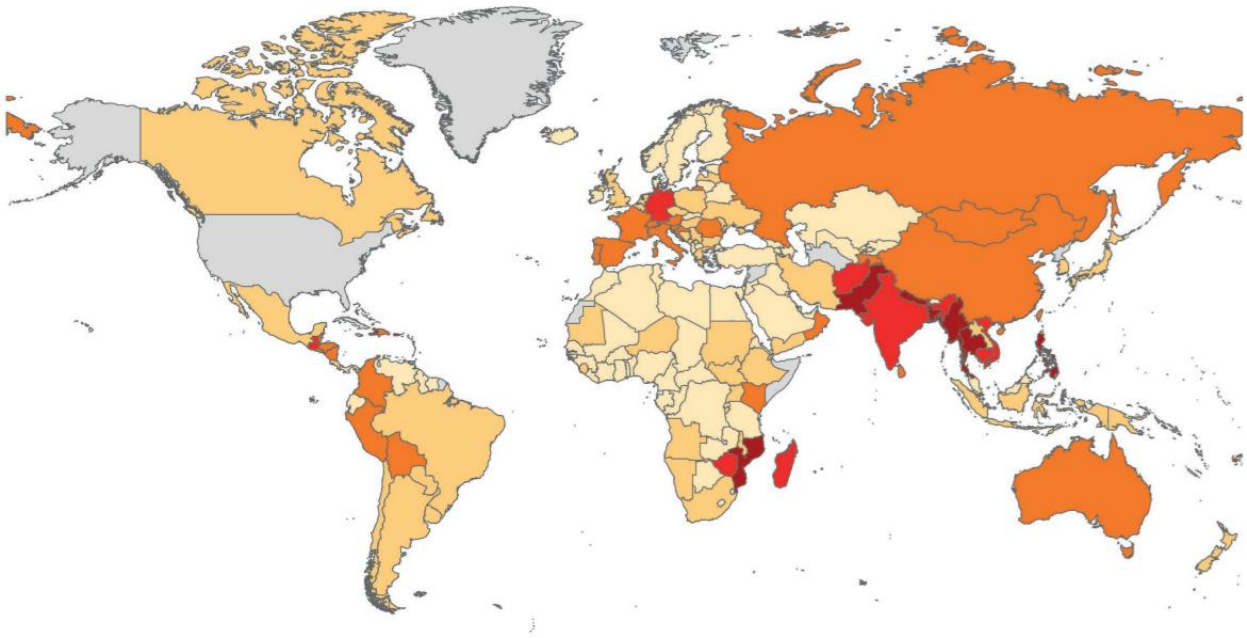


Figure 7 World Map of the Global Climate Risk Index 2000 – 2019 (*Source: Germanwatch and Munich Re NatCatSERVICE*)

The Global Climate Risk Index 2021 for the period 2000–2019 is based on average values over twenty years and Germany, coupled with many South European countries presents the lowest CRI average values. In particular, Germany achieves only 38.17, followed by Portugal (38.67) and Italy (39.00), with Romania presenting a CRI of 56.33, while the highest values are found for Finland, with a Global CRI (2000-2019) of 153.50 and for the Swedish case, which is 131.33.

Transport Externalities

European cities increasingly face problems caused by road transport. Alongside many benefits, road transport contributes to significant negative externalities on society and the environment – travel time loss, accidents, greenhouse gas emissions, air pollution, noise pollution, health impacts. Externalities are costs or benefits of an activity experienced by those who have not generated them. The internalization of road transport external costs is a key component to define strategies and policies. In particular, policy intervention should aim to make external costs part of transport planners' and users' decision-making process and lead to more efficient use of the road infrastructure (Huib van Essen et al., 2019). This section provides information on the most important transport costs and gives an overview of the current situation in the countries that are involved in the PriMaaS Project.

The total external costs per country are shown for road, rail, and IWT (inland waterways) in Table 4. This table also shows the share of these costs in the national GDP. This share range from 4.4 % in Nordic Countries and over 7% in Portugal. Road transport is the prevalent mode that produces by far the most external costs on the European Level (83% of the total costs incl. aviation and maritime; 97.5% excl. aviation and maritime). Maritime transport causes 10%, aviation 5%, rail transport 1.8%, and inland waterways 0.3% of the costs. 69% of the total costs are due to passenger transport, 31% of the costs are caused by freight transport (including LCVs).

Table 4 Total external costs in the PriMaaS countries.

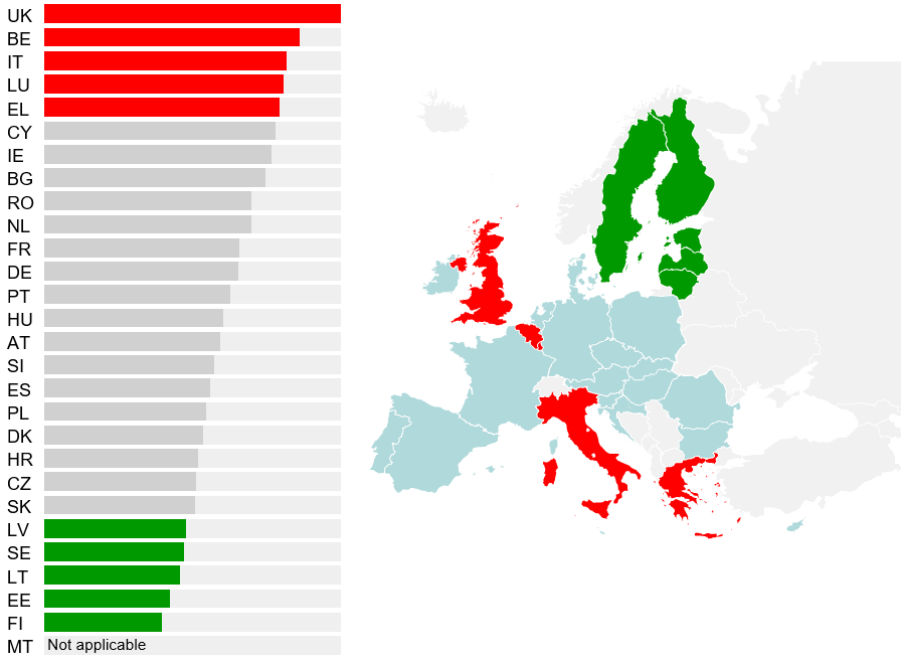
	Total external costs				
Country	Road bn €	Rail bn €	IWT bn €	Total bn €	% of GDP
EU 28	820,4	17,87	2,90	841,1	5,7%
Finland	7,4	0,23	0,073	7,7	4,4%
Germany	165,7	5,37	1,228	172,3	5,8%
Italy	115,0	2,20	0,009	117,2	6,8%
Portugal	16,8	0,18	-	16,9	7,2%
Romania	21,2	0,46	0,171	21,8	6,5%
Sweden	15,3	0,46	-	15,8	4,5%
United Kingdom	99,4	1,42	0,009	100,8	4,9%

Source: Handbook on the external costs of transport, January 2019.

Congestion

Congestion is an important problem for road transport and one of the main challenges for transport policy (Christidis and Rivas 2012). Travel time is significantly affected by congestion. Last data shows U.K. drivers spend more time in traffic than drivers in Portugal, Romania, France, or Germany, while drivers spend less in Sweden and Finland.

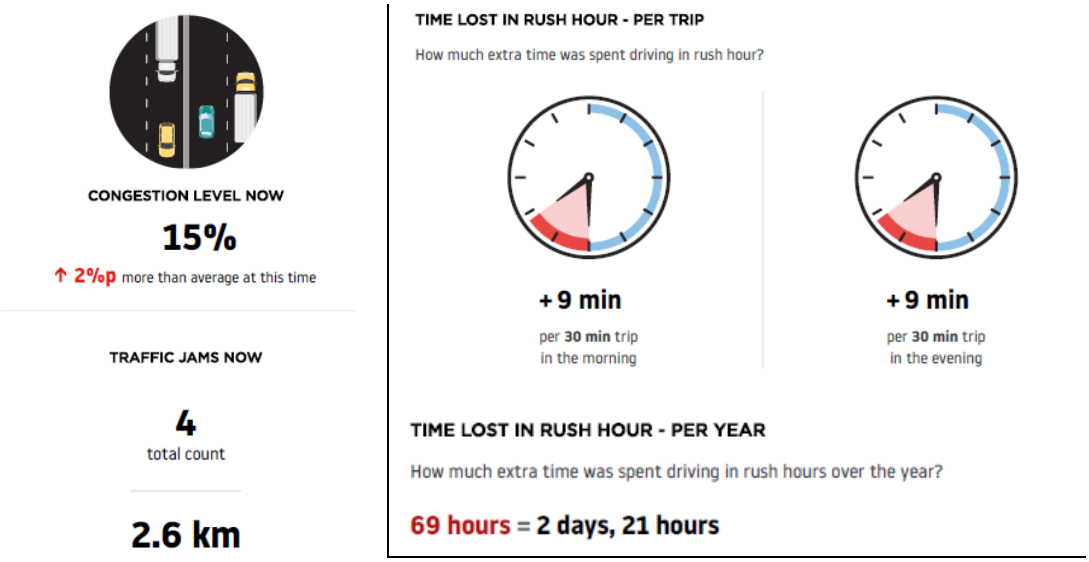
The value of travel time depends on the type of trip and travel conditions, and it is referred to the cost of time spent on travelling. The total travel time cost is the product of time spent travelling and unit costs, and it is usually expressed in euros per hour (Litman & Doherty, 2009). Various studies and organizations have developed estimates of travel time values. However, World Bank economist Kenneth Gwilliam, after an extensive review of international studies, recommends that work travel time should be 133% of the wage rate per hour and that a default value for adult personal travel (including commuting) time should be 30% of household income per hour unless better local data are available (Eurostat, 2016d).



Source: https://ec.europa.eu/transport/facts-fundings/scoreboard/compare/energy-union-innovation/road-congestion_en

Figure 8 Hours spent on road congestion in 2017.

The following figures illustrate the congestion levels for the PriMaaS regions (except for Thuringia and Timisoara due to the lack of data), before and after the pandemic era (COVID-19 – March 2020).



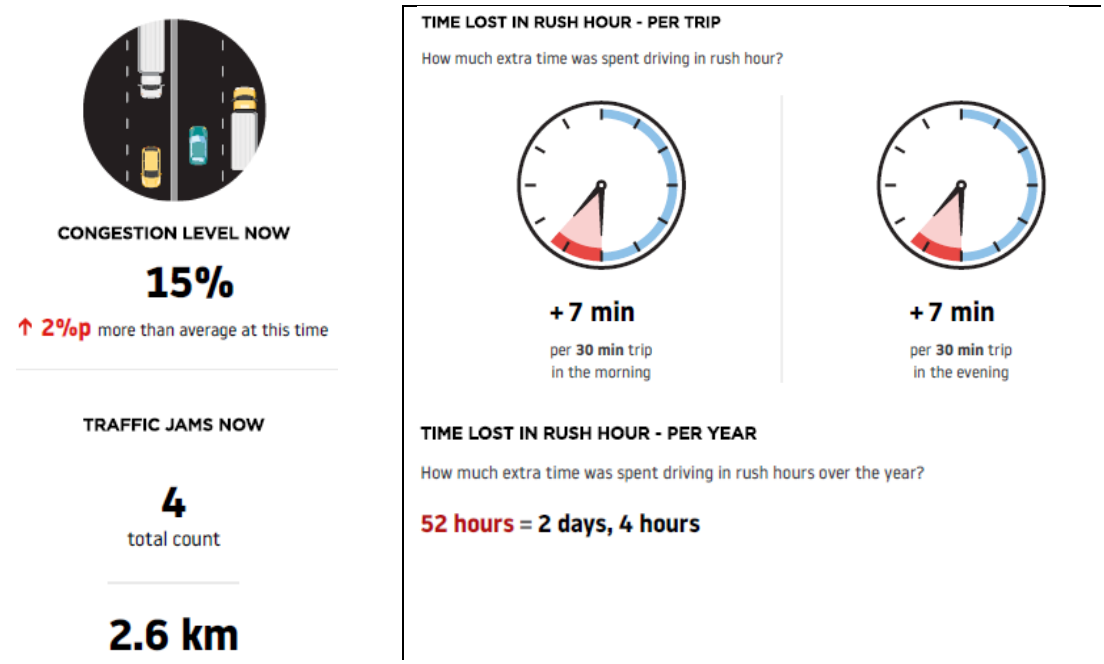
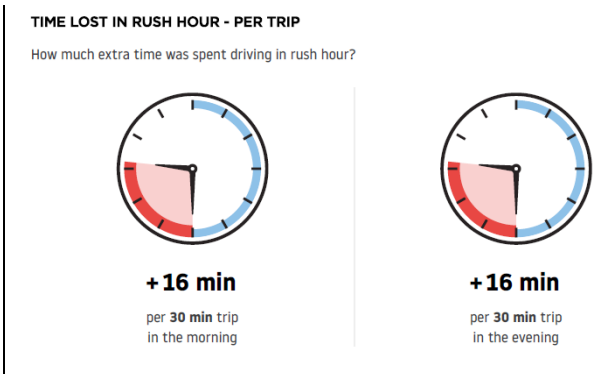


Figure 9 Traffic congestion statistics for Coimbra based on TomTom's historical database for 2019 (up) and 2020 (down) - Congestion level by road type: 3% Highway and 18% non-highways on 2019

Observing Figure 9, which is related to the case of the Coimbra Region, although the traffic levels did not change significantly, the time wasted in a rush-hour has decreased from 9 minutes per 30 minutes trip to 7 minutes per 30 minutes trip during the pandemic era. In fact, this trend was also followed in the other PriMaaS regions. These changes are mostly due to the restrictions imposed as lockdown measures to minimise the spread of the virus. Nevertheless, some points can be highlighted: the largest reductions in time lost in traffic during rush hours occurred in Scotland, while the smallest differences were observed in Tampere. Stockholm and South East Scotland showed to be the regions with the highest time on travelling due to traffic jams.



CONGESTION LEVEL NOW

29%

↑ 2%p more than average at this time

TRAFFIC JAMS NOW

4

total count

2.4 km

TIME LOST IN RUSH HOUR - PER YEAR

How much extra time was spent driving in rush hours over the year?

121 hours = 5 days, 1 hour

CONGESTION LEVEL NOW

29%

↑ 2%p more than average at this time

TRAFFIC JAMS NOW

4

total count

2.4 km

TIME LOST IN RUSH HOUR - PER TRIP

How much extra time was spent driving in rush hour?

+13 min

per **30 min** trip
in the morning

+14 min

per **30 min** trip
in the evening

TIME LOST IN RUSH HOUR - PER YEAR

How much extra time was spent driving in rush hours over the year?

103 hours = 4 days, 7 hours

Figure 10 Traffic congestion statistics for Liguria based on TomTom's historical database for 2019 (up) and 2020 (down) - Congestion level by road type: 13% Highway and 35% non-highways on 2019

TIME LOST IN RUSH HOUR - PER TRIP

How much extra time was spent driving in rush hour?

+16 min

per **30 min** trip
in the morning

+19 min

per **30 min** trip
in the evening

CONGESTION LEVEL NOW

28%

↑ **5%p** more than average at this time

TRAFFIC JAMS NOW

36

total count

27.2 km

TIME LOST IN RUSH HOUR - PER YEAR

How much extra time was spent driving in rush hours over the year?

133 hours = 5 days, 13 hours

CONGESTION LEVEL NOW

28%

↑ **5%p** more than average at this time

TRAFFIC JAMS NOW

36

total count

27.2 km

TIME LOST IN RUSH HOUR - PER TRIP

How much extra time was spent driving in rush hour?

+10 min

per **30 min** trip
in the morning

+15 min

per **30 min** trip
in the evening

TIME LOST IN RUSH HOUR - PER YEAR

How much extra time was spent driving in rush hours over the year?

98 hours = 4 days, 2 hours

Figure 11 Traffic congestion statistics for Stockholm based on TomTom's historical database for 2019 (up) and 2020 (down) - Congestion level by road type: 23% Highway and 30% non-highways on 2019

TIME LOST IN RUSH HOUR - PER TRIP

How much extra time was spent driving in rush hour?

+7 min

per **30 min** trip
in the morning

+8 min

per **30 min** trip
in the evening

CONGESTION LEVEL NOW

16%

↓ **1%p** less than average at this time

TRAFFIC JAMS NOW

1

total count

0.7 km

TIME LOST IN RUSH HOUR - PER YEAR

How much extra time was spent driving in rush hours over the year?

57 hours = 2 days, 9 hours

CONGESTION LEVEL NOW

16%

↓ **1%p** less than average at this time

TRAFFIC JAMS NOW

1

total count

0.7 km

TIME LOST IN RUSH HOUR - PER TRIP

How much extra time was spent driving in rush hour?

+5 min

per **30 min** trip
in the morning

+7 min

per **30 min** trip
in the evening

TIME LOST IN RUSH HOUR - PER YEAR

How much extra time was spent driving in rush hours over the year?

50 hours = 2 days, 2 hours

Figure 12 Traffic congestion statistics for Tampere based on TomTom's historical database for 2019 (up) and 2020 (down) - Congestion level by road type: 6% Highway and 23% non-highways on 2019

TIME LOST IN RUSH HOUR - PER TRIP

How much extra time was spent driving in rush hour?

+22 min

per **30 min** trip
in the morning

+24 min

per **30 min** trip
in the evening

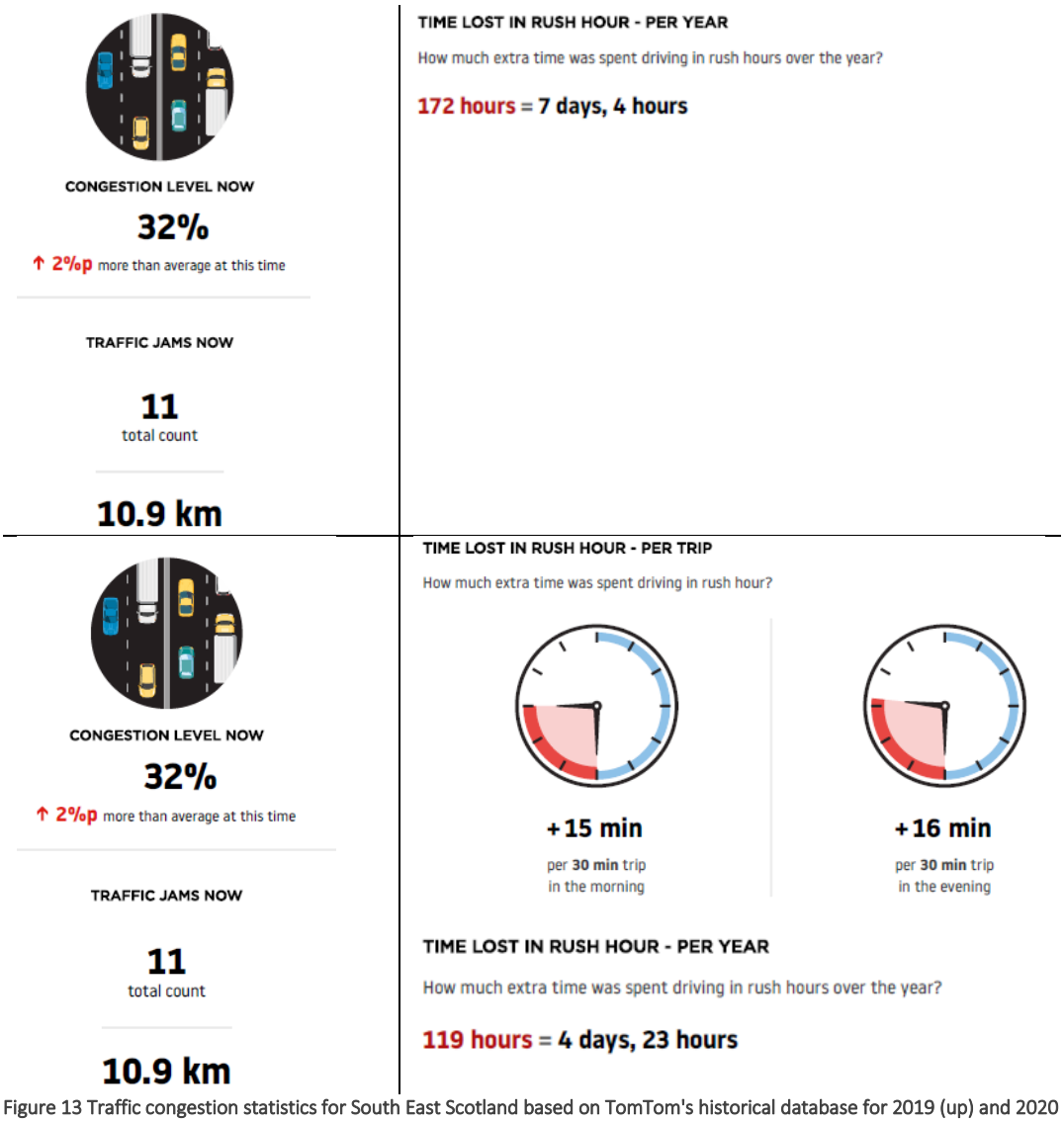


Figure 13 Traffic congestion statistics for South East Scotland based on TomTom's historical database for 2019 (up) and 2020 (down) - Congestion level by road type: 36% Highway and 43% non-highways on 2019

Traffic congestion poses serious costs to Europe such as fuel, social and environmental costs, and travel time costs, with significant impacts on car drivers and passengers. The mitigation of road congestion in Europe is one of the main priorities of most infrastructure, traffic management, and road charging measures. The estimated cost associated with the time spent in congestion can be monetised by means of reference values. Table 5 provides indicative values of personal travel time costs for PriMaaS areas based on the external costs provided in (Huib van Essen et al., 2019).

Table 5 Congestion costs per country (Billion Euro/year)

Country	Road Bn€	Total Bn€	% GDP
Finland	2.35	2.35	1.3
Germany	44.26	44.26	1.5
Italy	31.69	31.69	1.9
Portugal	7.52	7.52	3.2
Romania	6.77	6.77	2.0
Sweden	6.59	6.59	1.9
United Kingdom	42.68	42.68	2.1

A closer look at the results reported in Table 5 shows that the UK, Germany, and Italy are the countries that present higher Congestion Costs, being thus, the ones that need special attention and an improvement in policy measures to evaluate the external costs of congestion and the implications for internalisation. Regarding GDP, Portugal represents the country with the most significant impact of congestion, yielding more than 3% of GDP.

In particular, a recent report on the 2021 INRIX Global Traffic Scorecard (Bob Pishue 2021) highlights that in the UK, drivers lost an average of 73 hours due to congestion in 2021, up from 37 last year but down from 115 hours in 2019, while in Germany, drivers lost an average 40 hours due to congestion, up from 26 hours last year but down from 46 hours in 2019. Fewer vehicles on the road in 2021 resulted in drivers saving money due to the lack of congestion. However, data also suggest that collisions changed by 26% in the United Kingdom and 4% in Germany, but became more deadly over time: as traffic volume dropped due to the global pandemic, vehicle speeds increased, which has played a significant role in the rise of fatality rates around the world. The report also shows COVID's global effect on transport, as illustrated in the next figure.

Urban Area	Impact Rank (2020 Rank)	Hours Lost in Congestion (2021 Rank)	Change from Pre-COVID	Last Mile Speed (mph)
Edinburgh	142 (112)	45 (158)	-55%	19
Rome	7 (18)	107 (6)	-35%	15
Bucharest	11 (2)	98 (10)	-	15
Berlin	35 (41)	65 (46)	-1%	16
Coimbra	659 (768)	16 (667)	-20%	30
Stockholm	191 (98)	38 (261)	-20%	19
Tampere	718 (996)	13 (725)	9%	23

Figure 14 COVID's global effect on transport

Shifting travel patterns resulting from working from home, cycling and transit usage continued throughout 2021 – leading many experts to believe such trends will extend beyond post-pandemic.

Air Pollution

The rapid growth of the transport sector results in significant environmental impacts. It is a leading cause of many health problems and kills more than 3 million people worldwide every year (Huib van Essen et al., 2019). Indeed, traffic-related externalities cost countries billions per year in diseases and deaths and constrain economic development. Dealing with air pollution and improving air quality has become a top priority for policymakers and environmental agencies.

Table 6 Air pollution costs per country (Huib van Essen et al., 2019).

Country	Road Bn€	Rail Bn€	IWT Bn€	Total Bn€	% GDP
Finland	0.4430	0.0070	0.0003	0.4503	0.25
Germany	13.1620	0.4640	0.8959	14.5219	0.49
Italy	10.4710	0.0540	0.0007	10.5257	0.61
Portugal	0.7410	0.0120	-	0.7530	0.32

Romania	1.2870	0.0180	0.1114	1.4164	0.42
Sweden	0.7220	0.0200	-	0.7420	0.21
United Kingdom	4.8080	0.1180	0.0011	4.9271	0.24

Table 6 reports the costs associated with air pollution in the countries that compose the PriMaaS Partnership. Road transport is the sector with the greatest impact on air pollution. The UK, Germany, and Italy have higher air pollution costs, in absolute terms. However, when analysing these impacts relative to national GDP, the countries with higher costs are Germany, Italy, Portugal, and Romania. Inland waterways and rail transport represent the highest costs in Germany. Recent data suggest that regions with high levels of economic activity and/or population density usually present a greater impact in terms of air pollution (Eurostat 2021). Besides a direct impact on the environment, population exposure to pollutants has been proven to lead to adverse human health issues. The annual mean concentration of particulate matter (PM) is considered the best indicator related to air pollution health effects. As shown in the following figure, some urban European populations remain exposed to high concentrations of air pollutants. In particular, northern Italy and Romania revealed high PM concentration levels in 2018, while Portugal, Finland and Sweden presented low exposure levels.

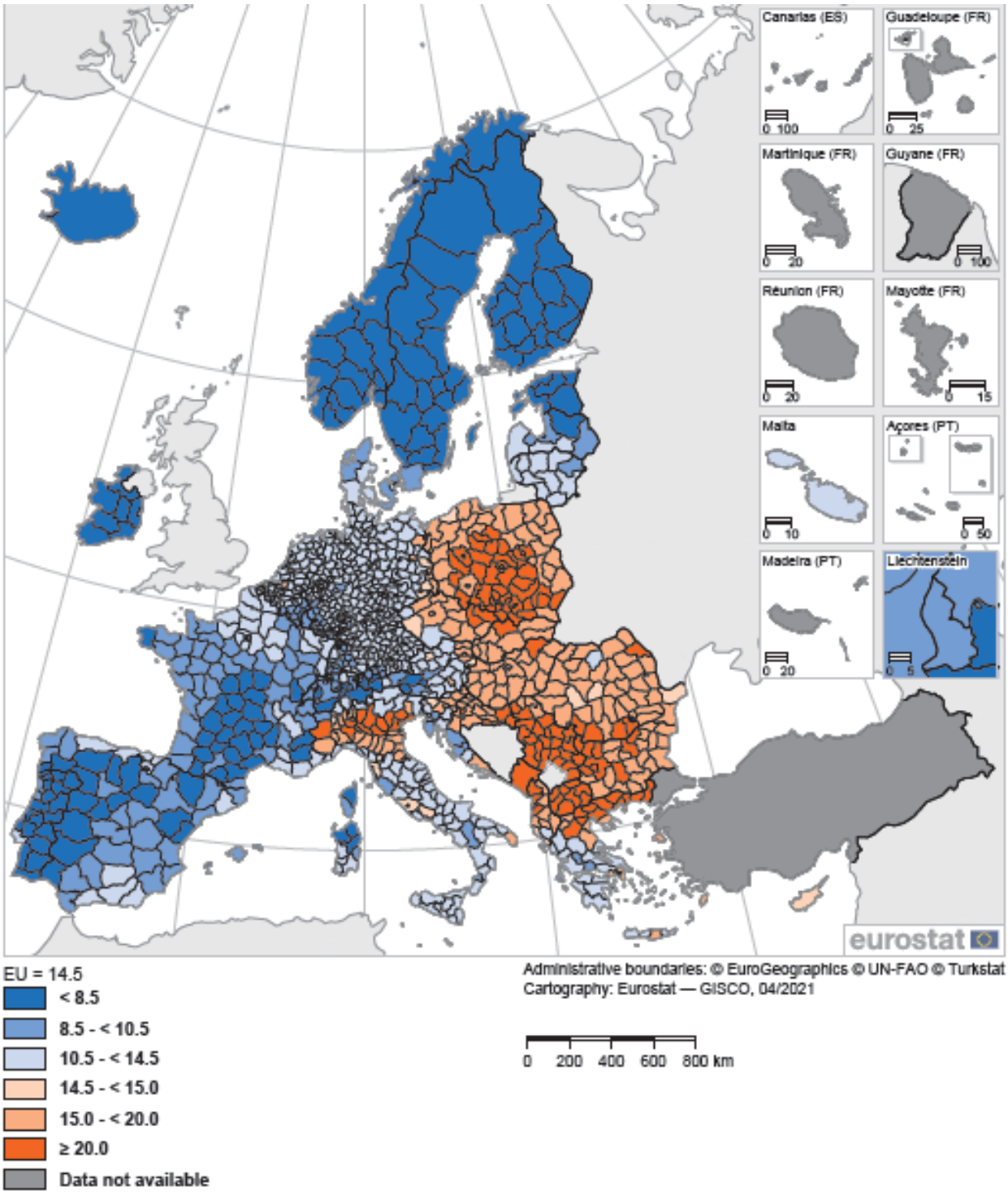


Figure 15 Exposure to air pollution by fine particulate matter (PM2.5), 2018 (Eurostat 2021)

Noise Pollution

The transport sector is the major source of noise, while traffic noise is one of the main local environmental problems in Europe, with around 80 million EU citizens suffering from unacceptable noise levels (Huib van Essen et al., 2019). The impacts of noise must be fully considered in decision-making for any policy, program, or project as noise emissions can affect

people's health, wellbeing, productivity, and the natural environment. Again, road transport is the sector responsible for the highest costs (Table 7), where Italy, Germany, and UK are the countries with higher costs associated with noise. Finland and Sweden are the regions with the lowest costs on road traffic-related noise. Germany and Italy represent the countries with a considerable cost on rail-related noise, while Portugal and Finland present the lowest costs. But considering the relation with the GDP, Italy, Romania and Portugal are the regions where noise has a higher relative impact.

Table 7 Noise pollution costs per country

Country	Road Bn€	Rail Bn€	Total Bn€	%GDP
Finland	0.3	0.07	0.37	0.20
Germany	5.0	2.00	7.0	0.24
Italy	16.2	1.31	17.51	1.04
Portugal	0.9	0.07	1.06	0.41
Romania	1.8	0.10	1.9	0.58
Sweden	0.5	0.16	0.66	0.17
United Kingdom	4.2	0.55	4.75	0.24

Climate Change

According to (Huib van Essen et al., 2019), the valuation of climate change costs, i.e., the evaluation of the cost of GHG emissions (Eurostat 2021), is connected with extremely high uncertainty due to complex global pathways of various effects and long-time horizons involved. The GHG emissions from transport EU-27 for 2019 reached 1106.2 million tonnes CO_2 equivalent, from which almost 793 come from road transport (European Commission 2021b). In this report, the calculation of the cost of GHG emissions is based on the estimates of CO_2 costs provided in (Huib van Essen et al., 2019), enabling the cross-regional comparison. Table 8 provides information about the GHG emissions from transport (including road, rail, inland navigation and domestic aviation) in the year 2019 for the countries represented in the PriMaaS project, while Table 9 presents the results of estimation values of climate change costs in PriMaaS Project areas are presented.

Table 8 GHG emissions per country by mode (million tonnes CO_2 equivalent)

Country	Road	Rail	IWT
Finland	10.9	0.1	0.4
Germany	157.7	0.8	1.7
Italy	96.9	0.2	4.1
Portugal	16.4	0.0	-
Romania	17.8	0.3	0.1
Sweden	15.0	0.0	-
United Kingdom	112.7	1.8	5.4

Table 9 Climate change costs per country

Country	Road Bn€	Rail Bn€	IWT Bn€	Total Bn€	% GDP
Finland	1.365	0.006	0.00035	1.371	0.783
Germany	14.707	0.100	0.14677	14.954	0.508
Italy	11.118	0.014	0.00016	11.132	0.651
Portugal	1.621	0.007	-	1.628	0.693
Romania	1.322	0.012	0.03494	1.369	0.404
Sweden	2.004	0.005	-	2.009	0.571
United Kingdom	10.180	0.086	0.00044	10.266	0.504

In Table 9, Road transport is the sector mainly responsible for climate change costs, representing higher costs for Germany, Italy and the UK. Regarding the climate change costs compared to the national GDP, Finland presents the highest values, while Romania presents the lowest, being all other countries with percentages between 0.5% and 0.7%.

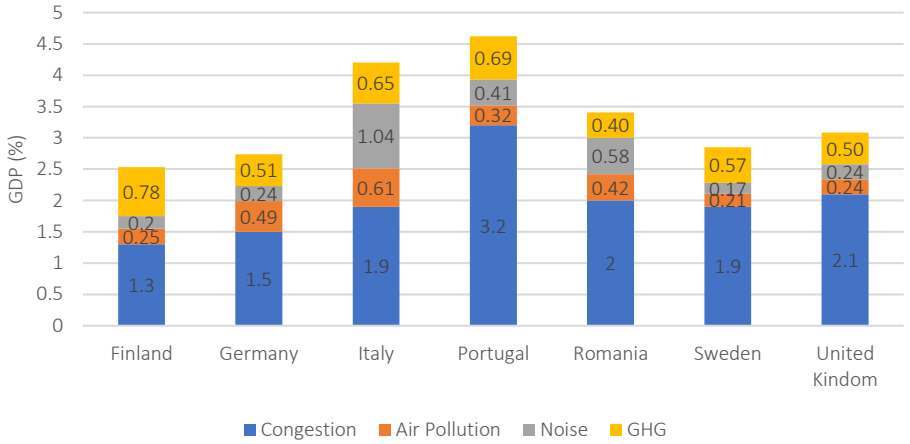


Figure 16 Overview of transport-related externalities concerning national GDP

Considering all the above information, as highlighted in Figure 16 which presents an overview of the externalities costs with the national GDP, we can conclude that Italy, Portugal and Romania are the countries where transport-related externalities related to congestion, air pollution, noise and GHG represent more than 4% of the national GDP. In particular, Portugal presents the highest impact in terms of air pollution, followed by Italy, which is also the country with the highest costs in terms of noise. Regarding GHG, Finland is the country with the highest costs, followed by Portugal and Italy.

Digital Agenda Scoreboard

The Digital Scoreboard measures each country's progress toward the European digital economy. The Digital Economy and Society Index (DESI) is a composite index that summarises relevant indicators on EU members' digital performance and tracks their evolution in digital competitiveness. The DESI is structured around five principal dimensions: i) the Connectivity dimension which measures the deployment of broadband infrastructure and its quality, ii) the Human Capital dimension, which measures the skills needed to take advantage of the possibilities offered by a digital society, iii) the Use of Internet dimension that accounts for the variety of activities performed by citizens already online, iv) the Integration of Digital Technology dimension measuring the digitisation of businesses and their exploitation of the online sales channel, and finally, v) the Digital Public Services dimension which measures the digitisation of public services, focusing on eGovernment (European Commission 2021a).

In this report, we summarise the main integrated indicators of the DESI in four main dimensions, and then, we zoom in on some key indicators regarding national capacity in ICT and data policy. Furthermore, we also make a brief analysis of the level of citizens' Internet access and digital literacy. Some data is not available for some indicators, namely related to the UK, mostly due to Brexit.

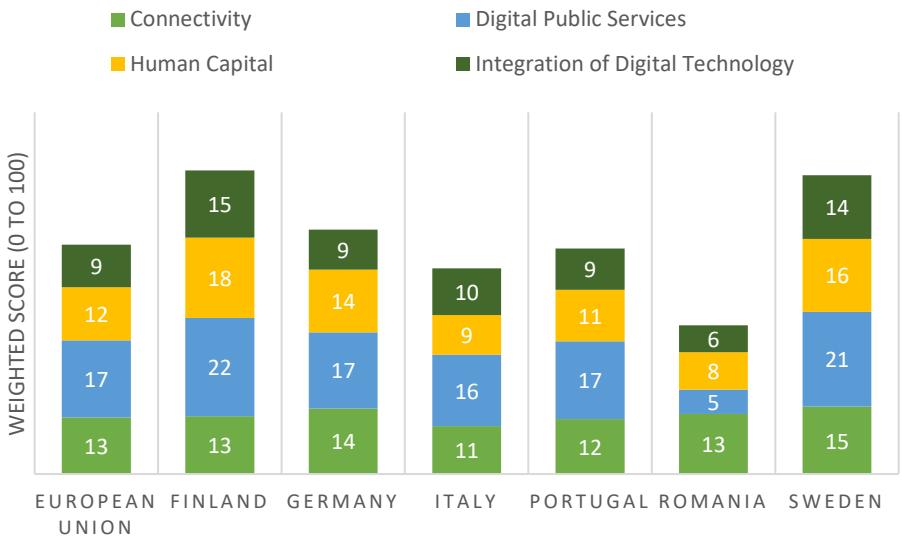


Figure 17 DESI overall index, calculated as the weighted average of the four main DESI dimensions of PriMaaS countries

Figure 17 demonstrates that the Nordic countries Sweden and Finland have a higher overall DESE index in all categories. In a second intermediate level in line with the EU average are Germany, Portugal and Italy. Romania is in line with the rest of the countries with respect to connectivity but clearly below in the remaining dimensions. From a positive highlight point of view, the biggest differences are in the human capital dimension and digital technology integration, with Finland reaching a score 50% higher than the EU average.

The integration of mobility services into smart digital platforms requires a set of ICT infrastructures, acquired know-how and human resources in various technological domains. For instance, the access and availability of open data is a key element for third parties to interact and manage new businesses related to planning, selling and allow the booking mobility services. Furthermore, the provision of truly intelligent user-oriented services requires the use of big data and smart machine tools capable of performing resource allocation tasks and continuous service improvement, taking into account constantly updated standards of accessibility needs. Logically, to manage these resources, it is necessary to have human resources strongly skilled in ICT in order to make the best use of these tools for low carbon and sustainable economy. Therefore, a set of indicators were selected from the Digital Economy and Society Index 2021 (Table 10) that allow characterising the current situation of the PriMaaS countries in these domains (Table 11).

Table 10 Definition and unit of measure of selected key indicators of DESI index relevant for MaaS Implementation

INDICATOR	*DEFINITION*	*UNIT OF MEASURE*
BIG DATA	Enterprises analysing big data from any data source	Percentage of Enterprises with 10 or more persons employed. All manufacturing and service sectors, excluding the financial sector. Breaks in series because until 2008 economic activities according to NACE Rev 1.1 and from 2009 data are based on NACE Rev.2. Since 2010 include also sector S 95.1-Repair of computers and communication equipment.
OPEN DATA	This composite indicator measures to what extent countries have an open data policy in place (including the transposition of the revised PSI Directive), the estimated political, social and economic impact of open data and the characteristics (functionalities, data availability and usage) of the national data portal.	Percentage of the maximum open data score

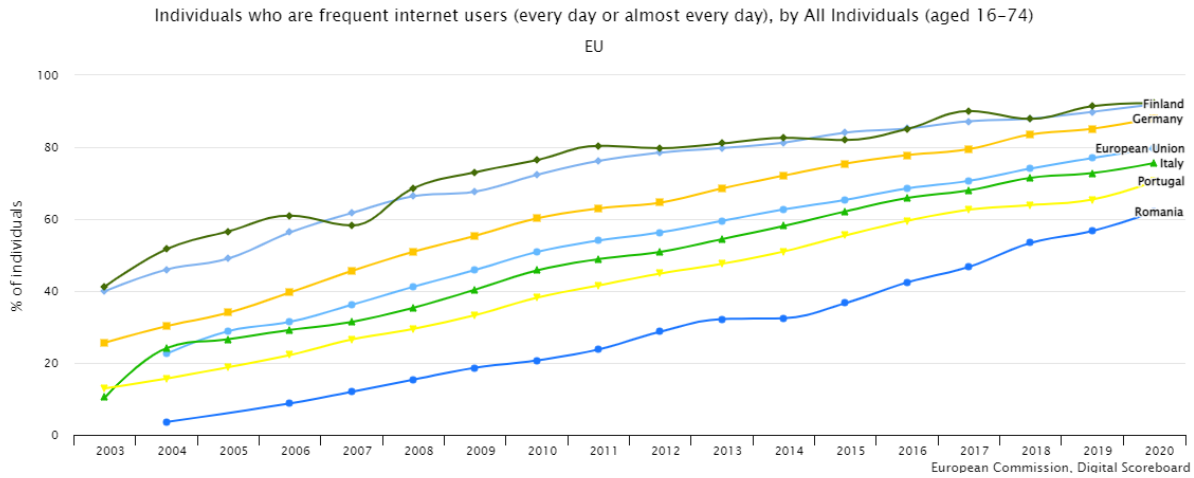
CLOUD	Enterprises purchasing at least one of the following cloud computing services: hosting of the enterprise's database, accounting software applications, CRM software, computing power	Percentage of Enterprises with 10 or more persons employed. All manufacturing and service sectors, excluding the financial sector. Breaks in series because until 2008 economic activities according to NACE Rev 1.1 and from 2009 data are based on NACE Rev.2. Since 2010 include also sector S 95.1-Repair of computers and communication equipment.
ICT SPECIALISTS	Employed ICT specialists. Broad definition based on the ISCO-08 classification and including jobs like ICT service managers, ICT professionals, ICT technicians, ICT installers and servicers.	Percentage of Total number of Persons in employment as defined for the Labour Force Survey
ICT FOR ENVIRONMENT	The indicator measures the level of support that adopted ICT technologies offered to enterprises to engage in more environmentally-friendly actions.	The level of intensity is measured based on the number of environmental actions (maximum 10) reported by enterprises to have been facilitated by the use of ICT. The following categorisation was achieved: low intensity (0 to 4 actions), medium intensity (5 to 7 actions) and high intensity (8 to 10 actions).
ARTIFICIAL INTELLIGENCE	Enterprises using at least 2 AI technologies	Enterprises with 10 or more persons employed. All manufacturing and service sectors, excluding the financial sector. Breaks in series because until 2008 economic activities according to NACE Rev 1.1 and from 2009 data are based on NACE Rev.2. Since 2010 include also sector S 95.1-Repair of computers and communication equipment.

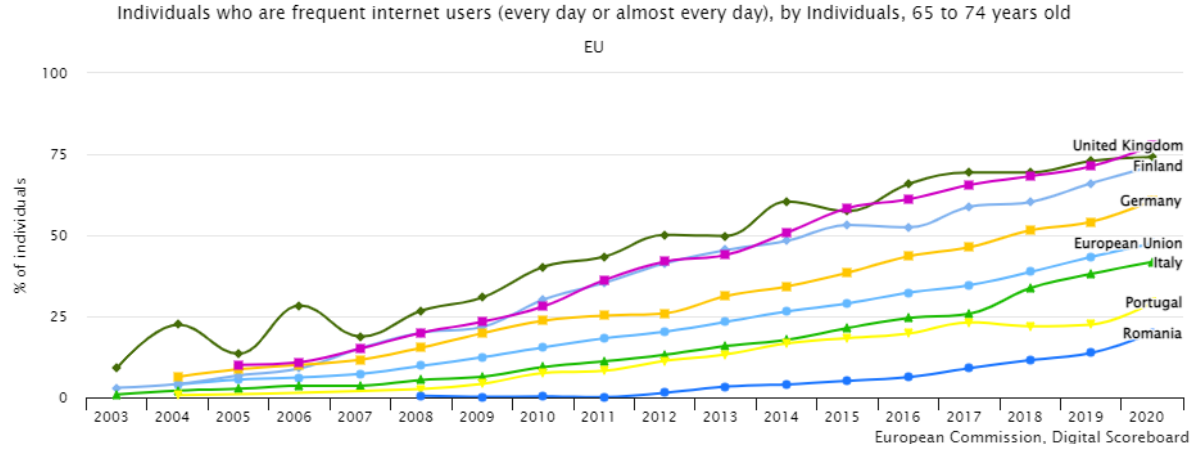
Table 11 Key indicators of DESI index relevant for MaaS Implementation in PriMaaS region and EU average

Region	*Big data*	*Open data*	*Cloud*	*AI*	*ICT for environment*	*ICT specialists*
EU	14,22	0,78	25,56	24,732	65,89	4,30
FI	21,62	0,85	62,10	20,2628	76,67	7,60
DE	17,83	0,88	20,31	27,6514	56,86	4,70
IT	8,55	0,87	38,27	17,6471	60,29	3,60
PT	10,61	0,48	20,86	31,3762	85,53	4,00
RO	5,10	0,69	13,29	30,9278	67,92	2,40
SE	19,21	0,84	59,15	29,8153	73,43	7,50

Table 11 shows that the Nordic countries also registered a significant advance in most indicators, namely in the access and use of cloud and big data. However, Germany and Italy also perform better than the European average regarding the use of open data. On the other hand, Romania and Portugal have better indicators on the use of artificial intelligence tools, and in the case of Portugal, on the application of ICT to improve sustainability. In terms of ICT specialists, Sweden and Finland are the countries with the highest rates of people employed with ICT skills.

Another relevant factor is the ability of the population to use MaaS tools which are largely supported by the internet. Figure 18 presents the evolution of internet users per country.





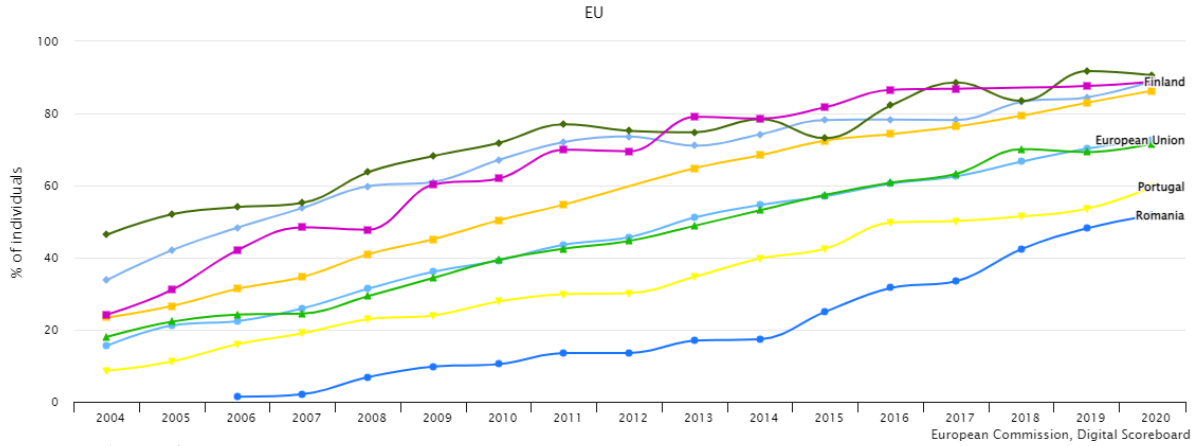


Figure 18 Evolution of internet users per country

In line with the other indicators, there is a clear division between the Northern countries (Finland, Sweden, and UK) and the Southern and Eastern European countries. For the entire population aged 16-74 years, in the northern countries, almost 90% of citizens are regular users of the Internet. However, in Southern and Eastern countries (Italy, Portugal and Romania), more than 30% of the population does not use the Internet despite the growing trend since 2004. This situation is particularly critical and notorious among citizens aged between 64 and 74. For example in Portugal and Romania, more than 75% of citizens in this age group do not use the Internet regularly. Geographic location also has some impact on the internet usage rate with average reductions of 10% in rural areas compared to the national picture.

Network Readiness Index

The Network Readiness Index (NRI) (Dutta and Lanvin 2020) is a metric that involves the technology and human dimensions of network readiness, and emphasizes the importance of measuring trust, security, privacy, and our abilities to leverage technological change to address global challenges such as climate change, and accelerate the realization of the Sustainable Development Goals (SDGs). Concretely, the report (Dutta and Lanvin 2020) assesses how countries are leveraging information technologies to be future-ready. The NRI is all about how the global community is embracing digital technologies to improve citizens' livability. The index focuses on four fundamental dimensions: Technology, People, Governance, and Impact, and it covers issues ranging from future technologies (e.g., AI and the Internet of Things (IoT)) to the role of digital transformation in reaching the Sustainable Development Goals (SDGs).

Table 12 Network Readiness Index for digital transformation for the countries within the PriMaaS partnership (Dutta and Lanvin 2020).

COUNTRY/ECONOMY	SWEDEN	FINLAND	GERMANY	UNITED KINGDOM	PORTUGAL	ITALY	ROMANIA
NRI RANK	1	6	9	10	31	32	49
NRI SCORE	82.75059	80.15672	77.48339	76.26793	64.40005	63.68529	54.1621
TECHNOLOGY	83.81713	78.23946	79.17835	78.34176	62.07489	58.54878	49.61983
PEOPLE	78.06656	78.19081	70.54101	69.68521	58.93491	57.6276	49.75014
GOVERNANCE	88.88472	88.60972	83.5244	82.64974	72.62473	73.25325	58.69119
IMPACT	80.23393	75.58687	76.68979	74.39503	63.96565	65.31151	58.58723
ACCESS	86.59383	86.54689	82.00222	90.37549	83.55251	75.91898	85.43381
CONTENT	81.65772	74.64039	77.13516	80.88398	57.49034	49.04194	38.5226
FUTURE TECHNOLOGIES	83.19984	73.53111	78.39767	63.7658	45.18183	50.6854	24.90306
INDIVIDUALS	71.54161	75.00303	58.83198	63.19868	62.43258	60.57426	59.28559
BUSINESSES	82.15587	78.83829	77.31823	68.8745	55.05654	57.48667	49.19384
GOVERNMENTS	80.5022	80.7311	75.47281	76.98245	59.31562	54.82188	40.77098
TRUST	88.22183	87.80569	84.48071	83.85452	56.68554	65.94851	45.73459
REGULATION	92.99003	93.60086	89.01158	78.72211	85.95472	77.05727	69.30947
INCLUSION	85.44231	84.42262	77.08092	85.37258	75.23393	76.75397	61.02952
ECONOMY	65.69977	54.75809	64.09028	56.63876	31.60487	43.18441	31.57226
QUALITY OF LIFE	91.07157	93.46319	84.14377	81.88569	78.55897	72.58947	71.32352
SDG CONTRIBUTION	83.93044	78.53933	81.83533	84.66064	81.73311	80.16066	72.86591

The 2020 NRI revealed that among the TOP 10 global best-performing countries there are four countries within the PriMaaS partnership, namely, Sweden, Finland, Germany and the UK, with Sweden taking the global lead. Although being considered good examples, there are some differences between them under the considered subpillars. In particular, Finland presented the highest level regarding Quality of life and Regulation, while Sweden yielded a better score on Future Technologies and the UK on SDG contribution. Surprisingly, the UK presented among them the worst score regarding Future technologies, Businesses and Regulation. Portugal and Italy are

really close in terms of NRI scores, and some interesting features can be highlighted as well, for instance, regarding the last subpillar, in which Portugal presented the worst score regarding Economy, but better results on the Quality of life. Both countries yielded similar high SDG contributions.

This underlines the importance of adopting a multidimensional approach to improving network readiness and digital transformation so that countries can take advantage of ICT to improve citizens' life. In particular, Intelligent Transport Systems (ITS) are fundamental for the management of the transport process to improve safety, mobility, and efficiency, increase security and reduce environmental impact. The use of ITS tools in transport is shown to significantly improve the transport systems performance and it is a key element in reducing carbon footprint and providing flexible and easy-to-use means of transport for people, as well as increasing sustainability on an urban scale. Under this context, well-structured policy guidelines based on interregional cooperation focusing on emerging technologies best practices can be relevant for promoting equitable mobility services truly focused on citizens' needs. The PriMaaS Project will contribute to low carbon transport policy goals, social inclusion, and increased levels of accessibility.

Integration of Transport Modes and Pricing Options

What is MaaS?

Advances in digital communication technology are leading to new mobility services. Being a relatively new concept, Mobility as a Service (MaaS) still does not have a universally adopted definition (Arias-Molinares and García-Palomares 2020; Hensher et al. 2020; Jittrapirom et al. 2017). A general vision is that MaaS offers an integrative mobility solution that focuses on user needs, by gathering into a single platform multimodal options within a journey planner and may allow for payments (Hensher et al. 2020). One of the MaaS promises is that the offered mobility services should be an attractive alternative to car ownership (Mulley, 2017; OECD and ITF, 2021). The MaaS key point is to provide a single platform for intermodal trip-planning, booking, and payment services that meet users' mobility needs (Kamargianni et al. 2016; Sochor et al. 2018). Users are the main actors in the MaaS ecosystem (Arias-Molinares and García-Palomares 2020). In essence, MaaS systems seek a major change in mobility behaviour, provide an attractive alternative to car ownership by offering door-to-door mobility services on a single platform, and at the same time aim to improve the daily lives of people and businesses. Thus, MaaS can be seen as a complementary solution to a more sustainable transport system. MaaS is intended to be multi-modal and demand-driven and offers tailor-made travel options to customers through a digital platform providing real-time information.

MaaS Initiatives

Research around MaaS has received great attention and research interest. However, MaaS business/platforms are just taking the first steps. MaaS initiatives, where various operators and transport providers are in a single digital platform, have been launched, all differing in set-up, and have already demonstrated potential to impact citizens' travel behaviour, such as in Finland, Germany and Sweden.

Table 13 Examples of MaaS initiatives

Project	Description	Run by	City/Country
Whim app	Whim, MaaS Global offers users access to various transportation options through its subscription-based integrated mobility app, from taxis to rental cars, public transport, and bike share. The app learns users' preferences and syncs with their calendars to suggest ways to get to an event intelligently.	MaaS Global	Helsinki, Finland
UbiGo	This fully integrated mobility service combines public transportation, carsharing, rental car service, taxi service, and a bicycle system—all in one app, all on one invoice, with 24/7 support and bonuses for sustainable choices.	Part of the project Go: smart by Lindholmen Science Park, with partners from industry, academia, and government, co-funded by Vinnova	80 households; approximately 200 users in the city of Gothenburg, Sweden
Qixxit	With more than 21 service providers, the Qixxit app plans routes according to user needs. It offers carsharing, ridesharing, and bike-sharing options, identifies ideal train connections and shows all travel possibilities for users to compare and choose from.	Deutsche Bahn	Germany

Moovel	Enables users to search, book, and pay for rides with a single app—book and pay for car2go, mytaxi, and Deutsche Bahn in a single experience. Public transportation mobile payments are available in Stuttgart and Hamburg.	Daimler	Germany; also testing in Boston, Portland (USA), and Helsinki, Finland
Beeline	In Singapore's first marketplace for crowdsourced bus services, users can book a bus seat listed by private bus operators and track their location. They can also suggest new routes since new routes are activated by community demand.	Government agencies Infocomm Development Authority and Land Transport Authority in partnership with transportation operators, academia, and the private sector	Commuters in Singapore
SMILE app	The idea behind SMILE was to offer a wide range of different transportation options with the following functions: information, booking, payment, usage, and billing. A standardized interface enables all mobility partners to link their technical systems via specific adaptors to provide all their data, including the ticketing.	Wiener Stadtwerke initiated the SMILE project in cooperation with Wiener Linien (Vienna's public transport provider), Austrian Federal Railways, and private car sharing, taxi, and bike-sharing service providers.	1,000 pilot participants in Vienna, Austria
Bridj	Bridj is an on-demand commuter shuttle service with a mobile phone application that allows passengers to ride a shuttle between home and work during commuting hours. Bridj optimizes pick-ups, drop-offs, and routing based on demand using a fleet of flexible vehicles, meaning a 40–60 per cent more efficient trip than traditional transit.	Bridj Inc.	Commuters in Boston, Kansas City, and Washington, DC, USA
Communauto/ Bixi	In Quebec, some municipal transport authorities have offered mobility packages that include bike-sharing by BIXI and carsharing provided by Communauto. For example, a user can save on the regular price of a public transport pass and bike-sharing by subscribing to the BIXI-AUTO-BUS package.	Communauto	Cities in Quebec, Canada
ALPIO	Digital platform for citizens to book a ride from a bus dedicated for statutory transport.	Tuomi Logistiikka	Tampere Region municipalities: Ylöjärvi and Sastamala

Sources: Whim, http://whimapp.com; UbiGo, http://www.ubigo.me/; Qixxit, https://www.qixxit.de/en/; Moovel, https://moovel-group.com/en; Beeline, https://www.beeline.sg/; SMILE app, http://smile-einfachmobil.at/pilotbetrieb_en.html; Bridj, http://www.bridj.com/welcome#how; Maria Kamargianni, Melinda Matyas, Weibo Li, and Andreas Schäfer, *Feasibility study for "Mobility as a Service" concept in London*, UCL Energy Institute, May 2015.

MaaS Levels differentiation

There are still some issues in comparing and evaluating MaaS schemes (Arias-Molinares and García-Palomares 2020; Kamargianni et al. 2016; Sochor et al. 2018). Various studies have been focusing on presenting MaaS schemes' topology in an attempt to ease the comparison of platforms and business models. For instance, some MaaS schemes were evaluated and compared based on ticket integration, payment integration, ICT integration, and mobility package integration (Kamargianni et al. 2016), in which a mobility integration index was developed based on scores on these characteristics. However, the developed index to evaluate the level of mobility integration yields a final score that may not clearly show the differences between MaaS offers and its disaggregation may be needed for a clear overview. A MaaS topology was proposed by (Sochor et al. 2018) which roughly defines 5 levels based on integration: 0, in case of no integration; 1,

integration of information; 2, integration of booking and payment; 3, integration of service offer subscription; and 4, integration of societal goals. This topology is mainly focused on the customer, provider, and business perspectives, and has been one of the major references in terms of MaaS schemes evaluation. Until now, level 4 integration of policy yields no MaaS scheme examples. In (Lyons, Hammond, and Mackay 2019), the Levels of MaaS Integration (LMI) taxonomy is proposed based on a user perspective regarding the mobility system beyond the private car. Such a scheme suggests that operational and informational integration are important for users and gives more finely graduated levels of integration than (Sochor et al. 2018) do.
Despite some relevant work on developing an insightful classification for MaaS systems, the topology suggested by (Sochor et al. 2018), although with some limitations, has been widely used. Thus, in what follows, we provide a brief description of these levels.

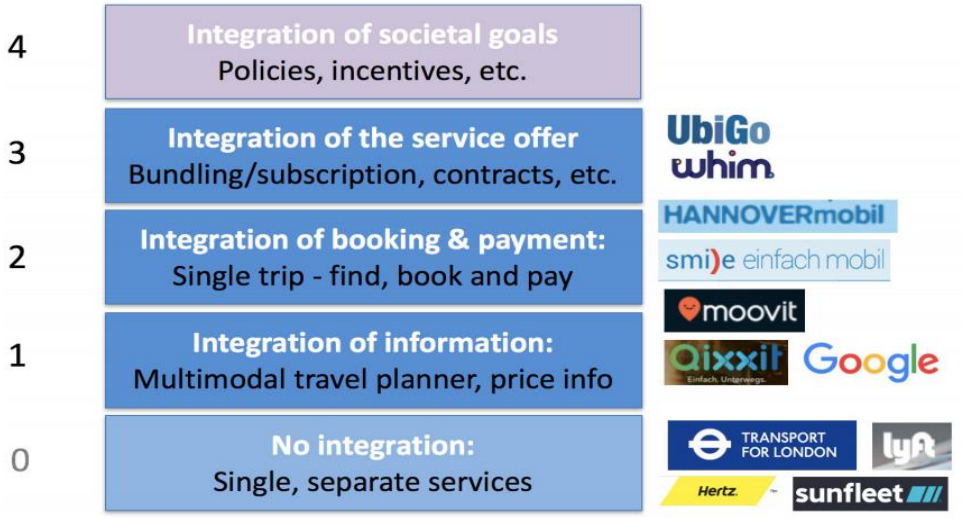


Figure 19 Different MaaS levels and examples as it is proposed in Sochor ICoMaaS 2017.

In the proposed scheme, the different levels are constructed based on the capabilities of the information/planning functions. The levels are not necessarily dependent on each other. A MaaS service that integrates societal goals (Level 4), such as the need to decarbonise the transport system, reduce congestion, innovation, and better accessibility, may be considered sustainable. It may also play a key role as an alternative for individual car ownership (Sochor et al., 2017).

Level 0
This basic level has no integration at all, and it corresponds to the case where different services are provided for different means of transport.

Level 1
This level corresponds to the integration of information in a centralized manner, and its main feature is decision support for finding the best trip within a multimodal travel planner. So, travel information is provided through (multi-modal) travel planners, which may or may not include information on routes and costs. Level 1 operator will not be responsible for the quality of the

service. The added value level 1 holds for users is that it facilitates the choice regarding the time of day, the route, or the mode of transport to be used.

Level 2

This level represents the integration of finding, booking and payment of individual trips. In Level 2, operators take responsibility for valid tickets, accurate bookings, and purchases, but not for the actual travel services. The added value of level 2 is that users can find, book, and pay for their trip at a single service point (e.g., through an app with a pre-registered credit card).

Level 3

This level represents the integration of transport services into passes and bundles. Besides covering individual travel movements, the service also meets the full daily mobility needs of individuals and families by offering different means of transport through bundles and passes. The MaaS operator takes responsibility for the service delivered. The added value of Level 3 is that users have a range of alternatives covering all their daily mobility requirements.

Level 4

This level corresponds to full integration with societal goals, with a special focus on a reduction of usage of private car ownership. At this level, MaaS extends beyond liaising between the demand for and supply of mobility. Supply and demand are now combined with goals such as reducing cars or promoting liveability in the cities. Incentives are implemented in the MaaS service (or implemented in individual services, as a Level 4 approach could be integrated at any level), reflected by, e.g., how well local, regional, and/or national policies and goals are integrated into the service. However, mixing public, often subsidized, services with commercial services into customizable packages poses different challenges.

Bearing all of this in mind, it is clear that the innovation in MaaS, but also the challenge, likely lies not only in the integration entailed in the levels above, but the organizational integration (not least between public and private actors) and the bundling required to achieve Levels 3 and 4. This typology tool for MaaS is important to compare different types of services, their viability, and their effects. The four levels (except the basic level) of MaaS integration can be summarized as follows.

Table 14 Levels of MaaS.

Level 1	Level 2	Level 3	Level 4
information regarding the trip	information regarding the trip	information regarding the trip	information regarding the trip
	booking and payment	booking and payment	booking and payment
		integrates service offers, contracts	integrates service offers, contracts
			integrates societal (local, regional or national) goals in the services

However, none of the mentioned approaches truly focus on assessing the potential societal effects (e.g., possibly a travel behaviour change favouring less car dependence (König et al. 2016), a more inclusive transport network, favouring green modes (Strömberg, Karlsson, and Sochor 2018)) and

contribution to sustainability objectives (Hensher et al. 2020). A holistic perspective should be considered for developing a sustainable MaaS system.

Public sector MaaS governance pathway

A framework for public sector MaaS governance pathways during the development, diffusion, and use phases was recently proposed in (Smith 2020) and it provides a more comprehensive tool for understanding public-private dynamics in MaaS developments, highlighted in the next figure. MaaS governance roles vary across different public sector actors, but these can be roughly classified as MaaS Promoter, MaaS Partner or MaaS Enabler.

Role	Development	Diffusion	Use
MaaS Promoter	Takes the lead in transforming MaaS visions and ideas into operational services	Acts as the lead customer for MaaS services and/or advertises MaaS services	Integrates mobility service data and tickets, and operates MaaS services
MaaS Partner	Participates in knowledge sharing forums and in MaaS experiments	Legitimizes MaaS services, supports marketing, and shares user insights and data	Mediates data and tickets from mobility service providers to MaaS services
MaaS Enabler	Opens for and funds MaaS experimentation and research	Promotes the diffusion of mobility services and/ or digital interfaces	Feeds data and tickets for its own mobility services into MaaS services

Figure 20 Pathways for governing MaaS developments (Smith 2020)

MaaS Promoters are directly involved in executing tactical and operational innovation activities, by mobilizing resources to lead and coordinate the development of MaaS services within the development phase, by accelerating the uptake of MaaS in the diffusion phase, and by taking on the MaaS Integrator and MaaS Operator roles in the use phase.

MaaS Partners are focused on building collaboration networks, and supporting and influencing private sector-led innovation activities, by harnessing knowledge-sharing forums and MaaS experiments during the development phase, by sharing user insights with MaaS Operators and by legitimizing their MaaS services during the diffusion phase, and by mediating data and tickets from other mobility service providers by taking on the MaaS Integrator role in the use phase.

MaaS Enablers define strategies for driving institutional reforms to enable MaaS innovation activities and fund experimentations in the development phase, and "promote the diffusion of mobility services and/or the use of harmonized digital interfaces for data and ticketing" in the diffusion phase, and "enable external actors to take on the MaaS Integrator and MaaS Operator roles" in the use phase (Smith 2020).

In some regions, like Sweden and Finland, a governance pathway was set (in 2020) in which public sector actors are involved as MaaS Promoters, MaaS Partners, and MaaS Enablers in the

development phase, as MaaS Partners and MaaS Enablers in the diffusion phase, and as MaaS Enablers in the use phase (Smith 2020).

Current Integration of Transport Modes and Pricing Options in the PriMaaS regions

Relevant factors behind a MaaS scheme under the PriMaaS Partnership

Given the large differences between MaaS packages, a detailed study on what is offered in a variety of MaaS platforms with special concerns related to functionalities and information types, customisation, and possible integration of specific societal goals should be made. In particular, a fundamental step regarding the current MaaS readiness level of each region is to explore existing mobility platforms for each region. Here, various European MaaS providers/platforms were explored under the PriMaaS partnership, which is composed of heterogeneous regions. Data were aggregated and analysed by applying cross-tabulation and clustering techniques.

The specific objectives of the presented analysis are to:

- highlight the most common variables among the studied MaaS platforms;
- reveal possible correlation and relationship between variables;
- explore the possible contribution of different variables to societal goals.

The methodology followed here relies on a survey of a set of 118 mobility services available in each PriMaaS region. For that purpose, each Project Partner (University of Aveiro (Portugal), Intermunicipal Community of the Coimbra Region (Portugal), TTS Italia (Italia), Intelligent Transport Systems Romania (Romania), University of Applied Sciences Erfurt (Germany), Timisoara Municipality (Romania), Liguria Region (Italia), eGovlab - Stockholm University (Sweden), Council of Tampere Region (Finland) and South East of Scotland Transport Partnership (United Kingdom)) filled a table, that besides information related to operational status, public or private transportation services, available platform (app, website), focused on the following factors, considered here crucial information: “Multimodal Level”; “Geographic Coverage Level”; “Pay as you go”; “Regular Trip”; “Subscription”; “Trip Planning”; “Booking”; “Ticketing”; “Payment”; “Personal/Smart Data”; “Customisation”; “Discount in Ticket Price”; “Discount in Mobility Services”; “Environmental Concerns”; “Comfort/Inclusive”. We further include other variables to better assess the possible fitting of the platform available services to a societal goal, namely, reducing car ownership; accessible, inclusive transport network; affordable transport for any individual; and more sustainable transport systems. A classification of the platforms was also proposed based on the widely used 0-4 MaaS level topology (Sochor et al., 2018). All the data used to describe the current status of mobility platforms in the PriMaaS regions are available in the Annexes.

The results on the characteristics of the mobility platforms under the PriMaaS Partnership revealed that only 36% of the mobility services platforms operators are under the public sphere. Approximately 70% of the mobility service platforms present one transport mode, while only 2% present 5 modes (bus, rail services, shared services, plane/ferry, soft modes). In terms of geographic coverage (whether a platform is urban, rural, national/international), practically half of them are city-centric. Most platforms present trip planning and payment functionalities (60 and 68%, respectively), and a quarter of them provide the option for a subscription. Regarding the personalisation and customisation functionalities, these represent more than 60%. The existing

incentives for passengers are somewhat residual. Most of the incentives are related to the possibility of getting a discount to use further in other mobility services, either in public transport or e-mobility services or even in shared mobility services. These are followed by discounts for selected groups either in terms of age or in terms of the number of tickets to buy (companies, groups). Surprisingly, only 14% of the studied platforms offer some incentives regarding the promotion of independence of vulnerable and disabled people. And the picture is worst concerning environmental reasons, with very few platforms (7%) promoting the use of more sustainable transport modes (e-mobility solutions). The results related to the different types of societal goals in which the provided services in a platform might fit were obtained by considering four major classes of societal goals: reducing car ownership, more affordable transport, more accessible, inclusive transport network, and more sustainable transport systems. These generally are related to the SDG Agenda 2030 to make cities and human settlements inclusive, safe, resilient, and sustainable. Practically 15% of the platforms can be considered that contribute to reducing car ownership, 20% can contribute to a more accessible, inclusive transport network, while approximately 27% of the platforms can be associated with the remaining societal goals equally. Figure 21 shows the frequency of each MaaS level integration as defined in (Sochor et al., 2018) within the PriMaaS regions.

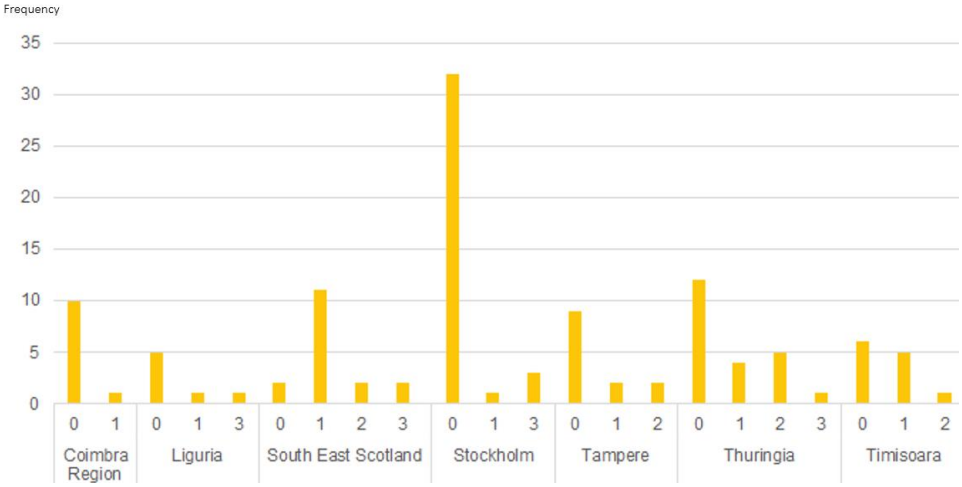


Figure 21 Classification of the mobility services platforms using the topology proposed by (Sochor et at., 2018)

Following (Sochor et al., 2018) MaaS classification approach, approximately 65% of the studied platforms do not present any integration – Level 0, while only 7 platforms (6%) belong to level 3. It can be observed higher levels of integration in Sweden; Scotland; Liguria; and Germany, while very low levels of integration in the Coimbra Region, in Portugal.

The data displayed in the heatmap presented in Figure 22, following a hierarchical clustering of 7 clusters, allow to see the relative number of observations (platforms) within a cluster.

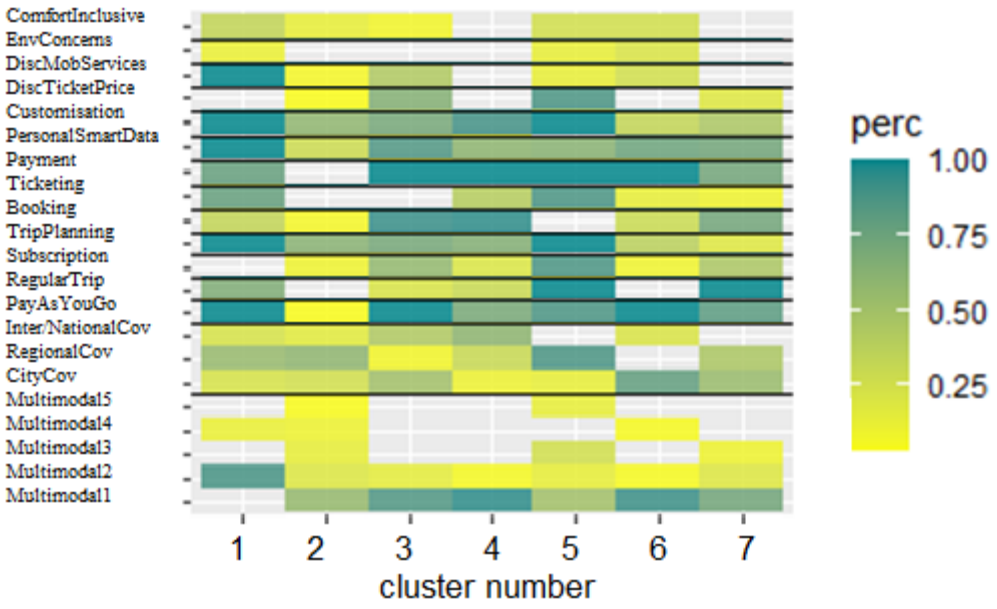


Figure 22 Distribution of the platform characteristics found in the PriMaaS Partnership across 7 clusters

The relative proportion of observations (platforms) per variable within each cluster is shown in the above figure. Results show common patterns for platforms within a cluster can be derived. Based on these results, it seems that:

- the Geographic coverage does not pose a significant contribution in dividing data into clusters;
- Pay-as-you-go, Regular Trip options, and the possibility of Payment, as well as Customisation and Trip planning, are indicative of being very relevant factors for all clusters;
- Cluster 1 is mainly composed of platforms of multimodal level 2 and by the functionalities of Pay-as-you-go, Trip planning, Smart data, Customisation and also the incentive related to Discounts in Mobility Services; while Cluster 2 is in general, mainly composed by the opposite attributes and significant contribution of platforms of all multimodal levels;
- Cluster 3, for instance, is mainly composed of platforms with the lowest multimodal level, with Pay-as-you-go, Booking, Payment and smart data options;
- for instance, Cluster 5 is mainly composed of medium levels of multimodality, Geographic coverage, and Smart data, but by high levels of Customisation and Ticketing, and any Tariff option is also relevant.

The analysis of the association between different features shows that mobility services platforms that allow the functionality of route planning are strongly related to those which present a high level of geographic coverage of the services. This result is aligned with those obtained in (Esztergár-Kiss et al. 2020) in which 30 MaaS services from 14 countries were analysed mostly focusing on the development directions of the MaaS business market. Three clusters were created with specific features and directions of development show for instance, that the group is mainly composed of a MaaS system with the route planning functionality reveals that few transport modes can be found, but the geographic coverage should be extensive. Moreover, in both studies, regional similarities were found, in particular considering the analysed mobility platforms from

Germany and Finland. Table 15 reports some examples of the analysed mobility services platforms within each cluster.

Table 15 Mobility services platforms examples.

Cluster	Examples
1	DB-Regio AG, Regio Südost, KomBus GmbH, NaviGoGo
2	Bus & Bahn Thüringen e.V., orariotrasporti, Moovit, Tripshare, SEStran, SMTUC, Transdev, Coimbra.Moveme, NäästMaaS
3	Nextbike, Bolt, GoMore, Movingo, Easybike
4	Sixt, Uber, Elbilio, FreeNow, Trainline, BloxCar
5	Ubigo, Trenitalia, Nysse public transport
6	Voi, Lime, Resplus, Flixbus, TfE M-Tickets, CP – Comboios de Portugal, Moovy
7	Aimo, ATP, BCR eGO, Forth Bike, ALPIO

Having a clear picture of the characteristics of current mobility services platforms in heterogeneous regions across Europe allows to frame the challenges for the future and to further improve them. This type of analysis paves the way for a better evaluation and comparison of MaaS schemes and can be regarded as a starting point when designing mobility packages with special factors in mind (e.g., geographic context, incentives for more sustainable options). Due to a lack of data, the real penetration of each platform is difficult to be assessed, as well as an analysis at the business level, financial and economic performance.

These findings turned out to be the basis for developing a sustainable MaaS indicator as a deliverable of the PriMaaS Project. It is intended to help to quantify the effectiveness of MaaS initiatives regarding intermodal journey planner, real-time information, payment, ticketing/booking, and subscription in the form of customised mobility packages in what concerns impacts translated into a level of sustainability of the MaaS scheme.

PriMaaS Multidimensional Indicator concept

The proposed classification system results from intense and fruitful discussions under workshops and exchange of experience meetings with several experts (academia, ITS organization) and (private and public sector) stakeholders. As previously mentioned, Project Partners explored various definitions of MaaS topological concepts to categorize different MaaS Services of the 7 European Regions composing the PriMaaS Partnership. This preliminary assessment allowed to conclude that current classification systems do not tackle key dimensions such as coverage, multimodality, infrastructure, and sustainability policies. Simultaneously, other variables related to the level of customization, personalization, and autonomous detection of individual and community mobility needs are not commonly considered. Furthermore, the integration of societal challenges (level 4 in Sochor et al. 2018) does not explicitly distinguish between rhetoric, objectives, and active social inclusion and environmental policies. The following table reports the main features behind each MaaS classification topology.

Table 16 List of relevant features on existing MaaS classification systems and the PriMaaS proposal.

Reference	Classification System	Coverage (geographic and modes)	Functionality, integration of services, ICT	Contributions for sustainability
(Kamargianni et al. 2016)	Ten levels (Transport modes (1 to 6) + 1 for ICT and mobility package integration	1 point for each transport mode. No geographic coverage	Integration of services (planning, payment, booking). Focus on what is more appealing to travellers.	Not directly addressed.

(Sochor et al., 2018))	Four levels 1-4	Possibility of adding layers of nuance, e.g. the number of modes - no clear assessment framework provided. No geographic coverage	Integration of functionality, from planning, ticketing, booking, and subscription. Focus on responsibilities and business models.	Integration of societal goals at level 4, but no clear assessment framework.
(Lyons et al., 2019)	Six Levels 0-5	Some levels depend on the inclusion of more than one mode. There is no clear classification for geographic coverage	Integration in terms of operations degree of seamlessness, information, and transactions (i.e., booking, ticketing, and payment via one interface). Focus on the user perspective.	Not directly addressed in the evaluation framework.
(Traffic Technology, 2018)	Seven Levels (O-6)	Some levels depend on the inclusion of more than one mode. There is no clear classification for geographic coverage	Integration in terms of operations degree of seamlessness, information, data policy, and other smart city tools.	Not directly addressed in the evaluation framework.
PriMaaS Multidimensional Indicator	Five levels * 6 categories	Framework assessment for geographic coverage and multimodality considering local context	Framework assessment for considering integration of services, technology, and personalization.	Framework assessment for considering the contribution to environmental and social pillars.

The existing topological frameworks for classifying the MaaS platforms offer a set of relevant information about each system's functionality but, in general, neglect many other dimensions, such as geographic, multimodal coverage, and contributions to sustainability. It is also verified that it is difficult to establish a clear distinction between the integration of services provided and the ease of use and personalization of the platforms. We propose to address this gap by suggesting a MaaS classification framework to support users to know the potential scalability, services and societal impacts of MaaS systems; and support experts and regional policymakers to benchmark and compare their regional integrated mobility services' performance. Therefore, a complementary approach to classifying MaaS systems based on three main pillars addressing the coverage, functionality, and sustainability performance is presented in this section. Each pillar is divided into two sub-dimensions whose classification is assigned based on specific features (Figure 23).

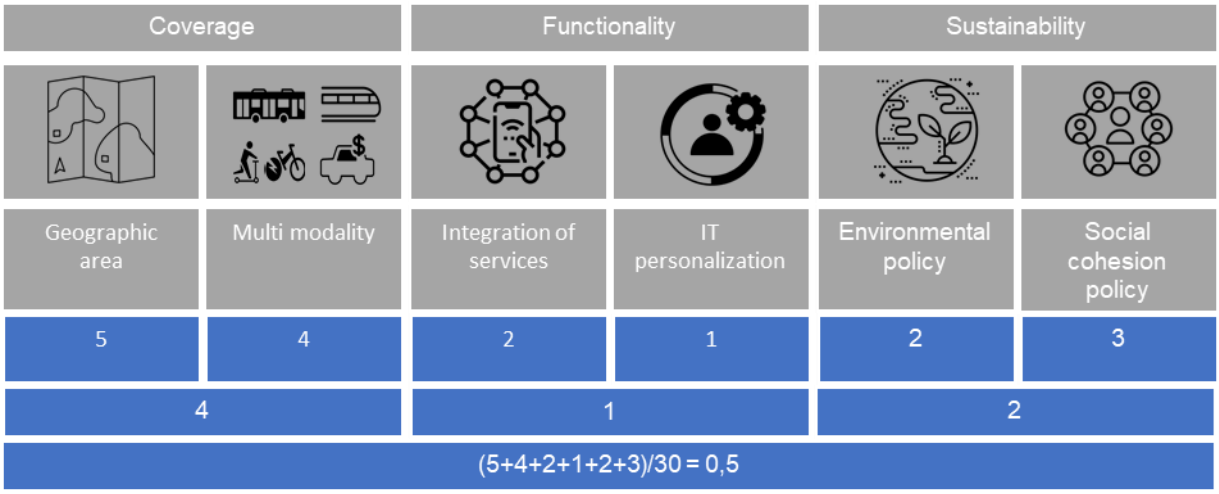


Figure 23 Illustration of the Multidimensional performance indicator and simulation of scoring possibilities in blue

The above figure shows that a more complex system can be presented for a more detailed analysis at the policymakers and technical discussion level (e.g., 4.5x4.3x2.1). For users, a more simplified system can be disseminated by indicating only the minimum of each pillar (e.g., 4x4x1) (similar to the air quality indicator with different pollutants). Naturally, the ratio between the sum of all scores divided by the maximum possible score (30) can be considered for a competitive ranking. This makes it possible to ascertain the overall performance of MaaS platforms of a given region compared to an optimal solution (5,5,5) and based on a holistic set of indicators. However, the key contribution of this tool is the inclusion of other dimensions based on tangible indicators that can be relevant for policymakers, MaaS operators, and potential users, in general.

The following sections detail the PriMaaS proposal on the Multidimensional Indicator for classifying MaaS platforms in different domains, namely under its components: Coverage, Functionality and Sustainability. This classification makes it possible to include other Mobility services, which do not always fully fit the traditional concept of MaaS. Depending on the factor to be analyzed, some indicators are built on a progressive scoring logic (e.g., Sochor et al. 2018); others are made using a cumulative scoring or percentual system.

Coverage

The coverage of MaaS platforms is analyzed from the perspective of the platform's geographic served area and diversity of transport modes. Under the geographic coverage, we consider that the minimum basic coverage is the urban or municipal territorial (level 1). Level 2 includes all MaaS services operating in a large metropolitan area, including several urban and suburban services. We also include in level 2 the MaaS platforms whose core is located in a defined urban area but includes a punctual long-distance service (e.g., long-distance train). Level 3 includes national platforms, while level 4 includes the services that can be used in different cities and countries with the same app and user account but with some geographic discontinuity. Level 5 corresponds to a generalized cross-border service with geographic continuity among different nations.

Table 17 Classification of MaaS services regarding geographic coverage.

Score	Characteristics	Examples
1	Single Municipality	Erfurter Verkehrsbetriebe GmbH (EVAG)
2	Metropolitan Area	SL (Stockholm Public Transport), Navigogo
2	City + single longer distance PT service	DB-Regio
3	National Level	Resplus (via Samtrafiken) BlaBla car
4	Multiple discontinued cities/regions	Uber
5	Generalized cross border service	Flixbus, Google maps

Under the multimodality coverage, existing evaluation schemes do not adequately reflect this aspect in particular, as the number of included transport modes is not considered at all, or is summarized in such a way that, for example, the complete public transport service has the same value as just one bike-sharing provider (e.g., Kamargianni et al. 2016). The classification is based on a score that assesses two aspects. First, the diversity in terms of the coverage of 4 main categories of transport solutions i) mass urban public transport (buses, metro, light rail, BRT, urban trains, water transport); ii) regional and long-distance transportation (coaches, regional and high-speed trains, iii) micro-mobility (E-rideable, E-bikes, E-scooters, Bicycles, Scooters, Mopeds, Active travel modes), and iv) small capacity car-based solutions (e.g., rent a car, car sharing, ride-hailing, taxis). The second aspect addresses the service coverage modes within each category. Additionally, it is necessary to recognize that the capacity of the MaaS system to offer mobility solutions depends on the variety of transport operators in each region. For this reason, classification is dependent on the type and number of services in each area.

Table 18 Classification of MaaS services regarding geographic coverage.

	Services categories coverage (CC)		Service modes Coverage (SC)	
Main Category (G)	Regional Offer (RO)	MaaS Offer (MO)	Nº of Regional Offer services (MO)	Nº of MaaS Offer Service (MO)
C1 Mass Urban Public Transport (Bus, Train Tram, LRT, BRT, Water transport, etc)	Y = 1, N = 0	y=1, no = 0	A	a
C2 Long-distance Transport (Coaches, Bus, Ferries, Regional and IC trains)	Y = 1, N = 0	y=1, no =0	B	b
C3 Micromobility (E-redeables, -E-bikes, E-sootters, Bicycles. Scooters, Mopeds, Active travel modes, etc)	Y = 1, N = 0	y=1, no =0	C	c
C4 Small/medium capacity and car-based solutions (Flexible on Demand, Taxi, Ride-hailling, car-sharing, rent a car)	Y = 1, N = 0	y=1, no = 0	D	d
		CC=∑MO/ ∑RO		SC=(a+b+c+d)/A+B+C+D)
Multimodality	(CC+SC)/2			
Ranking Multimodality	< 20 % = 1; 0-39 (%) = 2; 40-59% = 3 ; 60-79% = 4; > 79% = 5			

The final ranking on multimodality reflects the variety and percentage of main categories covered and the percentage of services that the MaaS platform serves in a region according to the average percentage of contained mobility service operators. A potential disadvantage of this scoring is that the same service may have different scores in different regions. However, it has the advantage of

simultaneously reflecting the offer's heterogeneity and does not penalize the classification of new MaaS systems implanted in areas of low population density and with less supply of transport.

Functionality

The functionality is defined in two sub-pillars. The first field refers to the level of integration of services available. This sub-indicator is close to the most used classification system (Sochor et al., 2018). A cumulative scale has been designed since the information, planning, payment, and subscription services can be provided independently. One point is accumulated for each service related to general information (maps, timetables), trip planning and ticketing. For platforms offering bundling or subscription services, two points are assigned, as we consider bundling a differentiating feature inherent to the most advanced MaaS services and an added value compared to the traditional services.

Table 19 Classification of MaaS services regarding the integration of services (left) regarding personalization (right)

Score	Characteristics	Examples	Score	Personalization feature	Examples
Yes +1, No 0	General Info	Google maps	Yes +1, No 0	App	EU-BIKE
Yes +1, No 0	Trip Planning	Moovit	Yes +1, No 0	Voyage Customization	orariotrasporti
Yes +1, No 0	Payment-Ticketing	AMT	Yes +1, No 0	Personalization	AMT
Yes +2, No 0	Bundling-Subscription	Ubigo, Navigogo	Yes +2, No 0	Automated personalization	Google mpas
			Yes +1, No 0	IoT Integration	

The second sub-indicator is related to personalization, customization integration of the platform in a broader context of IoT and smart devices. This indicator reflects the platform's potential to adapt to users' preferences, obtaining a higher ranking for platforms that do it autonomously. The category 'personalization' includes the possibility for storing personal data and preferences in the MaaS-service, such as frequently used/preferred locations, modes, stops or trips. Customization includes the possibility of customizing and filtering functionalities of the MaaS-service. This feature includes, for instance, frequently used/preferred modes, trip and routing criteria such as price, time, carbon footprint. The degree of, and need for, human intervention decreases as MaaS matures. The highest level corresponds to the generalized integration mobility with other digitized services. In the subclassification system reported in Table 19, the basic existence of an app is awarded one point. Manual customization and personalization options are also awarded one point each. An extra point is added if the process involves some degree of autonomy and artificial intelligence in recognizing users' preferences. The maximum score of 5 points is awarded if the MaaS platform connects beyond Mobility, interfacing with the IoT, smart buildings and smart cities. Although experts anticipate this possibility as the most advanced level of MaaS integration, we are not aware of this feature's existence on European MaaS platforms.

Sustainability

This indicator reflects the external contribution of the MaaS service in terms of sustainability. This pillar considers the social sub-pillar and the environmental sub-pillar independently. In this context, for each sub-pillar, a score is defined that rewards generic objectives in a less incisive way and strongly rewards active tariff policies promoting social inclusion and environmental sustainability (Table 20).

Regarding the environmental component, a single point is an award if the service provides information on the environmental impacts of the trip or includes a generic target in the platform strategy related to the environment and sustainable mobility (e.g., contributing to reducing car ownership). In case the platform allows users to customize their trip planning based on environmental criteria (e.g., carbon footprint), the platform receives a score of 2 points. The ranking increases as the incentives for promoting eco-friendly behaviour are available. Level 3 includes gamification strategies and incentives (e.g. store discounts) to reward sustainable transport mode choices. If these incentives are based on active smart pricing policies (e.g., pricing correlated to carbon footprint), a 4-point rating is assigned. An additional bonus point is assigned if the MaaS platform is integrated with wider regional or urban planning strategies. This bonus is only assigned to those platforms, supported by a coherent public policy framework (e.g., SUMP plan), and includes clear targets and an evaluation framework to enable the impact of MaaS on travel behaviour could be measured against local transport policy goals (Table 21).

Table 20 Classification of MaaS services regarding environmental policy.

Score	Description	Example
1	Generic Environmental Information or strategic target	Tripshare SEStran
2	Customization Environmental Goals	Free Now
3	Gamification for promotion of Environmental goals	Navigogo
4	Active or Dynamic Pricing with environmental goals. Discounts for sustainable travel choices	MTR Express
+1	Integration with regional or urban planning strategies. Clear Evaluation Framework	Riviera Transport

Table 21 Classification of MaaS services regarding societal contribution.

Score	Description	Example
+ 1	Discounts for selected groups	Stockholm MTR Express, SMTUC (Coimbra)
+ 1	Data sharing	Uber, Whim
+ 1	Promoting disability independence	Uber Stockholm, AMT Genoa TPL Linea (Liguria), Moovit Scotland
+1	Promoting healthier lifestyles and livability	Nysse public transport (Tampere), STPT / Velo TM system (Timisoara)
+1	Improving the accessibility of low-density areas	Resplus (via Samtrafiken)

Social contribution is assessed under different domains based on a cumulative scoring system as each feature can be provided independently. The inclusion of discounts for vulnerable groups through subsidized tickets or other pricing schemes is scored with 1 point. Likewise, concerns with accessibility and integration with urban plans and guarantee of accessibility to rural areas are rewarded. Another considered factor is promoting disability independence by providing information and or means of transport adapted to this population's needs with special needs. The platform's data policy is also taken into account, namely, the use and sharing of open data. It is intended to enhance the platform's contribution to increasing the network's efficiency, enabling operators to adapt the offer to the population's specific needs. Regarding this point, it should be noted that the role of platforms can be complicated since there are cases in which platforms act mutually as a marketplace and service providers. Given this ambivalence, a point to be improved is the necessity of MaaS systems to communicate the data privacy policy and the aggregated or individual data made available to operators, cities, and regional transport authorities (e.g., demand variability, OD matrices, etc.).

In a pandemic context, other information tools and assistive technology potentially useful in pandemic contexts (real-time occupation) or pervasive systems to support the mobility of the elderly population are also rewarded.
The development of the Multidimensional Indicator of MaaS performance can be used to evaluate a MaaS system either from the point of view of citizens to use MaaS more efficiently and MaaS providers, operators and facilitators in conceiving and developing sustainable business models, i.e., find the most robust model and contribute to enhancing adoption of MaaS. Thus, the PriMaaS Project deliverable is an important tool to help drive policy change with respect to MaaS implementation by bringing into the analysis equally important dimensions.

Comparing New MaaS Multidimensional Indicator with Sochor et al. levels

As stated before, a new MaaS indicator was developed during this project. In order to demonstrate the differences in coverage, functionality, and sustainability influences on the performance of the indicators, Table 22 demonstrates and compares what were the levels considered of those operators in the Sochor et al. (2018) indicator, and what is the 'level' – overall evaluation - of the same operator taking in account the coverage, functionality, and sustainability of the same.
Three operators from each region of the PriMaaS partnership were selected by considering the services with the highest coverage, functionality, and contributions to sustainability.

At a glance, among the various services analyzed, there is a clear tradeoff between coverage and functionality. Naturally, the services that cover a higher geographical area have some limitations on the perspective of the diversity of modes (Uber) or are mainly intended for information and travel planning purposes (Google maps). On the other hand, services with a high level of integration and multimodality have limited geographic coverage (EVAG, AMT).
Regarding sustainability, most companies have generic goals of contributing to green Mobility and healthier cities. Moreover, it may be expected that offering integrated mobility services could contribute to reducing private vehicle ownership. However, in practice, since MaaS systems are the last interface between mobility providers and users, we could expect more measures for actively promoting environmentally friendly Mobility (gamification, active dynamic pricing related to carbon footprint) and clear frameworks and indicators to evaluate these impacts.

Table 22 **New proposed MaaS Indicator for the Mobility platforms within the PriMaaS Partnership**

City/Region	Name of MaaS-Operator	Sochor MaaS levels	Coverage		Functionality		Sustainability		Overall
			Geographic Area	Ranking multimodality	Integration of services	IT Personalization	Environmental Policy	Societal Contribution	
Coimbra Region	COIMBRA.MOVEME	1	2	4	1	1	0	0	0.29
Coimbra Region	CP- Comboios de Portugal, EPE	0	3	3	1	1	0	0	0.28
Coimbra Region	UBER	0	4	2	1	1	0	0	0.24
Liguria	TPL Linea	4	2	3	4	1	0	2	0.42
Liguria	AMT Genova	4	2	5	4	3	0	2	0.56
Liguria	ATC La Spezia	4	2	3	2	1	4	1	0.45
South East Scotland	Borders Buses	0	2	2	4	3	0	0	0.38
South East Scotland	NaviGoGo	2	2	5	2	2	3	2	0.56
South East Scotland	Moovit	1	2	4	1	1	0	1	0.33
Stockholm	Resplus (via Samtrafiken)	4	3	4	4	2	1	2	0.56
Stockholm	Ubigo	3	2	5	2	3	1	2	0.53
Stockholm	SJ	0	3	2	4	3	1	2	0.51
Tampere	Nysse public transport	2	2	3	2	3	0	2	0.42
Tampere	VOI	0	1	2	1	1	3	2	0.34
Tampere	Google Maps	1	5	5	1	3	0	0	0.50
Thuringia	Verkehrsgemeinschaft Mittelthüringen (VMT)	2	2	5	2	3	4	2	0.63
Thuringia	Erfurter Verkehrsbetriebe GmbH (EVAG)	2	1	5	2	3	4	3	0.63
Thuringia	GVB Verkehrs- und Betriebsgesellschaft Gera mbH	2	2	5	1	3	4	2	0.60
Timisoara	Google maps	1	5	3	1	5	0	0	0.48
Timisoara	FreeNow	2	2	2	2	3	0	0	0.31
Timisoara	STPT - public transport company	1	1	4	0	1	1	1	0.29

Good Practices on Innovative Mobility Solutions

Innovative disruptive schemes for passengers (and goods) can be a solution for a more sustainable transport system. The mobility systems need to adapt rapidly to become more environmentally sustainable, resilient, flexible, inclusive and adaptable in the face of shocks. User-centric approaches such as MaaS schemes have the potential to be part of the solution and can be truly transformative.
Across Europe, many pilots and projects have been developed in an attempt to improve citizens' connectivity and livability. This section is devoted to pointing out some inspiring Good Practices found either during the PriMaaS exchange of experience events or following stakeholders' discussions.

Public Transport App with Check-In/-Out System

The traffic community in central Thuringia (VMT) offers an App in co-operation with the offerer FAIRTIQ over which not only travel information can be caught up, but also single travels, 4-Fahrtenkarten, daily tickets and group daily tickets can be booked. In addition, by using the check-in/check-out system, the cheapest fare can be determined automatically and aggregated over a week. Bookings are possible in the tariff area for buses, streetcars and trains. The technology works properly for several months now and the app is used by 'normal' customers. Therefore the system is widely accepted by the public, especially by people who are not familiar with the tariff system. Additionally, the app is perceived much more attractive than the manual search for a public transport ticket.

On-Demand Bus

The call or village bus system of the Wartburgmobil transport company has recently replaced the regular bus service in certain areas of the operating area around the city of Eisenach in western Thuringia. The service is similar to the well-known on-demand mobility services that you mostly find in urban areas. The bus can be ordered up to one hour before the desired trip and then runs between the regular public transport stops. Bookings can be made by phone or on the homepage. The fare is the same as the regular public transport fare (1,60 € - 2,90 € for a single ride). The system described here is primarily intended to ensure the provision of public transport in rural regions, where public transportation services are being reduced to an increasing extent. With the help of on-demand transport, empty runs can be avoided, thus reducing costs and environmentally harmful emissions. Therefore, it is possible to adapt public transport to demand, especially in rural regions, without having to discontinue it completely. The call or village bus system operated by the Wartburgmobil transport company has been in operation for quite some time and continues to run without any significant problems. The system is widely accepted by the public, especially by people who live in rural areas and have no own car. Additionally, the services are perceived much more attractive than the regular timetable-based public transport. As the operation appears to be marketable, the project can be rated as successful.

The Act on Transport Services

The Act integrates relevant legislation and enables digitalization of transport. Its key aim is the provision of customer-oriented transport services. For having a paradigm shift in transport from the use of privately owned vehicles towards Mobility as a Service (MaaS) it became more and more obvious that the existing legislation was not able to provide a sufficient framework. The Finnish Act on Transport Services views the transport system as one entity and provides the needed elements for a technology-neutral digitalization of transport services and new transport models. It has brought changes to the former state of the transport market that has been strictly regulated and guided by public measures. It promotes fairness of competition in the passenger transport market and competitiveness of the service providers of both passenger and goods transport. The Act creates a framework for a more efficient arrangement of publicly subsidized passenger transport by utilizing digitalization, combined transport, and different fleet types. The role of data is central, and the Act identifies essential data and interoperability of ticket and payment systems for MaaS.

As the Act belongs to national legislation and supports the paradigm shift towards the use of transport services it affects widely to the whole transport system. Therefore, there are also many stakeholders and beneficiaries. E.g. businesses have new opportunities, municipalities can improve their service offering and citizens benefit from improved services. Overall, the Act can inspire and be a reference to other European countries in the legal framework development of MaaS. The amount of services in the National Access Point (NAP) service catalogue has increased from ca. 500 in 12/2017 to over 7 000 in 9/2020. Transport service providers are obliged to submit essential information on their services via digital machine-readable interfaces to the NAP. Between 2015 and 2019, the amount of taxi driver licenses increased from 30 000 to over 35 000. According to a survey, new drivers sense that the Act enables more flexibility to drive in different situations.

Strategic Innovation Program for sustainable mobility solutions

Drive Sweden is a Strategic Innovation Program for sustainable mobility solutions creating connected and automated transport systems that are accessible for all. Drive Sweden is one of the 17 Strategic Innovation Programs co-funded by three Swedish innovation agencies. It aims at driving development towards sustainable mobility solutions and demonstrating efficient, connected and automated transport systems. As such Drive Sweden funds projects and pilots across Sweden to test new ideas in the field, from autonomous shuttles to robo-taxis. In these projects academic, public sector and business organisations join forces under the umbrella of Drive Sweden to develop sustainable mobility solutions and services for the future. At the same time Drive Sweden offers an ecosystem and network of partners, which today is composed of 160 members, from 19 different countries. Several conferences, events and workshops, a newsletter and a specific SME platform are also offered on a regular basis. The program was formed when it became clear that it takes a truly cross-functional collaboration to shape tomorrow's mobility and to take advantage of all of today's technology breakthroughs. There is not one 'winner category' thanks to Drive Sweden, but its success builds on the fact that all different stakeholders – public as well as private - have a lot to win if they collaborate. The success of the Drive Sweden Program

has been recognised as the natural arena and meeting place for collaboration on mobility in Sweden, an established platform for policy development that allows the increased knowledge and support of SMEs. The Program contributes to technical solutions and business models for a sustainable transport system, boosting the network of partners (with high participation of municipalities and authorities) and funding pilots and projects that make a substantial contribution to sustainable mobility solutions.

NaaSMaaS hobby pick-up service for school children

NaasMaas – MaaS linked to Tampere school pick-up service from school to hobby clubs and back to school – concept development, testing and trial. The idea behind the service is to solve the challenge of mobility faced by 2,000 Tampere-based junior athletes using the principles of public transport or shared transport. The aim is to create a safe transport service between the school and the hobby places, to shift the focus of the rehearsals to the afternoon and thus increase the time families spend together after the rehearsals, and to reduce car traffic related to hobby transport. The key challenge identified already beforehand was to gather and coordinate a sufficient customer base to carry out the project and enable continuous business. Another goal is to consider what kind of overall concept could be developed around the ride service to the city of Tampere and neighboring municipalities. NaasMaaS hobby pick-up service was first developed and tested in 2019 and early 2020. The expanded trial (spring to autumn 2020) did not quite reach the planned scale due to covid-19. However, the initial, potential impacts have been able to be verified for smaller numbers of users. The piloting was coordinated by MDI Public Oy and WSP Finland Oy. The pilot service was organised and subsidised by the City of Tampere and the Ministry of the Environment. Transport is provided by Tuomi Logistiikka Oy. The role of different sport clubs was the most important to this joint mobility service concept for children. The main beneficiaries are cities and municipalities, families, sport clubs and businesses.

Stockholm Public Transport offer a multimodal ticket

The whole greater Stockholm region is serviced by one publicly held non-profit public transport company, that offers one single immaterial digital ticket. Stockholm is a big urban area, with no other big cities nearby. The central Stockholm area is home to a quarter of all the workplaces in the whole of Sweden. The workers for these workplaces are drawn from the whole of the greater Stockholm area. Also; Stockholm is built on a number of islands in the Baltic Sea and the great lake Mälaren, with bridges in between. It is not possible for all the workers commuting from homes in the suburban and rural areas to workplaces in the center of Stockholm to travel by car across bridges between islands. Hence the Stockholm public transport system transports in total one million people on three million journeys per day over an area of 150 kilometres times 150 kilometres that is both urban, suburban and fully rural. Having a public transport system that is attractive enough to compete with commuting by car, is seen as a necessity for the economic viability of the geographically fractured greater Stockholm area. Public transport runs with a single-ticket intermodular system over trains, boats, subways and buses. One single ticket costs 37 SEK, ca 3,5 Euros, which is “blipped” on a Master or VISA card one time at the start of the journey. This ticket is valid for 75 minutes. Hence there is no need to find a kiosk or similar as a point-of-sales for tickets. The growth of travel on the Stockholm public transport system since single zone digital

ticketing was introduced in 2017 has been greater than the general growth of the economy and population of the greater Stockholm area. That fact indicates a net transfer of intraregional travel away from cars to the public transport system.

SIT FLEXI Intermunicipal demand responsive transport solution

In a context of low density and high territorial dispersion, public transport cannot effectively and efficiently cover 100% of rural areas. In these areas, public transport operates in most cases regardless of the low demand and is often directed at the student population. This leads to inadequate supply to a significant portion of the population. In these circumstances, any attempt to increase the coverage of the network is always associated with low demand rates, not adjusted to the typology/size of existing equipment, and in most cases making it impossible to achieve an efficient service. The Intermunicipal Community of Coimbra Region implemented SIT FLEXI in two municipalities (Góis and Pampilhosa da Serra) as pilot projects in 2020. In 2021 the IT FLEXI solution is being expanded to the remaining municipalities (except Coimbra, the most urban and densely populated municipality) In order to enable an offer in terms of transport services in these rural and low-density areas (most part of the territorial area of CIM RC) the SIT FLEXI is the most efficient and flexible transport solution. A demand-responsive transport solution of this nature has flexibility, depending on the needs of the population and the characteristics of the territory. SIT FLEXI has routes, stops and schedules but with the flexibility to make adjustments in order to give the best response to user needs.

Good Practices related to COVID-19 and Public Transport

At its most basic, safety requires physical distancing, frequent hand washing, and cleaning of surfaces, as COVID-19 spreads in air droplets from infected people coughing or sneezing, and the virus can survive on surfaces and pass onto people's hands. However, the required physical distancing makes high-density public transport a particularly risky environment. Working with the Interreg Europe community, the IE Policy Learning Platform collected around 20 good practices related to COVID-19 and public transport, and devised a typology of measures that can be introduced:

1. Increasing transport capacity by raising the number of buses and trains in circulation, as in Madrid and Dublin, so that people can travel whilst maintaining social distancing;
2. Limiting ridership to certain users only, such as the dedicated buses and trams for vulnerable people, implemented in Iasi (Romania) and Auckland, New Zealand, to provide transport services only to those who truly need them;
3. Shifting demand away from peak times, as has been done with businesses in France, and schools in the Netherlands, encouraging people to spread travel out, so not everyone is trying to travel at once in rush hour;
4. Helping riders to make choices that alleviate crowding by providing information on crowding. This is primarily being done through websites and apps, such as the Deutsche Bahn website, which gives information on carriage crowding when booking tickets, the Autocorb app in Catalonia, and the upcoming London app, developed by UrbanThings, which demonstrate real-time vehicle capacity;
5. Enacting safety measures such as mandatory mask-wearing, frequent cleaning, and onboard information. This includes free mask distribution in Madrid, travel guidelines in Ireland and the UK;
6. Restoring confidence through communication and public relations measures, such as the free train tickets offered in Belgium to encourage people to return to normal habits and also boost the domestic economy.

Following these examples, each region of the PriMaaS consortium has also promoted sustainable transport during the COVID-19 pandemic acute phase. For each typology presented before, the PriMaaS consortium classified their good practices as reported in the following tables.

1. Increasing transport capacity

Table 23 Good practices for Increasing Transport Capacity

Region	Example
Coimbra Region	Breakdowns were made in the identified hours/services with outdated capacity. Only in the cases identified have vehicles been reinforced
Liguria/Rome	
Erfurt/Thuringia	Increasing transport capacity by raising the number of vehicles
Timisoara and Bucharest	
Stockholm	Supply remained the same throughout the pandemic.
Tampere	Restoring the number of weekend buses to normal, preceding COVID-19 (although demand is lower). Arranging separate rides for social healthcare and disability service clients.
SE Scotland	

2. Limit ridership to enable physical distancing

Table 24 Good practices related to limitation of ridership to enable physical distancing

Region	Example
Coimbra Region	Limit of 2/3 of capacity in public transport
Liguria/Rome	
Erfurt/Thuringia	None
Timisoara and Bucharest	
Stockholm	Supply remained the same throughout the pandemic.
Tampere	Not possible to book a seat adjacent to an already booked seat in business class (train). In other words, only window seats are available.
SE Scotland	

3. Shift Travel demand away from peak hours

Table 25 Good practices related to Shift Travel demand away from peak hours

Region	Example
Coimbra Region	Promotion of working from home, if possible.
Liguria/Rome	
Erfurt/Thuringia	Promotion of working from home, if possible.
Timisoara and Bucharest	
Stockholm	Promotion of working from home, if possible.
Tampere	Promotion of working from home, if possible.
SE Scotland	

4. Help riders make choices that alleviate crowding

Table 26 Good practices to help riders make choices that alleviate crowding

Region	Example
Coimbra Region	At each moment, there were/are distinct situations; as of March 18 we had entered through the back door, and the validation of transport tickets was not valid. An adjustment in the capacity for 2/3 was made and an incentive to purchase.
Liguria/Rome	
Erfurt/Thuringia	In some cases, apps provide information about the occupancy rate in vehicles.
Timisoara and Bucharest	
Stockholm	From 17 March 2020, bus passengers are asked to board through the rear doors and not validate their tickets at the front doors. Update: in January 2021 the busier buses (the blue buses) allow passengers to bleep their cards entering from the front door.
Tampere	Tampere tramway starts to operate next year and ideas about real-time info for passengers on crowding have been presented.
SE Scotland	

5. Enact safety measures for PT users PUS;

Table 27 Good Practices regarding Enactment of safety measures for PT users

Region	Example
Coimbra Region	Mandatory use of Mask in PT and respective seat disinfection after travel
Liguria/Rome	
Erfurt/Thuringia	Wearing a mask is mandatory in public transport throughout Germany. In addition, e-ticketing offers are increasingly being created to minimize contact with ticket machines, for example.
Timisoara and Bucharest	
Stockholm	Efforts to limit crowding have been done in trains (SJ), by reducing the number of available seats for booking. However, all-year train ticket holders do not need to pre-book, which makes it challenging to control the crowding. Also increased cleaning and air replacement is being ensured.
Tampere	Mandatory use of mask in PT and respective seat disinfection after travel. Denying payment with cash in PT.
SE Scotland	

6. Restore confidence through communication and public relations measures

Table 28 Good practices related to restoring confidence through communication and public relations measures

Region	Example
Coimbra Region	Through the scrupulous implementation of security and hygienization measures imposed by the government at all times. In addition, since November 2020, we have increased the reduction.
Liguria/Rome	
Erfurt/Thuringia	Ticket offers adapted to the reduced commuting caused by working from the home office (e.g., Deutsche Bahn ticket for only 10 return trips per month on a fixed route).
Timisoara and Bucharest	
Stockholm	
Tampere	Various organisations: Videos and other media material guiding how to take care of hygiene, wear a mask, etc.
SE Scotland	

Public Transport and Mobility Trends in the Post-pandemic Era

With all the good practices implemented above, what would be the public reaction in this post-pandemic era regarding their mobility trends, particularly due to the social distancing making high-density public transport a risky environment? It is possible to further see that there were different behaviours in each partner region. Public transport, or transit stations, represents the mobility trends to public transport hubs such as subways, buses, and train stations. Workplaces are the trend for places of work. Residential is the mobility trend for places of residence. Retail and Recreation are the trends for places like cafes, restaurants, shopping centres, museums, etc. Grocery or Supermarkets and pharmacies depict the trends in farmers' markets, foods warehouses, drug stores, pharmacies, special food shops. Parks demonstrate the trends for places such as national parks, public beaches, marinas, dog parks, etc.

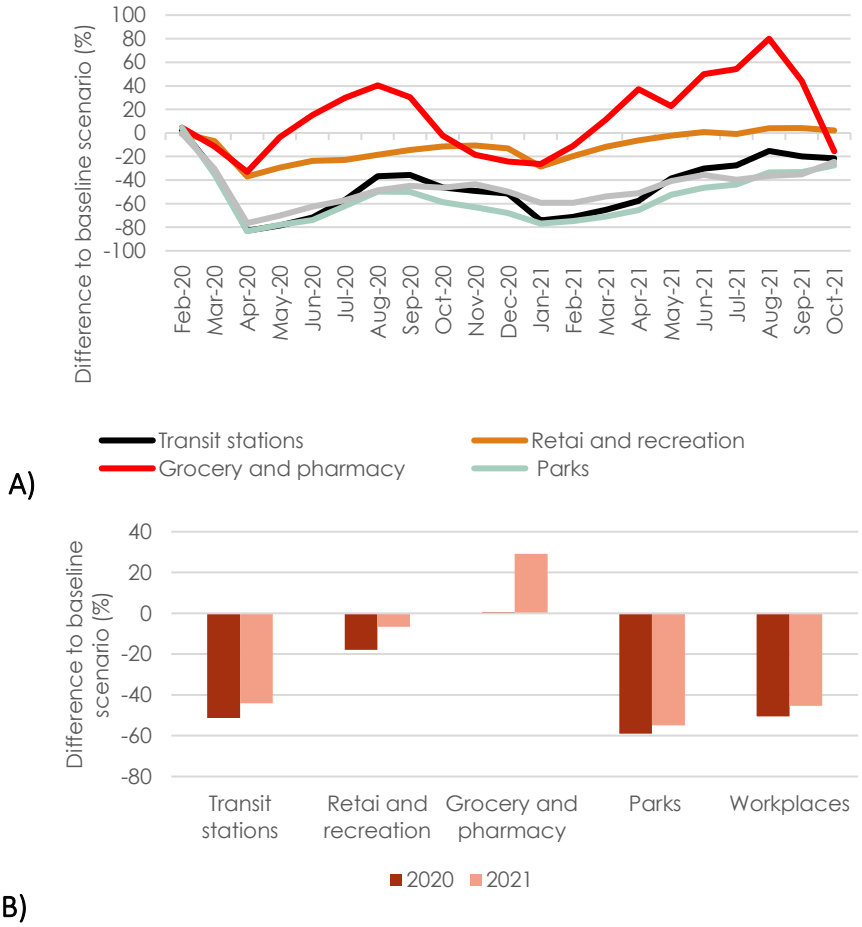


Figure 24 a) Average monthly change in people mobility trends between February 2020 and October 2021 for various categories in South East Scotland; b) Average annual change in people mobility trends between 2020 and 2021 in South East Scotland

The sector analysed whose demand variation was most negatively affected throughout the lockdown periods was the transport sector and Parks. However, since April 21 there has been a recovery although demand is not higher than in the pre-pandemic context. In general, the grocery sector was the least affected, with an increase in demand over the various months of the pandemic. The months with the highest restrictions were between February 2020 and April 2020, and November 2020 until March 2021, with a negative variation in all sectors. The sector analysed whose variation in demand was most negatively affected was the transport sector and Parks above 40% compared to the baseline scenario, both in the years 2020 and 2021.

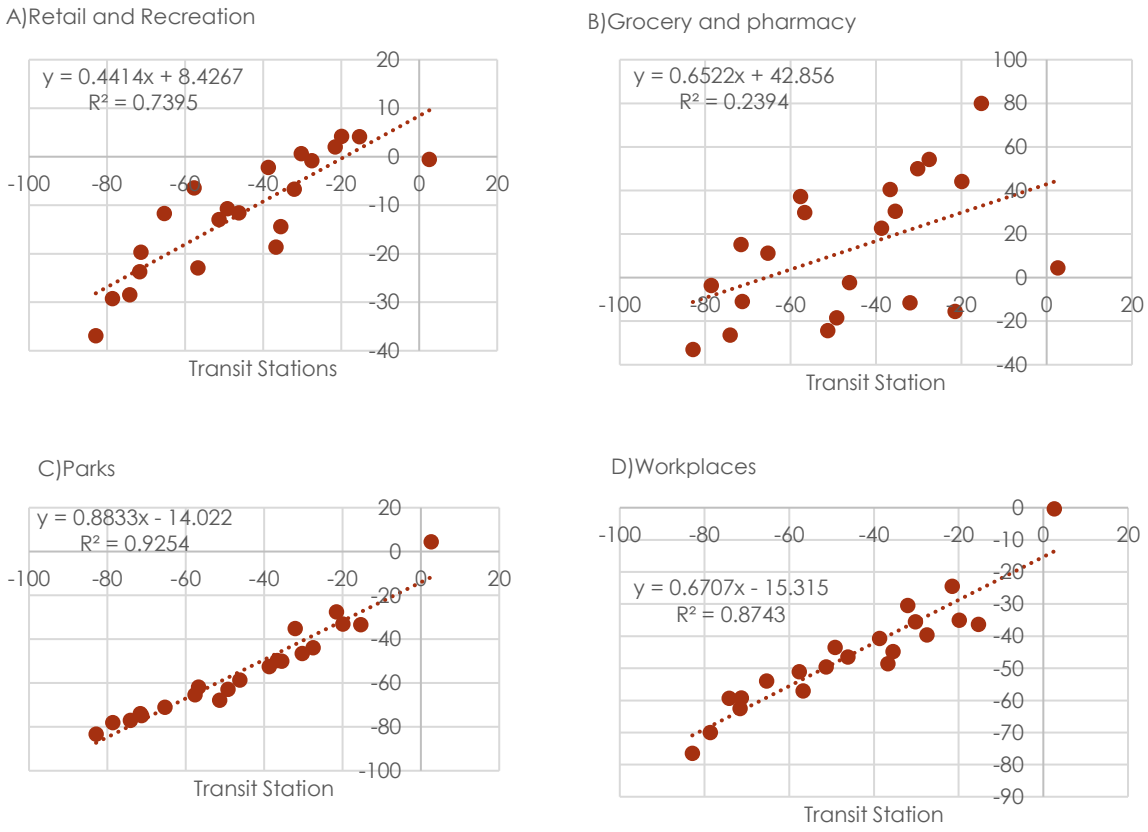
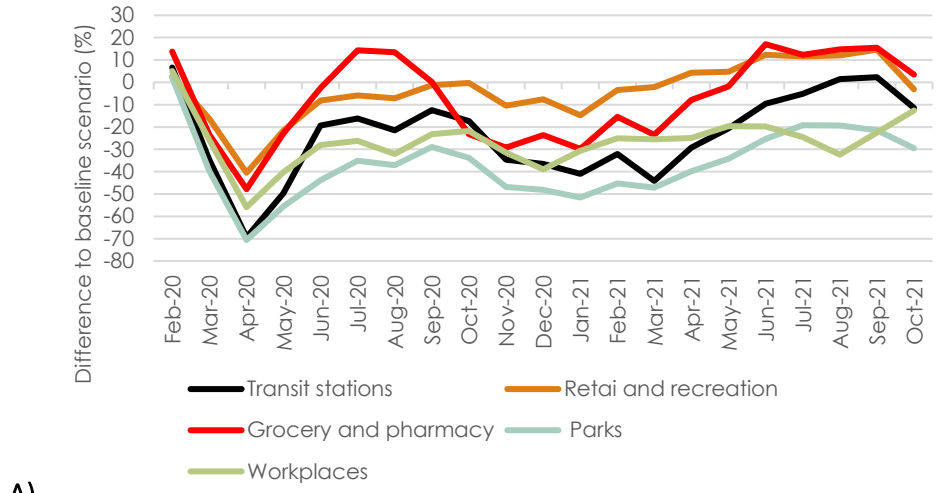
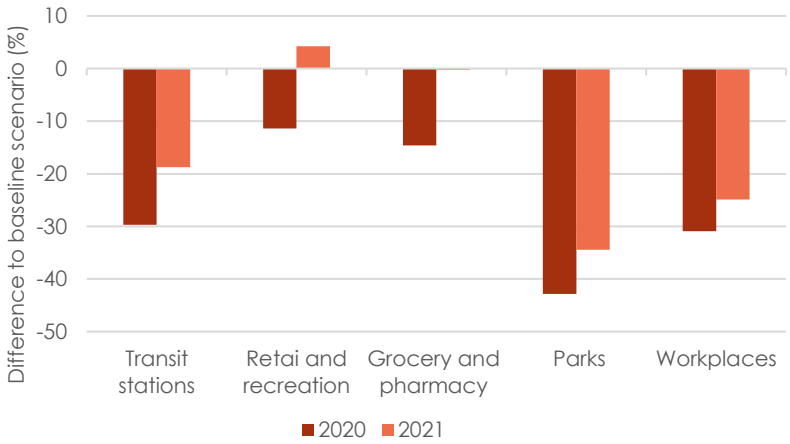


Figure 25 Relation between Public Transport and A) Retail and Recreation; B) grocery and pharmacy; C) Parks; D) Workplaces

In Figure 25, except for Grocery and pharmacy, the relationship of Public Transport with people mobility trends is quite evident, which clearly explains the similar variation over the years of the other sectors with public transport.



A)



B)

Figure 26 a) Average monthly change in human mobility trends between February 2020 and October 2021 for various categories in Timisoara; b) Average annual change in human mobility trends between 2020 and 2021 in Timisoara

The sector analysed whose demand variation was most negatively affected throughout the lockdown periods was the Parks and workplaces, although Public Transport was also affected significantly. However, since March 2021 there has been a significant recovery although demand is not higher than in the pre-pandemic context in Public Transport, Workplaces, and Parks. In general, the grocery sector and retail were the least affected, with an increase in demand over the various months of the pandemic. The months with the highest restrictions were between February 2020 and April 2020. The sector analysed whose variation in demand was most negatively affected was Parks above 30% compared to the baseline scenario, both in the years of 2020 and 2021.

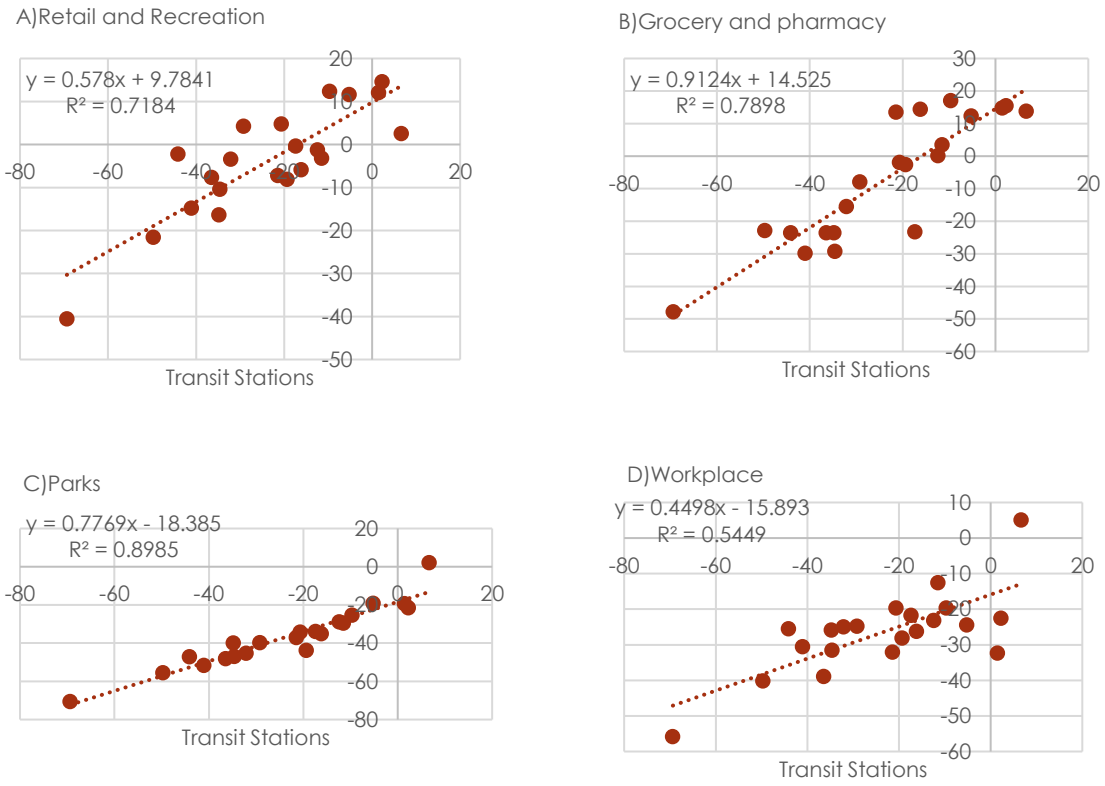
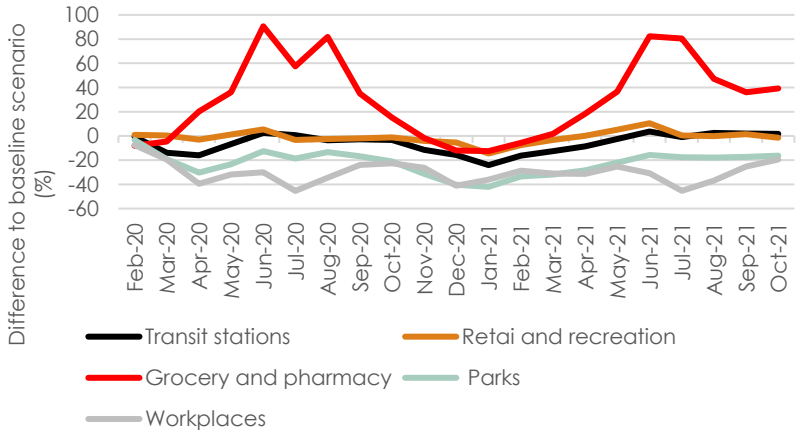
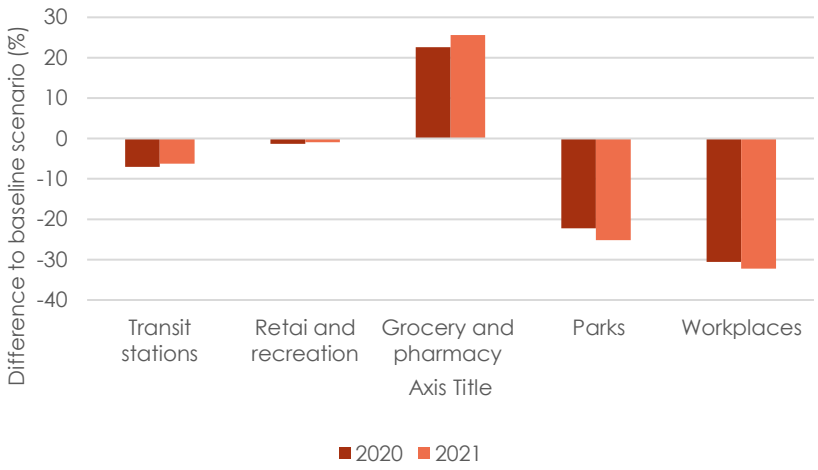


Figure 27 Relation between Public Transport and A) Retail and Recreation; B) grocery and pharmacy; C) Parks; D) Workplaces

In Figure 27, it is easily noticed the relationship of Public Transport with people mobility trends, which clearly explains the similar variation along the years of the other sectors with public transport.



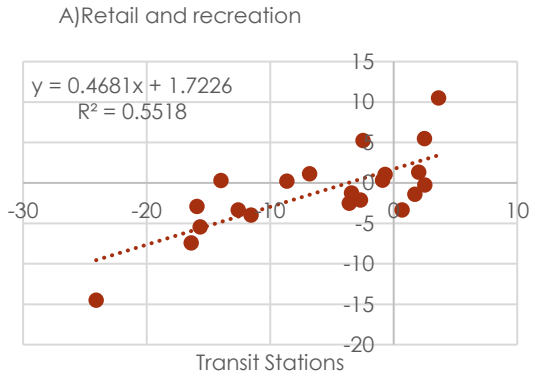
A)

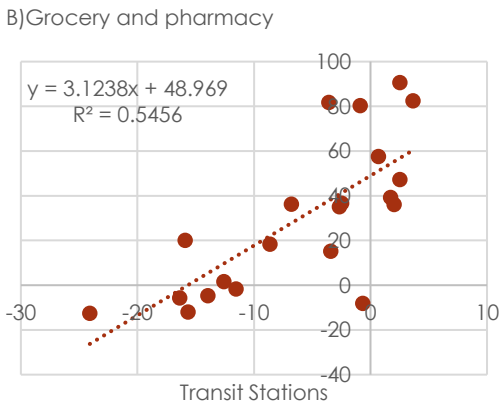


B)

Figure 28 a) Average monthly change in human mobility trends between February 2020 and October 2021 for various categories in Stockholm; b) Average annual change in human mobility trends between 2020 and 2021 in Stockholm

The sector analysed whose demand variation was most negatively affected throughout the lockdown periods was the Parks and workplaces. However, in the Stockholm region, there has been a significant recovery since March 2021, although demand is not higher than in the pre-pandemic context in every sector with exception of Grocery and pharmacy. In general, the grocery sector and retail were the least affected, with an increase in demand over the various months of the pandemic. The months with the highest restrictions were between February and April 2020. The sector analysed whose variation in demand was most negatively affected was Workplaces around 30% compared to the baseline scenario, both in the years 2020 and 2021.





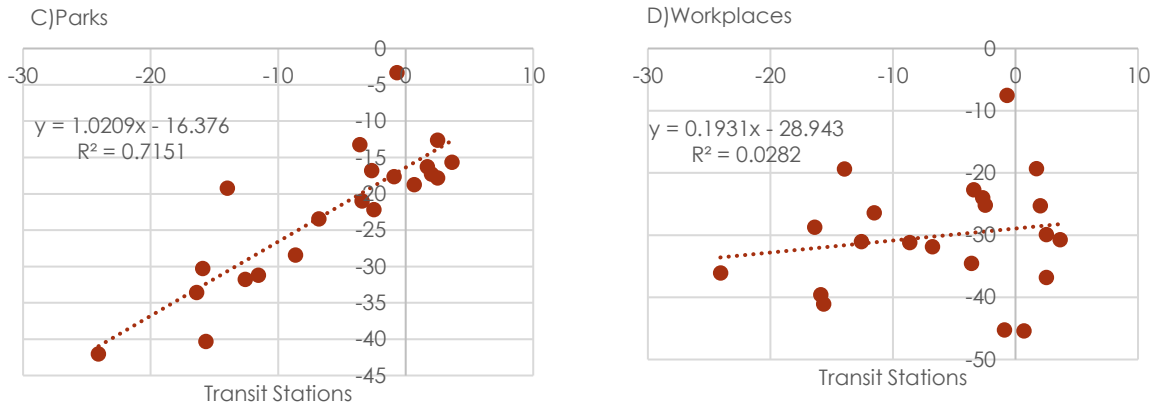
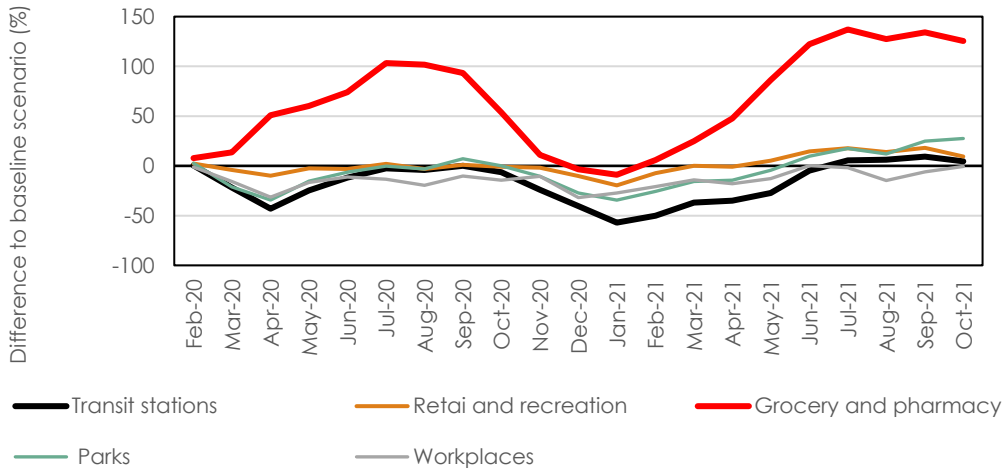
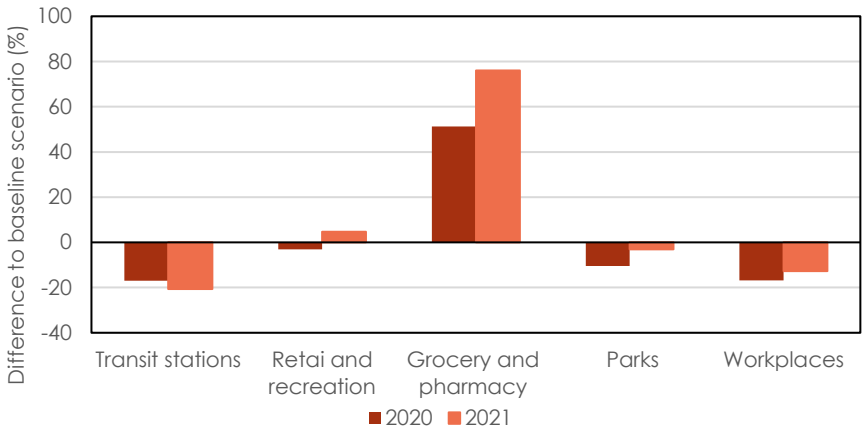


Figure 29 Relation between Public Transport and A) Retail and Recreation; B) grocery and pharmacy; C) Parks; D) Workplaces

In Figure 29, it is clear the relationship of Public Transport with people mobility trends, with exception of workplaces. The lack of relation between public Transport and workplaces may be due to the incentives/politics given by the government so people could work from home because there was not a big decrease in public transport usage in Stockholm.



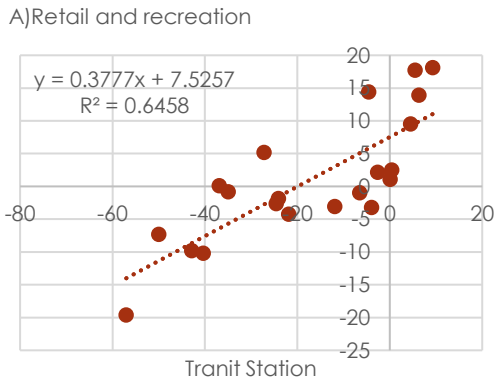
A)

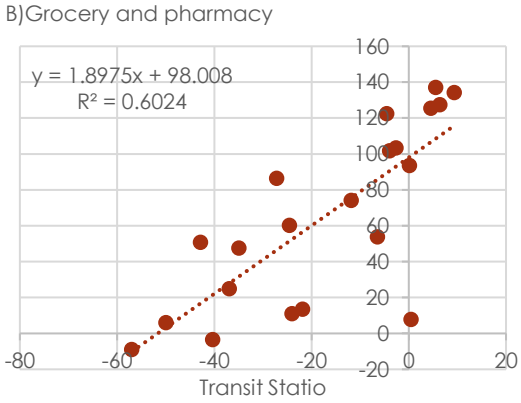


B)

Figure 30 a) Average monthly change in human mobility trends between February 2020 and October 2021 for various categories in Thuringia; b) Average annual change in human mobility trends between 2020 and 2021 in Thuringia

The sector analysed whose demand variation was most negatively affected throughout the lockdown periods was the transport sector. However, since June 2021 there has been a recovery and demand is now higher than in the pre-pandemic context, although workplaces still record a negative change. In general, the grocery sector was the least affected, with an increase in demand over the various months of the pandemic. The month with the highest restrictions was January 2021, with a negative variation in all sectors. The sector analysed whose variation in demand was most negatively affected was the transport sector with 10% in 2020 and 2021.





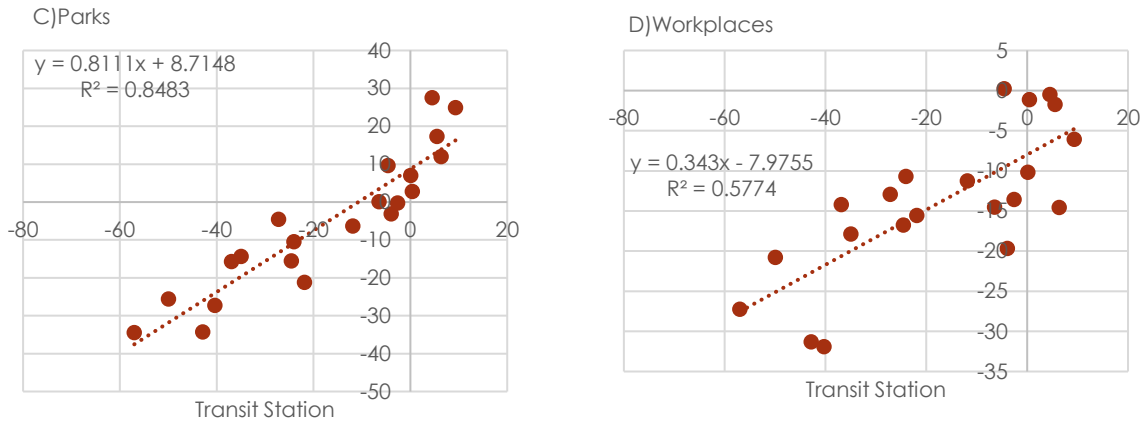
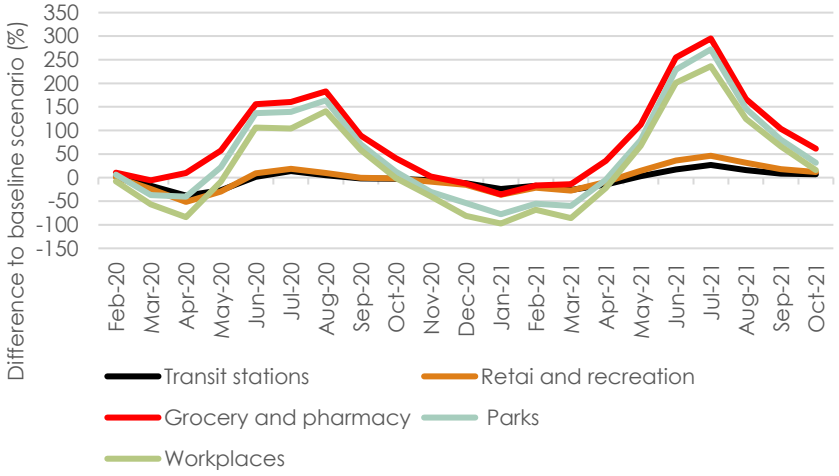
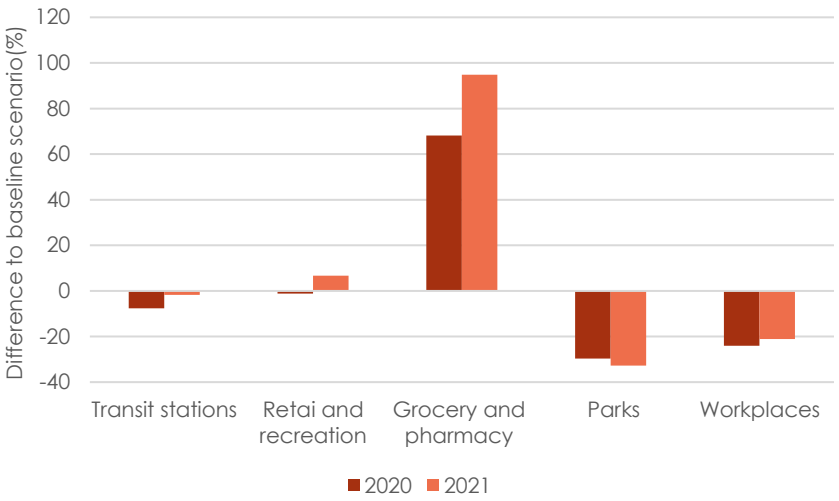


Figure 31 Relation between Public Transport and A) Retail and Recreation; B) grocery and pharmacy; C) Parks; D) Workplaces

In Figure 31, it is easily noticed the relationship of Public Transport with people mobility trends, which clearly explains the similar variation over the years of the other sectors with public transport.



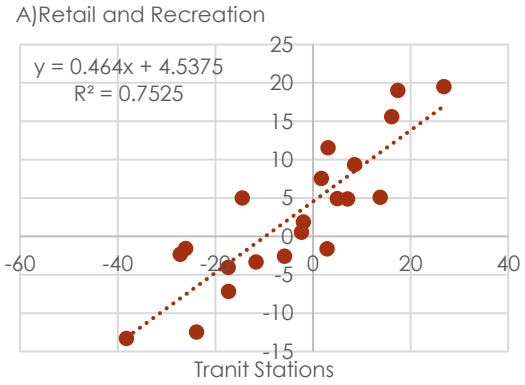
A)

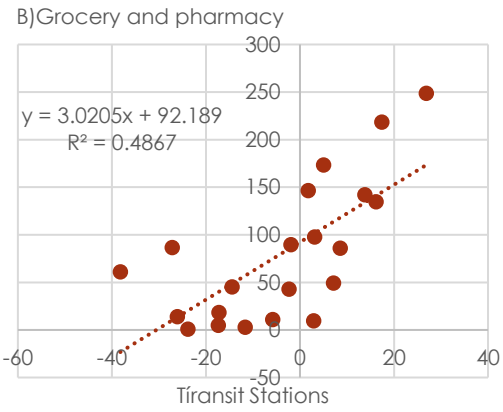


B)

Figure 32 a) Average monthly change in human mobility trends between February 2020 and October 2021 for various categories in Tampere; b) Average annual change in human mobility trends between 2020 and 2021 in Tampere

The sector analysed whose demand variation was most negatively affected throughout the lockdown periods was the workplace and Parks, although in a general way, in terms of comparison with previous PriMaaS partners, these sectors were not significantly affected. In general, the grocery sector was the least affected, with an increase in demand over the various months of the pandemic. The month with the highest restrictions was between December 2020 and April 2021. The sectors analysed with demand most negatively affected were above de 20% in both years.





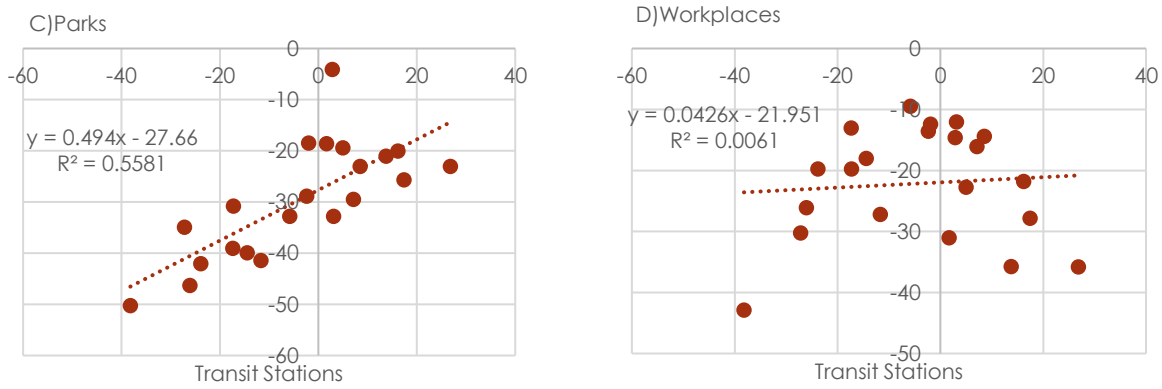
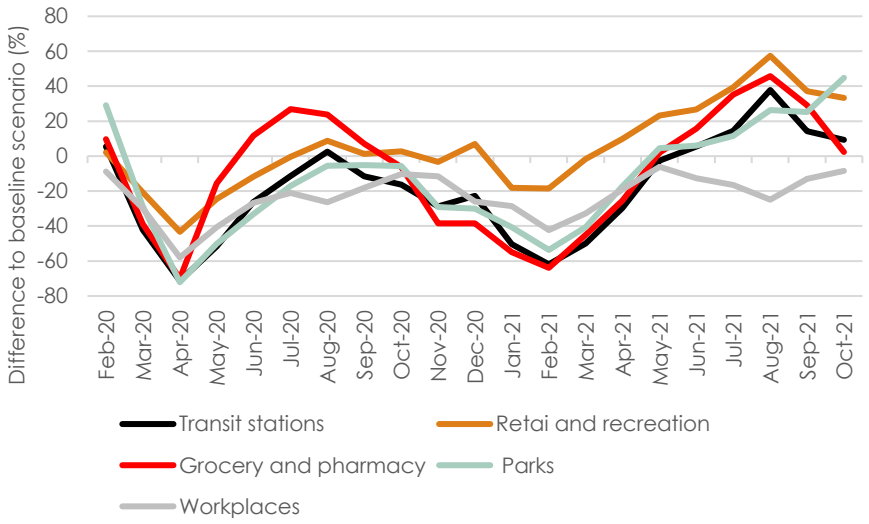
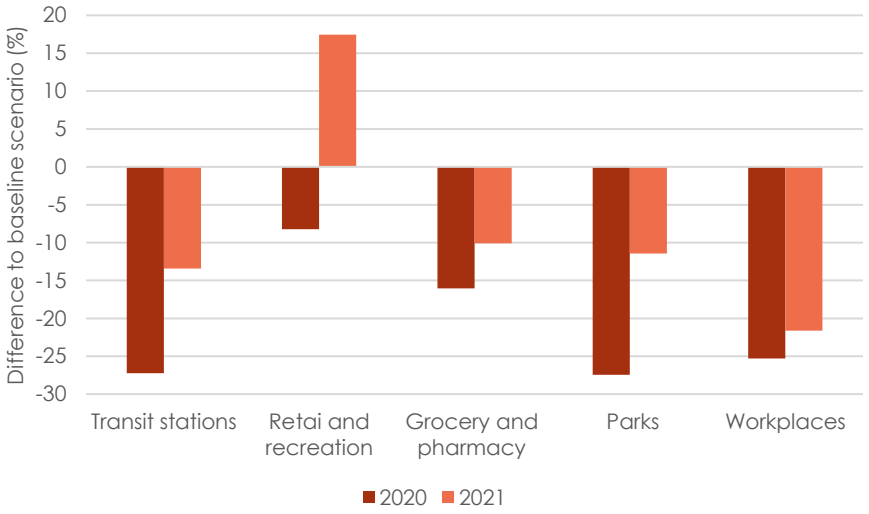


Figure 33 Relation between Public Transport and A) Retail and Recreation; B) grocery and pharmacy; C) Parks; D) Workplaces

In Figure 33, contrary to other PriMaaS regions, there is not a general and significant relation between Public Transport with people mobility trends. Maybe this can be also due to the implementations government did during this pandemic time (not allowing payments of PT in cash or making people work from home).



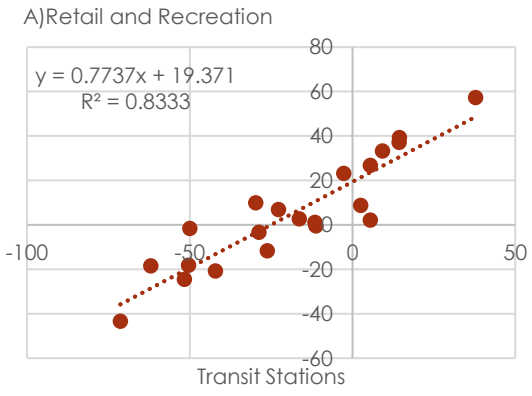
A)

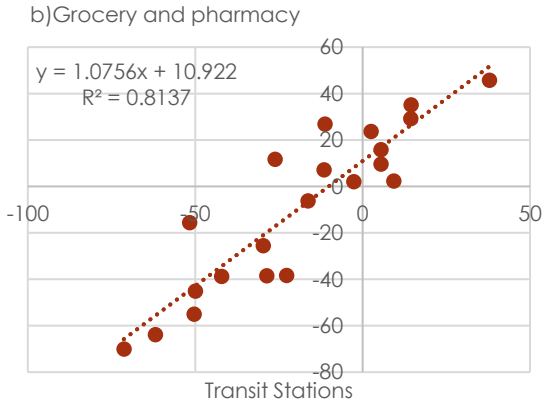


B)

Figure 34 a) Average monthly change in human mobility trends between February 2020 and October 2021 for various categories in Coimbra; b) Average annual change in human mobility trends between 2020 and 2021 in Coimbra

The sector analysed whose demand variation was most negatively affected throughout the lockdown periods was the workplace, Parks, and Public Transport. However, since June 2021 there has been a recovery and demand is now higher than in the pre-pandemic context, although workplaces still record a negative change. Only Retail and Recreation was not deeply affected in the year 2021, being less affected in 2020. The highest restrictions are found between January and April of 2020 and between December 2020 and April 2021. The sectors analysed with demand most negatively affected were above de 25% in 2020 and above 10% for 2021 for all sectors with exception of Retail and Recreation.





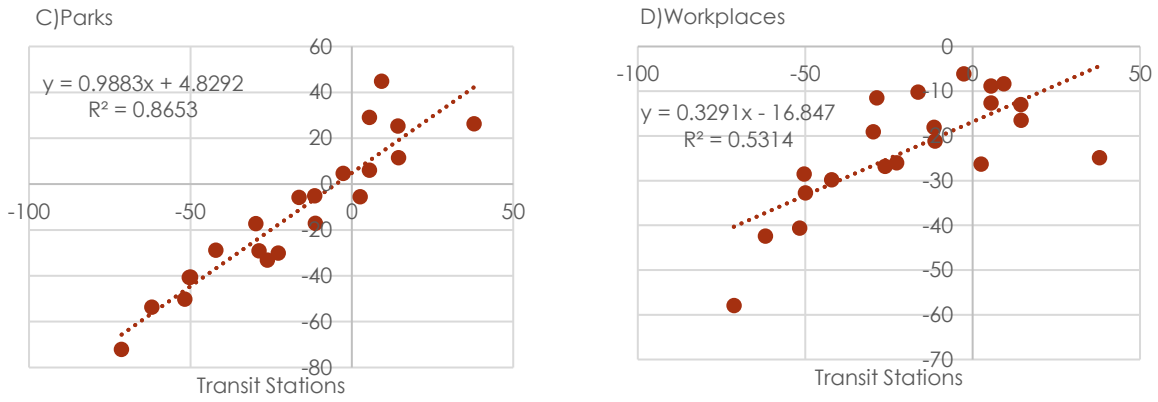


Figure 35 Relation between Public Transport and A) Retail and Recreation; B) grocery and pharmacy; C) Parks; D) Workplaces

In Figure 35, it is evident, once again, the relationship of Public Transport with people mobility trends, which clearly explains the similar variation along the years of the other sectors with public transport.

Stakeholder View on MaaS

MaaS main topics or long-term impacts

As part of the European interregional cooperation, this section is devoted to summarise the results of a survey conducted on the group of stakeholders of the PriMaaS Project. The main objective is to understand key stakeholders' perspectives on how to promote mobility services and ensure that integration and digitisation of mobility services improve the sustainability of the transport sector.

The conducted survey was inspired by the framework developed by (Karlsson et al. 2020) and based on comments of MaaS players from Sweden and Finland addressing the dependencies between levels and actors of the MaaS ecosystem following the PriMaaS Exchange of Experience events. First, we surveyed regional players regarding their opinion on national legislation and vision concerning transport. Then, at an intermediate level, we asked regional actors about the clarity (or not) of appropriate business models, collaborative environment, assumed roles and responsibilities within the MaaS ecosystem, and the contribution of MaaS to sustainability goals. We end up carrying out a survey consisting of 20 Likert scale questions to assess stakeholders' opinions and perceptions on four specific dimensions:

- Group 1) Broader societal and political factors;
- Group 2) Operational performance and business uncertainty factors;
- Group 3) Sustainability goals; and
- Group 4) Leadership.

This online survey focused on questions so that respondents within the regional stakeholders' groups were able to express their level of (dis)agreement on a 5-Likert-type symmetric agree-disagree scale. The proposed questions formulated in the survey are listed in the next table.

Table 29 List of Likert questions in the survey

Topic	Question	
G1	Q1	National legislation hinders innovation and renewal in the transport sector.
	Q2	National law is unclear about the role of public transport within a MaaS ecosystem that includes both subsidised and commercial services.
	Q3	MaaS implementation is difficult because of State aid and public procurement rules (e.g., PT authority cannot cooperate with specific private firms without procurement, and public actors cannot restrict or distort market competition).
	Q 4	There is a clear lack of national vision for MaaS implementation.
G2	Q5	It is not clear who is allowed to sell tickets, who can give certain discounts and under which conditions.
	Q6	Overall, the private entrepreneurial mindset has a negative attitude towards innovation and change and willingness to participate in pilots or collaborative innovation.
	Q7	Public transport authorities and their goals are largely designed for their traditional task, i.e., to manage the regional public transport system and not to innovate outside the traditional border of public transport.
	Q8	It is not clear if MaaS provides a business opportunity with acceptable margins of profitability.
	Q9	There is a high level of uncertainty about travellers' actual willingness and intention to adopt MaaS.
	Q10	Losing own brand image and relation to the customers is a big risk that affects the willingness of operators to integrate MaaS platforms.
	Q11	Entering a MaaS business model will lead to loose market control for certain participants.
	Q12	For collaborative work, the roles and responsibilities of different actors must be established by public authorities.
G3	Q13	Integrated mobility services could play a part in achieving a sustainable regional transport system.
	Q14	There is a high level of incompatibility between public and private goals, such as between public transport's goals of sustainable transport and the commercial goals of a MaaS business.
	Q15	It is not given that a commercial actor would consider a sustainable society as the goal for the business.
	Q16	Public authorities must lead the process to ensure that MaaS moves towards sustainability.

G4	Q17	Public sector leadership is crucial for the development and implementation of MaaS.
	Q18	MaaS should be a public task and be run in a non-commercial way.
	Q19	There is a clear public sector's lack of competence in the field, so it is not realistic that a public actor could be able to be the driving force of MaaS.
	Q20	Overall, there is an underlying degree of suspicion or even fear of being dominated by other actors and losing control over the development.

To better understand stakeholders perspectives, three open questions were formulated to address the following issues:

1) What are the main barriers regarding a collaborative MaaS App?

2) What are the main risks regarding a MaaS App? and

3) What are the main opportunities that may result from MaaS?

The obtained results represent stakeholders' perceptions within these regions. The survey's target group consisted of people who deal with the topics MaaS or Mobility in general in their everyday work. To analyse the data, a first step was conducted to code each measurement item of the five-point bipolar Likert scale ranging from 'strongly disagree' (1) to 'strongly agree' (5), where 3 stands for neutral. Additionally, missing values were treated by performing a widely used procedure of imputation with an estimated value based on the average of each respondent's response to the remaining items on that scale. The sample size is reported in the next table.

Table 30 Sample size and response rate per country

Country	Participants [#]	Participants [%]	Requests	Private Sector Participants [%]
Finland (Tampere)	17	8%	100	65%
Germany (Thuringia)	30	14%	47	63%
Italy (Rome, Liguria)	40	19%	174	73%
Portugal (Coimbra Region)	52	25%	180	12%
Romania (Timisoara and Bucharest)	14	7%	55	50%
Scotland (Sotheast Scoltland)	37	18%	120	57%
Sweden (Stockholm)	21	10%	133	62%
Total	211	100%	809	50%

The sample included 18% of respondents from the Academia and Research sector, 13% from Consultancy and other private interest organisations, 36% from Public Administration and Public operator, 10% from Private Transport Operators and 22% from ICT Software developers and MaaS Providers. Considering academia as a public sector, 55% of the respondents are from the private sector and 45% from public institutions.

National vision and legislation framework

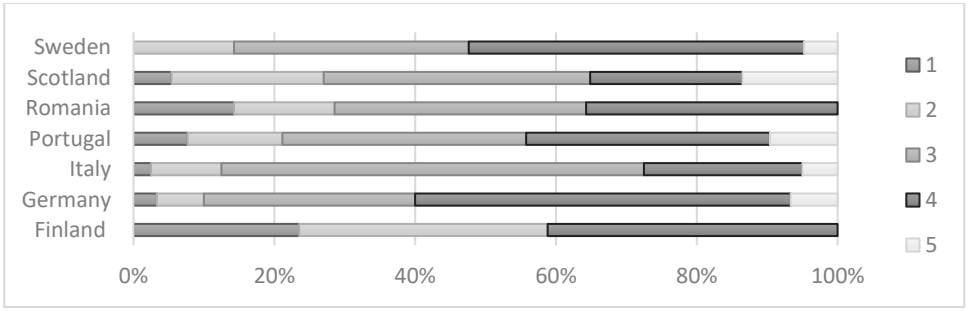
The first group of questions seeks to gather the stakeholders' perspectives to understand how legislation on transport and a collective vision's existence (or not) affect MaaS implementation. The distribution of responses by country is shown in the next figure.

The analysis of the responses shows that concerning the Q1, results suggest an overall dissatisfaction with respect to the national legislative framework, more evident in Germany and Sweden, where MaaS presents particularly high integration levels, while the Finnish stakeholders seem to be satisfied. In general, more than half of the respondents agree that national legislation

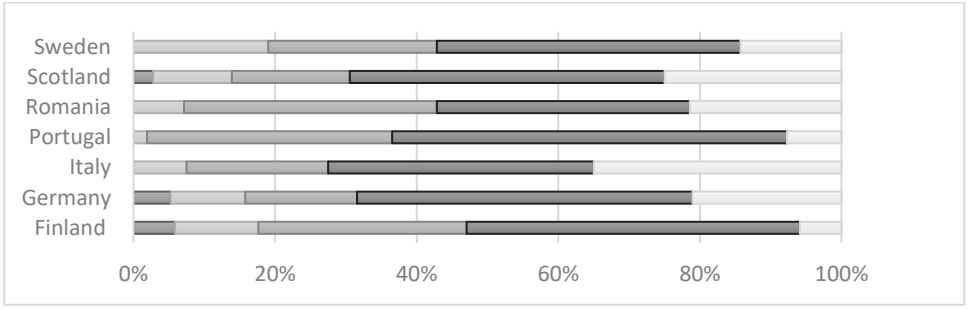
hinders innovation and renewal in the transport sector. Being public transport an essential part of any MaaS ecosystem, all surveyed stakeholders considered legislation is not clear enough regarding the role of public transport (Q2) and also regarding state aid and public procurement (Q3). As argued by (Karlsson et al. 2020), public transport authorities cannot cooperate with specific private firms without procurement, as public actors are not allowed to restrict market competition. Except for Finnish respondents, stakeholders tend to agree that this is a barrier to MaaS development, more notorious in Germany and Romania, considering the high level of agreement with the Q3 statement in these countries. A common problem discussed by MaaS discussion forums is to clarify which role public transport would be allowed to take when both subsidised and commercial services are included. A national vision for MaaS may allow public and private actors to cooperate under comprehensive policy frameworks. Regarding Q4, the Nordic PriMaaS Project partners, Sweden and Finland, are those that present a more positive perspective about a shared vision. The remaining respondents strongly agree that the inexistence of a national vision hinders MaaS implementation. In particular, Italian and German respondents are unenthusiastic regarding the national vision of their respective countries.

The obtained results of each country must be analysed with caution, considering the level of knowledge of the current regulatory laws that vary from region to region depending on the level of development of MaaS. Certainly, part of the more optimistic vision of Finnish stakeholders with national legislation is related to the Act on Transport Services that brought together transport market legislation and created the preconditions for digitalisation of transport and new business models (MaaS global). This can be a basis to transfer this knowledge to other regions and develop a similar, adjusted framework for country-related legislation development.

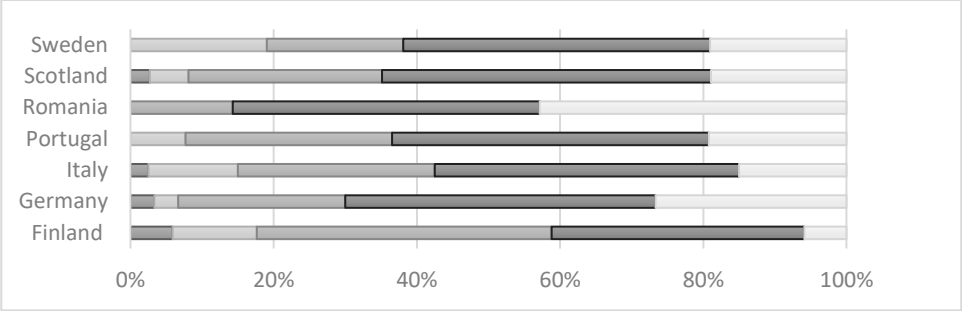
Q1



Q2



Q3



Q4

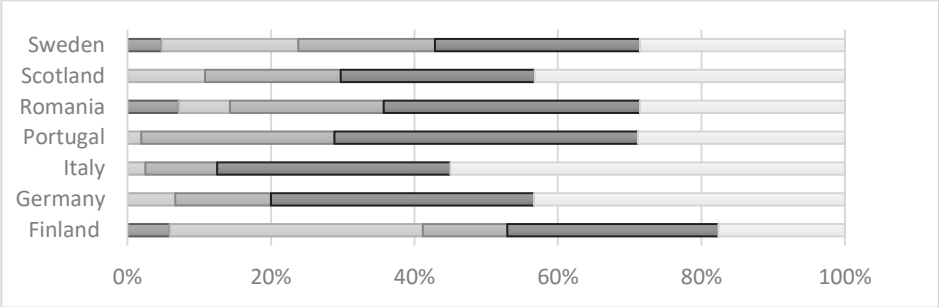


Figure 36 Results on the first set of questions.

Business Uncertainty

Considering that both the uncertainty of roles and the inherent risk of the MaaS business model can be seen as strong barriers to the diffusion of MaaS. The second group of questions is aimed at understanding the current perceptions regarding roles (e.g., Q5, Q7), the potential of the business model (Q8), and which factors can be related to the cooperation and collaboration of private and public sectors (Q6, Q7, Q12) and risk of losing control over development (Q10, Q11).

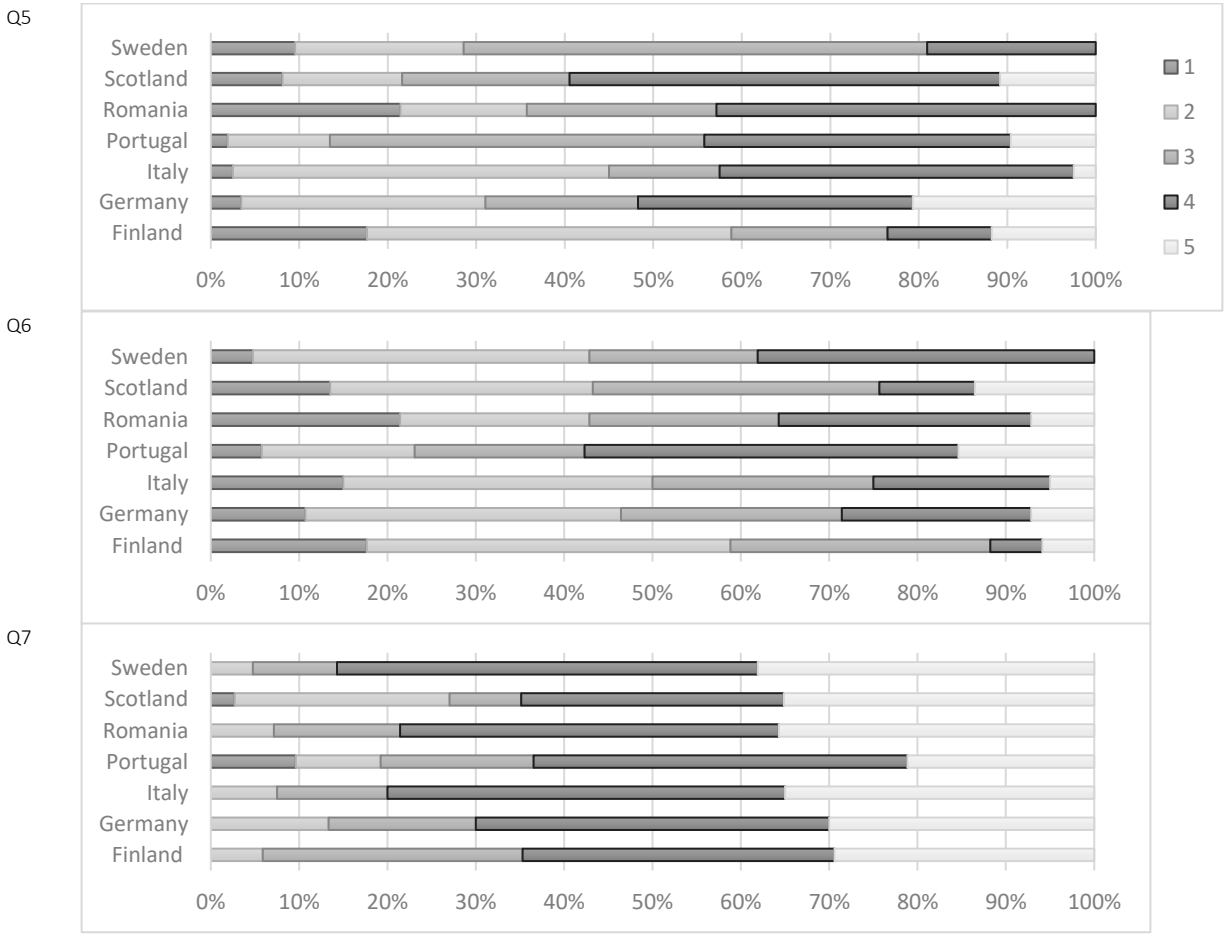
One example of potential uncertainty among stakeholders is to which extent third-party actors may be allowed to sell public transport tickets under which condition. Once again, the Finnish stakeholders have the least agreement regarding the existence of this uncertainty. On the other hand, respondents from Portugal, Romania, and Germany reveal greater uncertainty regarding the commercialisation of transport tickets. Despite obtaining an average neutral score in Italy, there is a symmetrical division between the stakeholders, with approximately half of them agreeing. In Sweden, many respondents opt for a neutral opinion.

In Q6, stakeholders were surveyed about the attitude of the private entrepreneurial mindset towards collaborative innovation. Most respondents of all countries disagreed that the attitude of the private entrepreneurial hinders collaborative innovation. This was the most consensual answer from the standpoint of disagreement. On the contrary, there is an overall perception that public transport authorities and their goals are mostly conceived for their traditional task (Q7). Swedish and Romanian respondents highlight that public transport companies may face difficulties innovating beyond their conventional roles. Once again, the perception of the public sector's capacity for innovation varies from country to country, regardless of the level of MaaS integration achieved so far.

Overall, stakeholders tend to agree on a high level of uncertainty about the economic viability of the business model (Q8), and the interest and motivation of passengers to adhere to these models (Q9) remain. Interestingly, the Finnish stakeholders have shown the greatest agreement regarding the business model's viability uncertainty. Respondents from Romania are the least pessimistic about the business model's financial uncertainty and potential attractiveness. This evidence may seem disappointing in the sense that contact with a more advanced penetration in Finland lowers expectations about the viability of the business models associated with MaaS.

Stakeholders from all regions moderately agree that fear of losing their brand image may constrain operators' willingness to join MaaS platforms. Scotland's stakeholders are the ones who most value this risk as a potential obstacle to MaaS implementation, while Romanians attach less importance to this issue. Another risk relatively valued by all respondents is the issue of loss of market control (Q11).

Observing the values of the central tendency of each country, it appears that the most valued barrier was the inability of the public transport sector to adapt to new business models, followed by the uncertainty regarding the possibility of obtaining viable profit margins. The risk perception index associated with the business model component is relatively similar among the analysed regions, with the lowest value in Romania and the highest in Portugal.



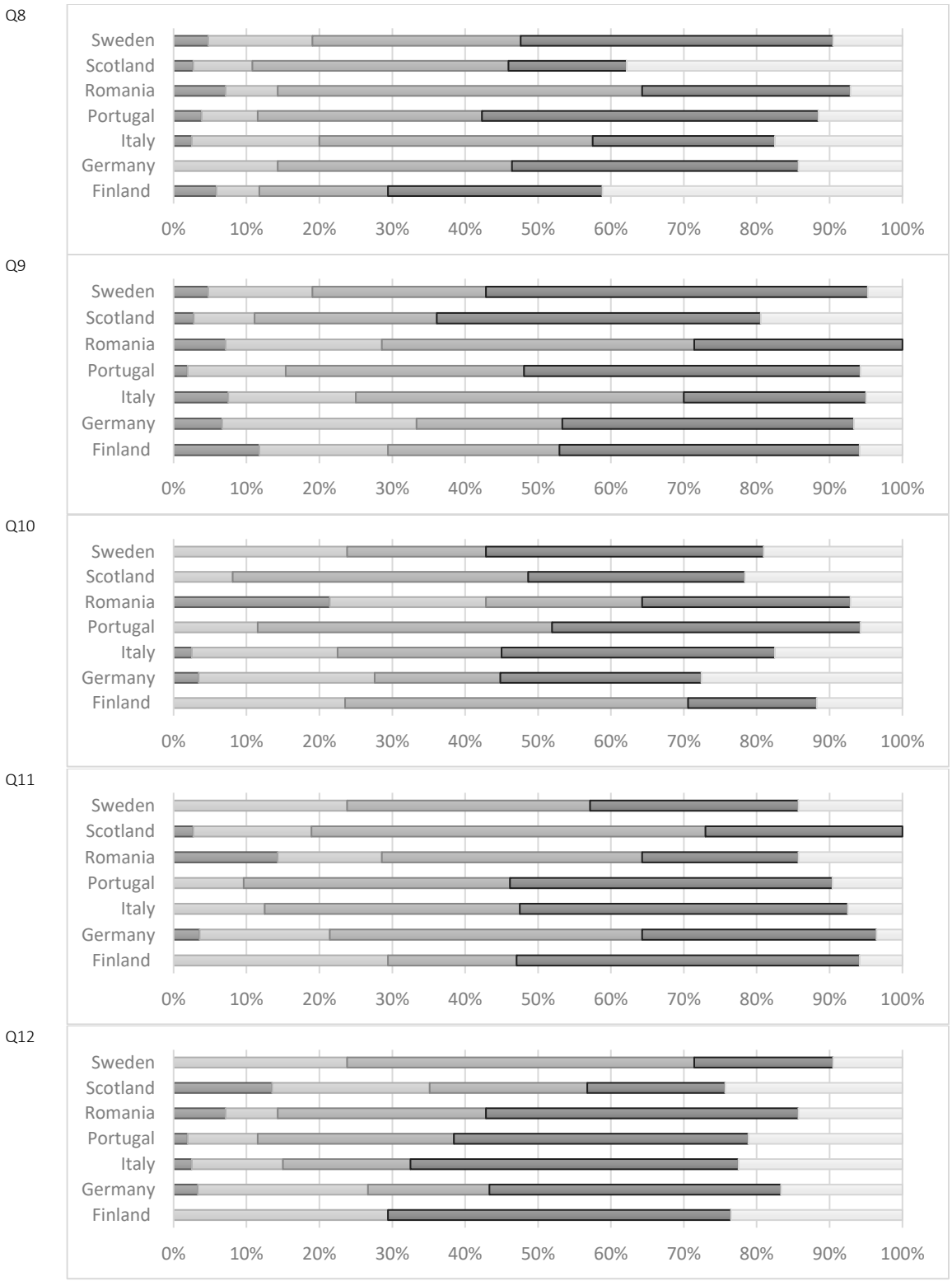


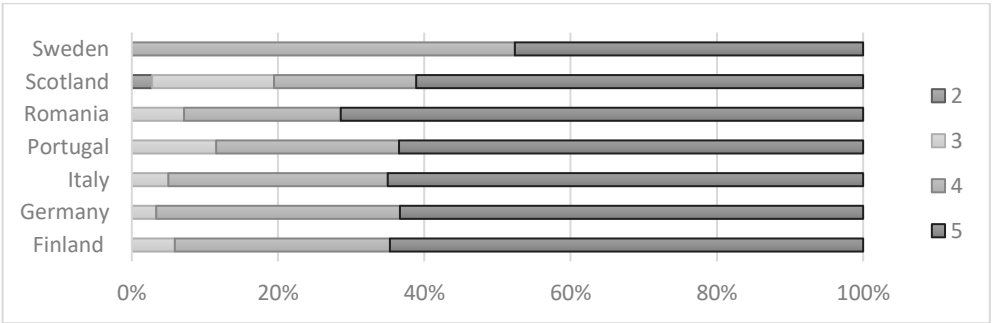
Figure 37 Results on the second set of questions.

MaaS Design and Sustainability

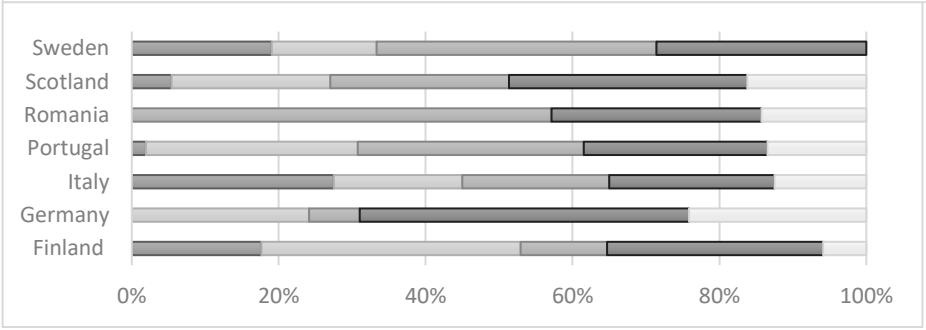
The most consensual issue among the participants was that integrated mobility services could play a key role in achieving a sustainable regional transport system. However, there appear to be significant differences regarding the public sector's role in promoting sustainable MaaS. While most respondents in Italy (53%) and Germany (86%) consider there is a high level of incompatibility between public and private goals, less than half of respondents agree with this statement in Portugal and Sweden.

In line with this trend, there are also different views regarding leadership in the public sector. Following the previous question, most German participants tend to consider that it is up to the public sector to manage mobility services in a non-commercial way. It can be observed a correlation between the perception of the uncertainty of a commercial actor considering a sustainable society as the goal for the business (Q15) and the opinion that Public authorities must lead the process to ensure that MaaS moves towards sustainability (Q16) (R^2 = 45%). Analysing the central tendency of the responses, there is an opposite trend among respondents from Finland who have a more positive view of the potential of the private sector to contribute to social goals and attribute less importance to public sector leadership and a more conventional view of Germans and Portuguese respondents giving greater importance to the leadership of the public sector to ensure sustainability goals.

Q13



Q14



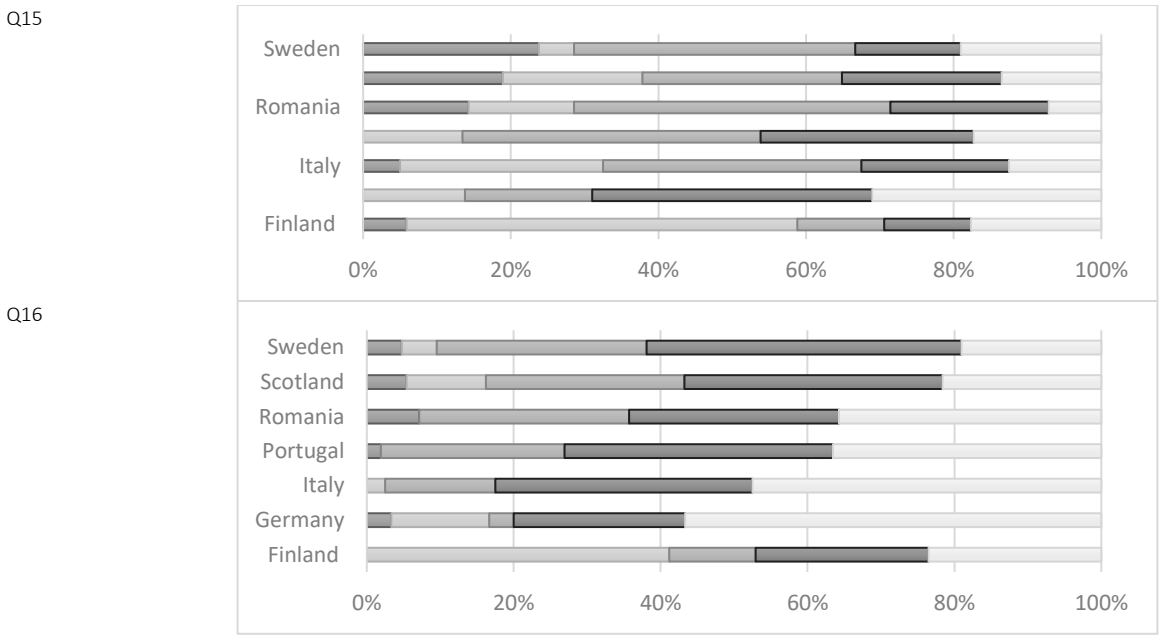


Figure 38 Results on the third set of questions.

Who Should lead MaaS structures?

The last group of questions was devoted to assessing from an institutional point of view who should lead the MaaS structures as a whole. In all countries, stakeholders tend to consider that public sector leadership is crucial for the development and implementation of MaaS. However, opinions vary widely as to whether this task should be eminently public and managed on a non-commercial basis. German, Portuguese and Romanian respondents tend to value the management of MaaS platforms as a task of the state, while Northern European and Nordic stakeholders tend to disagree more with this statement. Interestingly it appears that the relevance of the role of the state sector is independent of the perception of the technical competencies of the public sector in the field. The Finnish respondents are the ones who least point to the lack of competence in the public sector as a barrier to the development of MaaS, but at the same time, they are the ones who least value the importance of the public sector as a fundamental lever for the deployment and success of Mobility as a service. Interestingly, in all countries, respondents tend to consider that overall, there is an underlying degree of suspicion or even fear of being dominated by other actors and of losing control over development. Regardless of the heterogeneity of views on the leadership and role of the public sector, these results highlight the need to foster a transparent policy of trust between the various parties to promote the integration of services based on a solid structure.

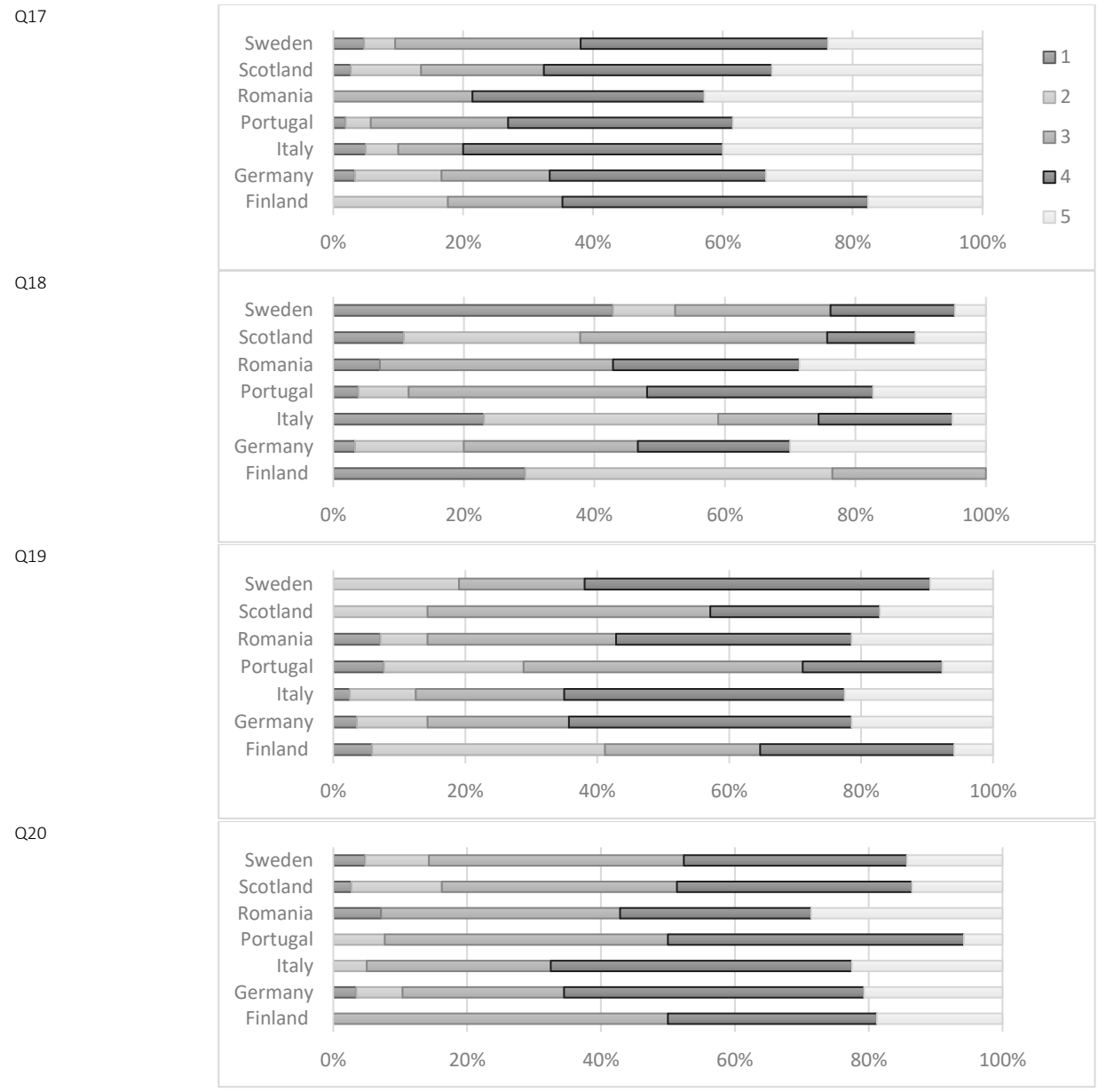


Figure 39 Results on the fourth set of questions.

Stakeholders' perspectives: open-ended questions

The survey also contained a section with open-ended questions. In that part, the respondents had the opportunity to share their point of view regarding three main issues:

1. What are the main barriers regarding a collaborative MaaS-App?
2. What are the main risks regarding a MaaS-App?
3. What are the main opportunities that may result from MaaS?

After collecting all the answers, we end up with relevant insights that deserve special attention from different levels.

Main Barriers

Regarding the first question a qualitative assessment of the 176 comments allowed us to group the opinions into four main groups: i) barriers associated with contracts, administrative and regulatory framework; ii) barriers associated with business models; iii) barriers related to technology, data sharing and other operational issues; and iv) Stakeholders inability and lack of interest.

Among these four groups, the multiple players' lack of interest in cooperation was the most frequent barrier mentioned. Often the lack of alignment between the objectives of the public and private sector was pointed out, e.g., "the public administration does not take responsibility for the development of the application and the private party has no interest or resources to maintain the application" (Finland); "There is lack of commitment from the public sector and lack of interest from the private sector (Portugal)"; or "there is a massive barrier between the public/private/third sector transport provision as we all have different goals, and no one is willing currently willing to risk their bottom line or identity in pushing forward with an innovative and collaborative approach" (Scotland).

Frequently the loss of contact with users is a decisive factor "entities do not want to open data freely; companies and even Public Transit companies do not want to lose the direct contact to the user - for this reason, they always prefer to have their app and even are not keen to allow the resell of their tickets". While some respondents recognise the difficulty related to different public policy objectives and private interests, a significant part of the respondents put the onus of responsibility on the lack of leadership or competencies existing in the public sector, e.g. "Public entities and public service operators are not yet fully aligned in the implementation of a MaaS system. Other priorities remain", "State culture rewards low risk (Portugal), "there is lack of understanding for technical challenges, processes and risks on public sector side (Germany)" or there is "lack of professionals in public administrations in designing a good system" (Scotland). On the other hand, the lack of willingness of the private sector to cooperate and give up its niche is seen as a major barrier by another part of the respondents "Walled gardens, lack willingness of individual private operators to cooperate (Scotland)"; "business interest first than public goals (Italy); "Lack of long-term commitment, especially by private actors (Germany)."

Among the various regions analysed, the lack of cooperation between stakeholders is particularly relevant in Romania and Portugal with more than 45% of comments, possibly reflecting the initial stage of development of the MaaS concept in the regions studied. Interestingly, in the most advanced countries in terms of MaaS integration, the main barriers are no longer at the level of inter-institutional cooperation, but rather at the level of business model related barriers. The awareness of the barriers related to the uncertainty of the business model implies that some steps have been overcome or taken into consideration, such as the existence of some level of understanding between stakeholders, clear legislation and technological standards. Some Finnish respondents stress "there is no business model for commercial MaaS operators and no clear benefit for public transport operators to include commercial operators in their offering". Bottlenecks remain when it comes to the public-private negotiating interface. "MaaS provider

cannot sustainably provide the same ticket price as the PTA as currently the transfer price equals the end-user price" and economic and geographical dimension "MaaS solutions have had a too narrow scope; long-haul transport should be involved, too" and "It's difficult to reach a critical mass of passengers or freight, geographically distributed urban areas and infra"(Finland). In the UK Scotland, other fears are directly related to user acceptability "I think that convincing people would be the most difficult part of a MaaS-App. Download it, create an account…. People will do it if they have no alternatives"." Why do people have to change their own habits?" and the viability of the business model at a vertical level "there is lack of win-win-win business models or "clear business models where all stakeholders can have positive economic impacts".

Contracts, regulatory and administrative frameworks are also frequently mentioned barriers towards the development of collaborative MaaS platform. One of the most mentioned obstacles is related to administrative-geographical boundaries fragmentation. This fragmentation may have impacts at the level of organisation and "transparency of the service offer coverage" (Germany) but also at the level of technological compatibility as highlighted by a Scottish stakeholder "Imagining a journey across three councils and different transport authorities - If the technology is procured and delivered in differing means in each authority then the offer to the public will be incoherent or incomplete for parts of that journey" (…) That complexity rises further when then dealing with the numerous operators systems". Other stakeholders identified barriers related to SME participation in public procurement due to their scale "tender processes are long and costly which make it very difficult for smaller companies to participate. (Germany)". Further barriers identified by stakeholders are the inefficiencies of the legislative framework at a higher institutional level for the regional mobility market context "there is little legislative flexibility to find innovative solutions and more adjusted to the market as a whole and not only for large urban centres (Germany) ". "There is a lack of coordination at legislative and economic level".

Despite being a hot topic of debate in the last decade, the availability of online, free of cost, accessible data that can be used, reused and distributed is still a frequent perceived issue risen by stakeholders. "there is a missing point, which is open transport data. The first step to achieving a true Mobility-as-a-Service, integrated and sustainable, is the transparency of data and the integration of information on timetables, lines and routes, fares, etc (Portugal). In this field, complaints also concern the lack of quality and frequency of data updating, advances in the field of digitalisation, or lack of cooperation between operators for data sharing (Germany, Romania). However, having overcome these upstream problems, there are still concerns about interaction with users "there is also the digital inclusion barrier whereby many of my service users are older and can struggle to access any digital platform let alone one that requires an entire change in mindset".

Main Risks

The most mentioned economic risk in all regions concerns the lack of user acceptance and lack of behavioural change that may affect the financial viability of platforms. Within this theme, several reasons for the existence of this risk are pointed out, from the design of the MaaS offer, its cost, and the demographic and age limitation of consumers. e.g "The service is developed for the interests of the operator not to serve the interests and freedom of choice of the customer, which leads to subpar or unattractive MaaS offerings compared to a private car and then leads to

reduced interest and low levels of uptake of a MaaS application and service" (Finland) "Using MaaS is too expensive: MaaS must be more financially attractive than using private vehicle" "cost! lots of public money being spent for limited behaviour change" (Germany). The main risk will regard the number of people that will use it. MaaS is an innovative concept and for sure will attract young people. A good section of the population may have problems adopting MaaS and for sure via mobile app (Italy).
Other factors that may affect economic viability are investment and maintenance costs in a context of uncertainty "Uncertainty of support and financial sustainability". There is a high risk associated with the long-term financial sustainability of schemes, especially in a post-pandemic world where there is an expectation that traditional public transport usage will be reduced thanks to changing work patterns and a further reduction in the retail industry".

Other stakeholders point to economic risks related to market dynamics. Interestingly, the risk of cannibalisation and monopoly is one of the most frequently mentioned risks. Stakeholders fear new MaaS platforms focus on current customers instead of capturing new customers, therefore MaaS could fail to increase its market share while almost certainly increasing its costs of production. "There are perceived risks regarding a loss of market position, brand, customer relationships and cannibalisation (i.e. loss of customer base"(Sweeden). The risk of market dominance is often highlighted "(e.g) Legislation allows operators to build walled gardens and treat Transport Service providers unequally (Like Amazon case for selling access to consumers on its platform) and this way distorts the competition at the market and limits the customer's choices i.e. platform economy thinking - one application rules the market (Finland).

The second-largest group of risks highlighted by stakeholders in the various regions was related to the operational management of MaaS. Such risks can arise from two major factors: 1) technological incompatibilities and 2) administrative management failures.

Regarding technological risks, the connectivity issues (ticketing, connection, information) and data security, and data protection are the most mentioned. Among the risks associated with the management of the MaaS system is the lack of understanding between stakeholders, the inability, and lack of resources in the public sector to lead the processes. "From the public perspective, there is a risk of overload of existing human resources for its management, extensive legal situations due to lack of clarity current legal framework" (Portugal). Other stakeholders mention the trade-off between ensuring a smooth transition, ease of use for passengers, and the lack of control that can potentially lead to misuse " concerning on-demand traffic: there is a risk of abuse by end customers if barriers to use are kept as low as possible ". In general, respondents are concerned about the risks associated with managing a complex or bureaucratic system and a lack of understanding of the elements in the ecosystem e.g., "difficulty to define clear boundaries of free level, of services from premium level services (Italy)"; More operators – can affect the quality of service (Romania)"; "Over bureaucratic approaches "(Scotland); "Compatibility towards a plethora of solutions (lock-in effects); " Too complicated, too many conflicts of interest (Germany)".

Finally, there is a group of risks that involve negative impacts on society, both at the level of environmental sustainability and the level of social inclusion. In the first, respondents emphasize there may be a trade-off between public service objectives and the profit goals of the private

sector "Developing public transport and sustainable society will become a secondary goal after making money with subsidised transport (Finland). "There is a risk of lack of stakeholder involvement with a vision that is not only commercial (Portugal)". MaaS could lead to a "lack of control for public authorities to drive sustainable transport agendas" (Germany).

Additionally, MaaS place can lead to social exclusion in several aspects. Firstly, it can exclude the info-excluded and promote digital poverty "Some users could not access the technology and will be barred from participation in the transport network" (Scotland), "MaaS could not reach the most vulnerable" (Portugal) Secondly, it can exclude the most isolated population living in low-density areas e.g., "MaaS may only work in cities due to density and services available" (Germany).

Main Opportunities

In the last open question of the questionnaire, stakeholders were asked about the main opportunities that may arise from the introduction of the MaaS. Regardless of the region, survey participants converged on three groups of opportunities creating a virtuous cycle. MaaS can contribute to higher quality and efficient transport system, which could increase the quality of user experience. In turn, this increased satisfaction with alternative transport solutions will reduce the dependence on car use and contribute to achieving sustainability goals, improve the quality of life in cities, while promoting new business opportunities and jobs.

This line of thought common to the rhetoric associated with MaaS is substantiated by concrete examples of opportunists. Interestingly, in areas where MaaS is pointed out as a risk for cohesion and accessibility for citizens (guaranteeing the transport service in areas of low density), it is also pointed out as an alternative to guarantee transport in these areas in a more sustainable way. "MaaS could support building genuine travel chains and filling the gaps in PT offers". Possibility to replace some unsustainable (both environmentally and financially) PT lines with more agile private transport services (given that the pricing is kept fair for the passengers) (Finland). "In remote areas that cannot sustain traditional bus operation, (MaaS) can give the opportunity to connect these communities into a public transport network and remove some inequalities faced by those residents (Scotland). MaaS can contribute to the "Reduction of CO2 emissions as transport demand leads rather than running on empty seats (Scotland)." Another example of risks that can be turned into opportunities is user costs. Several participants in the survey considered MaaS as a potential opportunity since the increased efficiency of the system could lead to a reduction in the cost of mobility services.

In terms of efficiency, participants highlight different factors from innovation and cooperation between the various players in the ecosystem to increased efficiency resulting from better use of data and adaptation to demand: " cross-fertilization among sectors not integrated (Italy),. Maas Could support "long term optimization of transport networks and related savings/efficiencies" supported by "smart payments methods" and adaptation of supply to demand (Germany). "Mass Could contribute to increased cooperative/collaborative work to serve populations"; Increased data integration and dissemination may improve mobility management (Portugal)". Overall "Better Interoperability" and "interconnectivity" and "flexibility" are frequently used comments in all regions to describe the potential increase in the quality of the transport system.

In terms of user experience, MaaS could be an "Enabler for starting to explore new ways of travel" (Sweden) and provide a "higher level of integration and usability of the mobility environment"

(Italy). For instance, MaaS can “Create awareness that the means of transport does not matter to get to your destination” (Germany). Finally, MaaS “could help provide mobility services for people who now do not have access to transport services” (Finland).

The opportunities mentioned above result in a new set of opportunities and positive externalities for society. Stakeholders highlight potential benefits in the fight against climate change, urban planning benefits, increased accessibility for citizens and new incentives for entrepreneurship.

MaaS Readiness Indicator

Mobility as a Service (MaaS) has been considered by many experts as crucial to lead to changing the transport behaviour of the citizens and how the cities can achieve their goals regarding sustainable mobility. But a transition should be made from the current transport system infrastructure. This involves a series of challenges that regions must overcome for a successful establishment of new multimodal transport services in their areas. The MaaS readiness indicator (Aaltonen 2020) was created to support national and regional authorities in evaluating how well prepared the different local authorities for the changes are. This indicator is a valuable tool to support them to make decisions regarding the implementation of new transport services. These readiness level indicators are aimed as a starting point for local authorities and can be considered as a checklist for the local authorities as they make plans toward a more sustainable inclusive transport system.

MaaS indicators proposed in (Aaltonen 2020) consist of eight different components:

1. Strategic readiness
    a. Strategic focus
    b. Parking policies
2. Internal use
    a. Internal travelling
    b. Use of shared mobility
3. Shared use
    a. Shared economy
    b. Public transport
4. Shared understanding
    a. Integration platform
    b. Visibility

Based on these components, the local authorities choose the level that describes their situation best, yielding a clear picture of which areas the readiness level is satisfactory and which deserve more attention and effort, and possibly investment. The tool allows for establishing priorities in case there is still work to be done in order to improve the MaaS implementation in the region.

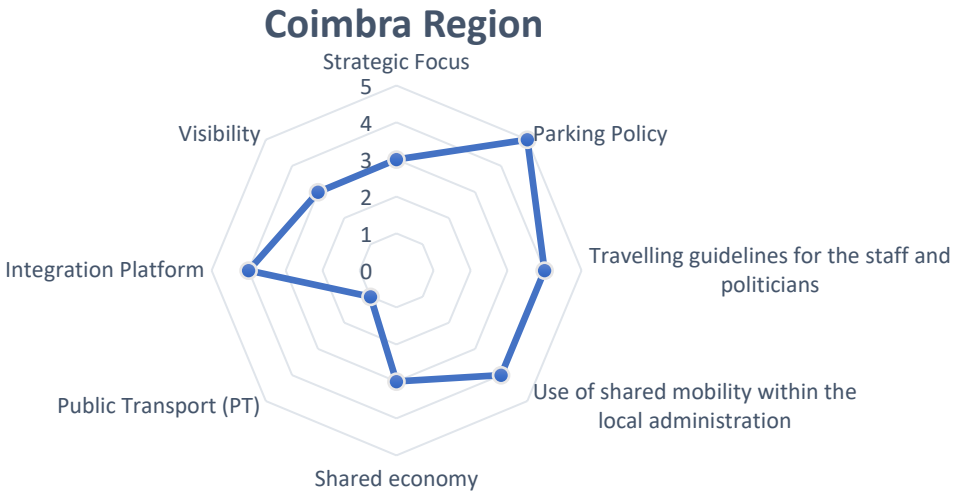
The next table presents a brief description of the factors under the MaaS Readiness Indicator as proposed in (Aaltonen 2020) and can serve as a starting point for analysing the factors on which the regions within the PriMaaS Partnership should focus to assess their MaaS readiness status.

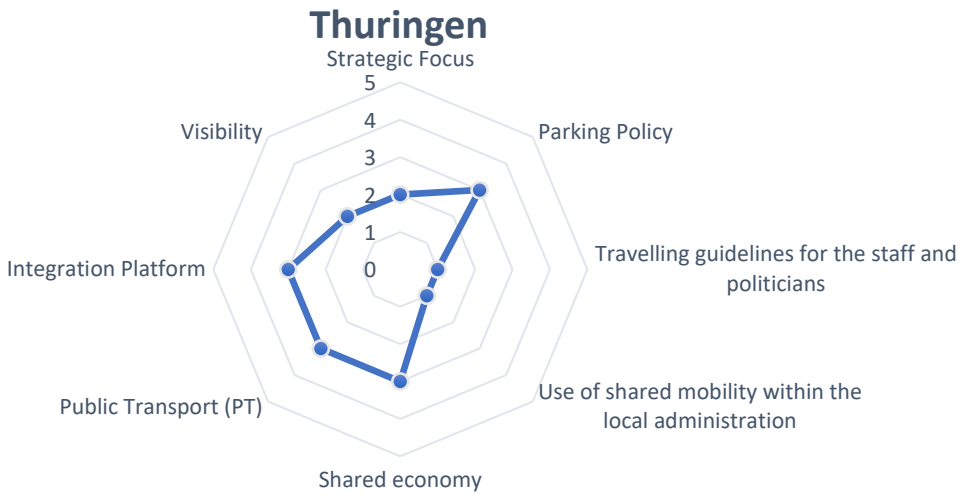
Table 31 MaaS Readiness Indicators (Aaltonen 2020)

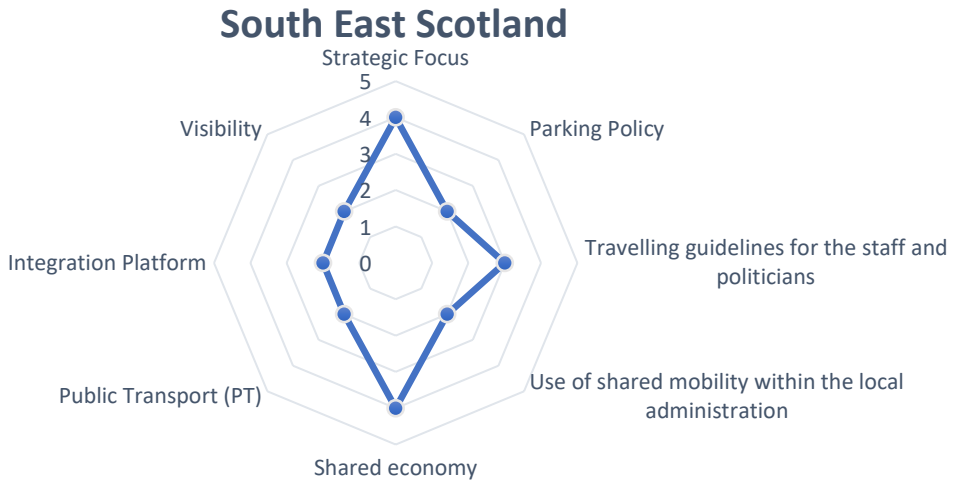
MAAS READINESS INDICATORS	SUB-INDICATORS	LEVEL	DESCRIPTION
STRATEGIC READINESS	Strategic Focus	1	The local authority has no measure taken to explicitly support MaaS development in the city
		2	The local authority is involved in measures to support the development of mobility services together with the service providers and/or incentives are used for creating the Maas
		3	The local authority has a plan/strategy/policies to explicitly support the development of MaaS in the local context
		4	The local authority has local funding to support the change (project or continuous funding)
		5	The local authority has a named person to be in charge of MaaS development. The local authority develops MaaS systematically
	Parking Policy	1	The local authority does not have a parking policy
		2	The local authority has a parking policy, but it does not explicitly support the shared use of vehicles and/or transport on demand
		3	Politicians are ready to change parking policy in critical areas in the local authority or they are ready to take measures to reduce private motoring/ car ownership
		4	The local authority is active in supporting new business models by adapting parking standards for (new) residential developments (reducing the area of parking space, allocating parking spaces for shared cars/transport on demand, and enabling new mobility services for residents).
		5	The parking policy supports shared cars by offering priorities/cheaper parking/parking zones for shared vehicles and parking permits are easy to acquire.
INTERNAL USE	Travelling guidelines for the staff and politicians	1	Internal travelling guidelines for staff and politicians of the local authority do not prioritize sustainable mobility
		2	Internal travelling guidelines prioritize sustainable mobility but are not monitored by the local authority
		3	Internal travelling guidelines prioritize sustainable mobility and travel patterns are monitored and reported annually by the local authority
		4	Internal travel instructions prioritize sustainable mobility, travel patterns are monitored annually by the local authority and there is a clear plan to reduce the use of private cars on work travel and to promote the use of shared mobility.
		5	Internal travelling instructions prioritize sustainable mobility, travel patterns are monitored annually, the use of private cars on work travel has declined during the past 3 yrs.
	Use of shared mobility within the local administration	1	The local authority is not using shared mobility services itself
		2	The local authority offers shared cars/bikes etc for the use of its staff and politicians, but it is limited to a small number of employees
		3	The local authority offers shared cars or bikes for the use of the majority of staff and politicians.
		4	The local authority uses shared mobility services offered by several service providers.
		5	The local authority uses shared mobility services offered by several service providers, not limited to working hours only.
SHARED USE	Shared economy	1	No companies are offering shared vehicles in the local authority
		2	There are pilots/campaigns/incentives taking place in the local authority regarding shared mobility options
		3	There are different kinds of shared mobility opportunities offered by companies available for citizens
		4	There are more than five different kinds of MaaS operators providing combined mobility within the local authority covering e.g., the following modes: public transport, shared vehicles, shared bikes, ride-sharing, rental cars, taxis, rental boats, etc
		5	Regular service providers (grocery stores, theatres, estate developers and housing companies etc) work together with MaaS operators and offer package deals to their customers.
	Public Transport (PT)	1	Customers can buy local PT tickets only via PT service providers' own channels, which differ from each other
		2	Customers can buy the tickets to PT through several sales channels offered by third parties
		3	The public transport authority (PTA) is actively connecting with other MaaS operators/transport providers in the area and they have plans to offer package deals to customers. (bicycle/car sharing, carpooling, taxis, etc).

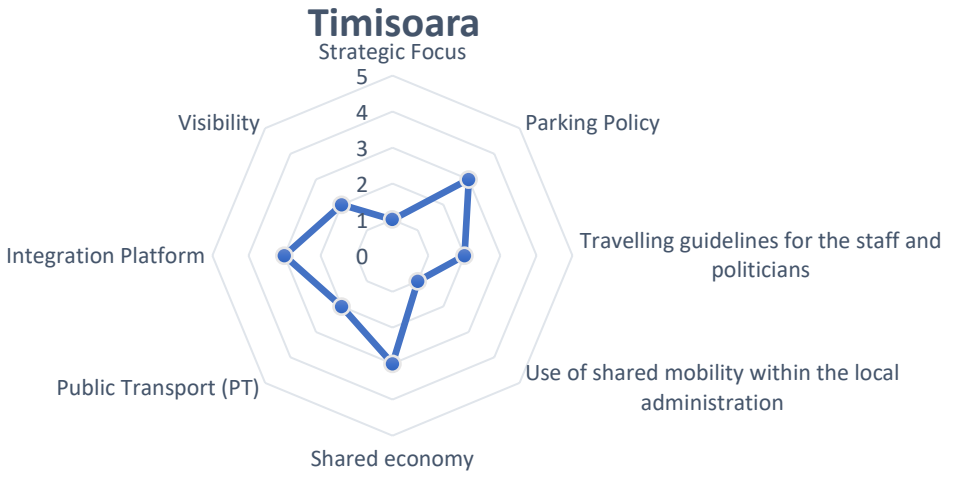
SHARED UNDERSTANDING		4	The PTA already offers multimodal package deals with other MaaS operators to customers
		5	Hotels, theatres, shopping malls, etc. regular service providers offer several service packages combining PTA with their own services.
	Integration Platform	1	The local authority has not opened data gathered from public transportation operation
		2	PTA and the local authority have opened data/standardized information gathered so that third parties can use it to create new apps and services.
		3	Third parties already use open data and provide mobile applications (with information about one mode of transport or more than one, real-time information, information about other services, official public transport applications, etc.)
		4	The local authorities are promoting and facilitating cooperation between different providers by any means (technical exchange platform, standardizations, etc.).
		5	Third parties work together to sell their MaaS services by using the same apps as other private and/ or public MaaS operators. The app may be provided by the PTA or a private service operator
	Visibility	1	Customers can find multimodal (min. 2 modes of transport) traveller information
		2	Customers have several channels from which they can find multimodal traveller information.
		3	Customers get visuals or see campaigns on sustainable mobility options/MaaS services while travelling in the city
		4	Customers can change their means of transport easily in several places within the local authority (min 4 transport means in one place).
		5	Customers have found MaaS services and their usage has increased within the last year.

After a thorough analysis of the mobility services, and considering all the above factors in each PriMaaS region, the following figure illustrates the MaaS readiness level for each PriMaaS region.




Thuringen
Strategic Focus
5
4
3
2
1
0
Parking Policy
Travelling guidelines for the staff and politicians
Use of shared mobility within the local administration
Shared economy
Public Transport (PT)
Integration Platform
Visibility


South East Scotland
Strategic Focus
5
4
3
2
1
0
Parking Policy
Travelling guidelines for the staff and politicians
Use of shared mobility within the local administration
Shared economy
Public Transport (PT)
Integration Platform
Visibility


Timisoara
Strategic Focus
5
4
3
2
1
0
Parking Policy
Travelling guidelines for the staff and politicians
Use of shared mobility within the local administration
Shared economy
Public Transport (PT)
Integration Platform
Visibility

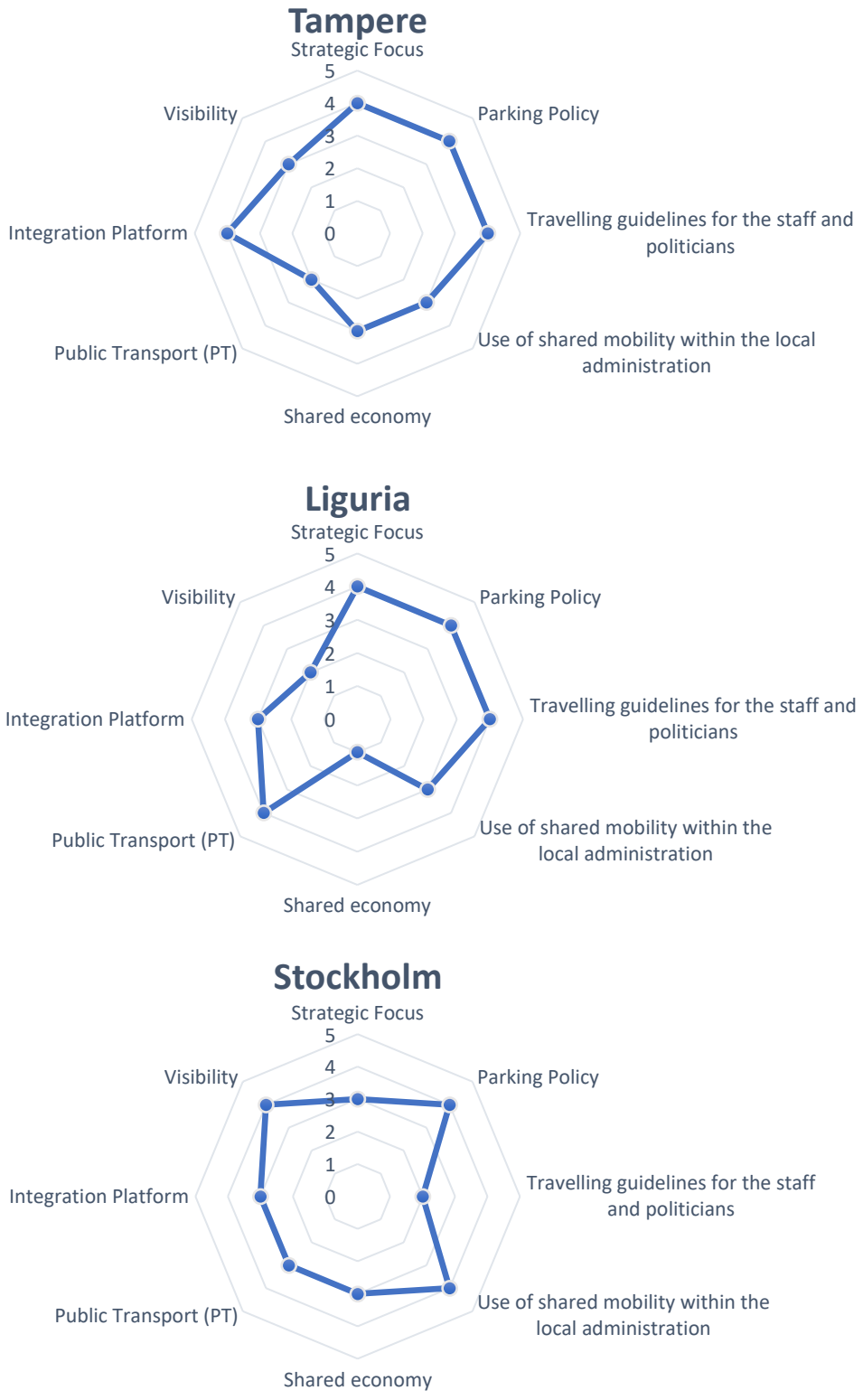


Figure 40 Readiness Levels for each PriMaaS region

Based on the above results, it can be concluded that overall, there is a need for each PriMaaS region to improve the different indicator levels. The MaaS concept seems to be very new for these regions, except for Finland and Sweden, which present the highest MaaS Readiness Indicators levels. In general, most of the regions have been focused and investing more in parking policies, traveling guidelines, shared mobility, and integration platforms. Strategic Focus, shared economy, and Public Transport seem to be indicators that still need improvement in many of the PriMaaS regions.

A closer look allows concluding that Stockholm, Tampere and Liguria gather the best conditions for a successful deployment of MaaS solutions. In fact, these regions are already taking steps in this direction, with integrated mobility platforms and actions to facilitate its implementation. In the Liguria case, there is however a huge difficulty in the shared mobility and in the visibility pillars. Timisoara and Thuringen seem to be the regions with overall low MaaS readiness levels, being the lowest level selected with respect to the Internal use in the local authorities main pillar. This cross-sector view analysis shows that local authorities in these regions are not currently prepared for the change, so it is expected that many actions are needed in all pillars to support the implementation of the new transport services. South East Scotland showed a medium level of MaaS readiness, like Coimbra Region. In the former case, there is a notorious need in working out the Shared understanding main pillar, which shows a lack of Integration platform and Visibility and usage. Efforts should be made to show mobility operators and related stakeholders the benefits of new emerging mobility schemes. On the latter, Coimbra Region seems to present relatively low levels under the Shared use main pillar, presenting very low levels of transport provision and integration.

Therefore, the analysis based on the factors that integrate the MaaS readiness indicator shows how heterogenous is the level of preparedness across different cities in Europe. This entails different strategies and perspectives. There is no doubt that some key elements need to be ensured:

- create a shared vision of the future
- provide the policy, regulation and legislation framework with a clear step-by-step plan
- make sure public and private operators are in a symbiotic relationship
- focus on stakeholder engagement and business models to ensure user needs
- provide customers with new mobility options that can be combined with traditional ones
- improve integration platforms, open data and public transport information
- improve accessibility and include offers for all citizens (inclusive goals)
- focus on sustainable local mobility offers
- reduce car dependency through parking policies and adapt facilities to be mobility hubs
- focus on pilot projects and raise awareness about new integrated mobility services.

Overall Conclusions and Lessons Learned

Smart mobility solutions are key to sustainable cities. Many current trends, like traffic emissions, urbanisation, and the mobility needs of an ageing population, are global issues. MaaS is a concept that has the potential to be one of the solutions to tackle these issues. Ensuring a citizens transition away from ownership and use of private vehicles to mobility solutions that are flexible, convenient and tailored in a user-friendly integrated service platform is at the core of the MaaS concept. For that to happen, MaaS needs a legislative framework enabling it. In fact, the legislation in the countries varies a lot and in the majority of cases, is delaying the MaaS process. There have been encouraging developments related to MaaS (most of them through pilots), but success is still limited. There are various barriers to widespread MaaS adoption and measurable impact.

The learning process based on insightful discussions with many different stakeholders in the PriMaaS Thematic Conferences and Capacity-building Workshops were fundamental for presenting the present report that is focused on providing what are the main required ingredients for a successful MaaS implementation and being able to deliver on its promises. A robust MaaS system can play a key role in the implementation of sustainable mobility policy goals and can be seen as an opportunity to redefine public transport and its financing. A first conclusion is regarding the successful design and deployment of MaaS which should be considered into steps, based on a comprehensive and holistic approach, including strategic, technical, regulatory, and change considerations. Stakeholders perspectives differ from the region, and bringing their opinions into a discussion led to the following conclusions with respect to a generalised dissatisfaction with the current legal frameworks (except in Finland):

- Differing views on the leadership and responsibilities of the public and private sector in both encouraging and managing platforms and ensuring sustainability goals;
- Differing views on barriers to be overcome. The more advanced countries have a deeper awareness of the uncertain barriers to the business model itself;
- Stakeholders pointed out various risks to the operation and negative impacts on society the most critical are related to economic viability, but there are many risks related to operational management of platforms and negative societal impacts;
- There is a fine line between opportunities and risks.

Taking into consideration all the Good Practices shared within the PriMaaS Project, many of the principles highlighted in the Finnish Act on Transport Services, e.g., the openness of data, user-centricity and collaboration of public and private transport market players, can be seen as part of the universal building blocks of functioning for a successful and sustainable MaaS ecosystem. MaaS should be supported by a coherent public policy framework. Additionally, the common Swedish practice of working in a true triple-helix environment with close collaboration between industry, government and academia seems to be also a key element.

Providing door-to-door services is not an easy task. Providing a tailored-made mobility service is not an easy task. Providing MaaS solutions are highly dependent on data, so it is very important to ensure trust between all MaaS players. There should be made efforts to gain the trust of new

mobility operators by making them involved in the early stages of the MaaS development process. It is also important to ensure cooperation between all (public and private) agents, with the involvement of the policymakers and a long-term vision for MaaS in collaboration with private and social sector actors, should be envisaged. Defining each one's roles can minimize the risk of conflicts or difficulties during MaaS business design and implementation. A public transport authority can have a relevant role, especially as a facilitator and by providing similar contract conditions and pricing for all MaaS operators to avoid any unfair and non-transparent conditions. A general concern is related to the design of the most appropriate bundled/packaged MaaS offerings. Investing in pilots and establishing internal institutional conditions is a way of learning which is best suited for each region.

In the MaaS user-centric approach, it is fundamental to integrate customer points of view and needs in all steps of the development of a mobility service. From the point of view of (potential) users, it was found that a MaaS scheme should not only provide an integrated offer including the whole range/vast majority of services available in the city/region, but it is also very important that services outside of the traditional transport system are included (e.g., bike-sharing, car-sharing, car-pooling, etc) in order to MaaS be attractive. If the COVID-19 pandemic brought something positive it may be related to working as an accelerator for the use of innovative mobility services. For instance, many transport operators across the EU starting to incorporate some COVID-19-related information as part of their MaaS offering, by providing information on hygiene recommendations, sanitation of the public transport services, in-vehicle overcrowding levels as part of some route planning functions. These features can be part of the solutions for improving the travel experience and may stay from now on as essential information.

The MaaS ecosystem involves different actors and a collaborative relationship is expected for the success of the MaaS schemes on a service product and customer framework. In fact, behind the MaaS core idea, in a well-designed system, MaaS would be relevant as an aggregator of information and can help manage mobility across all transport modes at regional and local levels. Thus, public transport authorities can play a crucial role as facilitators and coordinators of innovative and integrated mobility solutions, while ensuring that basic interests should be preserved, namely regarding citizens' interests and needs, high levels of accessibility and equity, as well as do not deviate from sustainable policy goals.

In conclusion, some inspiring words from the Commissioner for Transport Adina Vălean show how relevant interregional cooperation can be in delivering a smart, competitive, safe, accessible and affordable transport system: "As the backbone that connects European citizens and business, transport matters to us all. Digital technologies have the potential to revolutionise the way we move, making our mobility smarter, more efficient, and also greener. We need to provide businesses a stable framework for the green investments they will need to make over the coming decades. Through the implementation of this strategy, we will create a more efficient and resilient transport system, which is on a firm pathway to reduce emissions in line with our European Green Deal goals."[1]

[1] https://ec.europa.eu/commission/presscorner/detail/en/ip_20_2329

References

Aaltonen, Stella. 2020. *MaaS Readiness Level Indicators for Local Authorities*.

Arias-Molinares, Daniela, and Juan C. García-Palomares. 2020. "The Ws of MaaS: Understanding Mobility as a Service Fromaliterature Review." *IATSS Research* 44(3):253–63.

Bob Pishue, Transportation Analyst. 2021. "2021_INRIX_Scorecard_Report." (December).

Christidis, Panayotis, and Juan Nicolás Ibáñez Rivas. 2012. *JRC Publications Repository - Measuring Road Congestion*.

Dutta, Soumitra, and Bruno Lanvin. 2020. *THE NETWORK READINESS INDEX 2020 Accelerating Digital Transformation in a Post-COVID Global Economy*. Portulans Institute.

Esztergár-Kiss, Domokos, Tamás Kerényi, Tamás Mátrai, and Attila Aba. 2020. "Exploring the MaaS Market with Systematic Analysis." *European Transport Research Review*. doi: 10.1186/s12544-020-00465-z.

European Commission. 2021a. "DESI — Digital Scoreboard - Data & Indicators." Retrieved February 8, 2022 (https://digital-agenda-data.eu/datasets/desi/visualizations).

European Commission. 2021b. *EU Transport in Figures : Statistical Pocketbook 2021*. edited by Directorate-General for Mobility and Transport. Publications Office.

Eurostat. 2021. *Eurostat Regional Yearbook 2021 Edition*.

Hensher, David, Corinne Mulley, Chin Ho, Yale Wong, Goran Smith, and John Nelson. 2020. *Understanding Mobility as a Service (MaaS)*. Elsevier.

Huib van Essen, Lisanne van Wijngaarden, Arno Schroten (CE Delft), Daniel Sutter, Cuno Bieler (INFRAS), Silvia, and Kareen El Beyrouty (Ricardo) Maffii, Marco Brambilla, Davide Fiorello, Francesca Fermi, Riccardo Parolin (TRT). 2019. *Handbook on the External Costs of Transport*.

Jittrapirom, Peraphan, Valeria Caiati, Anna Maria Feneri, Shima Ebrahimigharehbaghi, María J. Alonso-González, and Jishnu Narayan. 2017. "Mobility as a Service: A Critical Review of Definitions, Assessments of Schemes, and Key Challenges." *Urban Planning* 2(2):13–25. doi: 10.17645/up.v2i2.931.

Kamargianni, Maria, Weibo Li, Melinda Matyas, and Andreas Schäfer. 2016. "A Critical Review of New Mobility Services for Urban Transport." Pp. 3294–3303 in *Transportation Research Procedia*. Vol. 14. Elsevier B.V.

Karlsson, I. C. M., D. Mukhtar-Landgren, G. Smith, T. Koglin, A. Kronsell, E. Lund, S. Sarasini, and J. Sochor. 2020. "Development and Implementation of Mobility-as-a-Service – A Qualitative Study of Barriers and Enabling Factors." *Transportation Research Part A: Policy and Practice* 131:283–95. doi: 10.1016/j.tra.2019.09.028.

König, David, J. Sochor, Jenni Eckhardt, and Martin Böhm. 2016. "State-of-the-Art Survey on Stakeholders' Expectations for Mobility-as-a-Service (MaaS)." in *23rd World Congress on*

Intelligent Transport Systems, ITS Australia.

Lyons, Glenn, Paul Hammond, and Kate Mackay. 2019. "The Importance of User Perspective in the Evolution of MaaS." *Transportation Research Part A: Policy and Practice* 121(January):22–36. doi: 10.1016/j.tra.2018.12.010.

Mulley, Corinne. 2017. "Mobility as a Services (MaaS)–Does It Have Critical Mass?" *Transport Reviews* 37(3):247–51. doi: 10.1080/01441647.2017.1280932.

Oecd, and Itf. 2021. "The Innovative Mobility Landscape The Case of Mobility as a Service." in *International Transport Forum Policy Papers*. Paris: OECD Publishing.

Smith, Göran. 2020. "Making Mobility-as-a-Service Towards Governance Principles and Pathways." CHALMERS UNIVERSITY OF TECHNOLOGY.

Sochor, Jana, Hans Arby, I. C. Mar. Anne Karlsson, and Steven Sarasini. 2018. "A Topological Approach to Mobility as a Service: A Proposed Tool for Understanding Requirements and Effects, and for Aiding the Integration of Societal Goals." *Research in Transportation Business and Management* 27(November):3–14. doi: 10.1016/j.rtbm.2018.12.003.

Strömberg, Helena, I. C. Mariann. Karlsson, and Jana Sochor. 2018. "Inviting Travelers to the Smorgasbord of Sustainable Urban Transport: Evidence from a MaaS Field Trial." *Transportation* 45(6):1655–70. doi: 10.1007/s11116-018-9946-8.

Annexes

Coimbra (Centro Region)

Level 0 MaaS services:

Name of MaaS-Operator	Function of MaaS-Operator	Integrated transport modes	Regional scope/Geographic coverage	Type of Platform	Available Functionalities	Information provided	Integration of societal goals	Implemented incentives in order to achieve the goal
SMTUC	Public	1	City	Web	None	1, 2, 3, 4	0	-
Transdev	Private	1	National	Web	Trip planning	7, 4	0	-
Joaquim Martins da Fonseca, Lda	Private	1	Regional	Web	None	4	0	-
Marques, Lda	Private	1	Regional	Web	None	7, 4	0	-
RDL - Rodoviária do Lis, Lda	Private	1	Regional	Web, App	None	7, 4	0	-
Alfredo Farreca Rodrigues, Lda	Private	1	Regional	Web	Other, None	4	0	-
CP-Comboios de Portugal, EPE	Public	12	National	Web, App	Ticketing, Payment	7, 4, 5, 6	0	-
Metro Mondego, S.A.	Public	1	Regional	Web	None	7, 4, 6	0	
UBER	Private	10	National	App, Web	Ticketing, Payment	7, 3	0	
FlixBus	Private	1	National INTERNATIONAL	Web, App	Ticketing, Payment	7, 4, 5, 6	0	

Level 1 MaaS services:

Name of MaaS-Operator	Function of MaaS-Operator	Integrated transport modes	Regional scope/Geographic coverage	Type of Platform	Available Functionalities	Information provided	Integration of societal goals	Implemented incentives in order to achieve the goal
COIMBRA.MOVEME	Private	1, 12	Regional	Web, App	Trip planning	7, 3, 4, 6	0	-

Liguria

Level 0 MaaS services:

Name of MaaS-Operator	Function of MaaS-Operator	Integrated transport modes	Regional scope/Geographic coverage	Type of Platform	Available Functionalities	Information provided	Integration of societal goals	Implemented incentives in order to achieve the goal
TPL Linea	Public	1, 4	Regional	Web, App	Trip planning, Payment, Ticketing	7, 4, 6, 3	1, 2	2.1, 4.1
Riviera Trasporti	Public	1, 4	Regional	Web, App	Trip planning, Payment, Ticketing	7, 4, 6, 3	2, 4	2.1
ATP	Public	1, 4	Regional	Web	Trip planning	7, 4, 3	0	

Level 1 MaaS services:

Name of MaaS-Operator	Function of MaaS-Operator	Integrated transport modes	Regional scope/Geographic coverage	Type of Platform	Available Functionalities	Information provided	Integration of societal goals	Implemented incentives in order to achieve the goal
ATC La Spezia	Public	1, 4	Regional	Web, App	Trip planning, Payment, Ticketing	7, 4, 3	2, 4, 6	2.1
AMT Genova	Public	11, 1, 12, 13, 14	Regional	Web, App	Trip planning, Payment, Ticketing	7, 4, 6, 3, 8	1, 2	2.1, 4.1
Trenitalia	Public	12	Regional	Web, App	Trip planning, Payment, Ticketing	7, 4, 6, 3	2, 3	2.3
orariotrasporti	Public	1, 7, 12, 1, 13, 6	Other	Web, Other	Trip planning	7, 4, 6, 3	0	-

Timisoara

Level 0 MaaS services:

Name of MaaS-Operator	Function of MaaS-Operator	Integrated transport modes	Regional scope/Geographic coverage	Type of Platform	Available Functionalities	Information provided	Integration of societal goals	Implemented incentives in order to achieve the goal
STPT - public transport company	Public	1, 6, 13, 14, 0	City	Web	None	7, 7, 3, 4	5, 12	4.2
STPT / Velo TM system	Public	0	City	Web, App	Other	6, 9	12	4.2
STPT/24 pay ; STPT/mobilpay	Private	1, 6, 13, 14	City	App	Ticketing	7	0	-
CFR- National Railway Operator	Public	12	National	Web	Trip planning, Booking, Ticketing, Payment	7, 6, 1, 3, 8, 5	0	-
BCR eGO	Private	3	Regional	App	Booking, Payment	10, 7, 9	0	-

Level 1 MaaS services:

Name of MaaS-Operator	Function of MaaS-Operator	Integrated transport modes	Regional scope/Geographic coverage	Type of Platform	Available Functionalities	Information provided	Integration of societal goals	Implemented incentives in order to achieve the goal
Moovit	Private	1, 6, 7, 9, 13, 14	City	App	Trip planning	11, 3, 4, 8, 6, 9	0	-
Google maps	Private	1, 7, 12, 13	National	Web, App	Trip planning	1, 4, 6	1	-
Uber	Private	9	Regional	App	Trip planning, Booking, Payment	7, 9	0	-
Bolt	Private	9	Regional	App	Trip planning, Booking, Payment	7, 9	0	-
FreeNow	Private	9, 11	Regional	App	Trip planning, Booking, Payment	7, 9	0	-
e-twow	Private	5	Regional	App	Booking	9	12	4.2
transporturban.ro	Private	1, 7, 13, 14	City	Web	Trip planning	6	0	-

Thüringen

Level 0 MaaS services:

Name of MaaS-Operator	Function of MaaS-Operator	Integrated transport modes	Regional scope/Geographic coverage	Type of Platform	Available Functionalities	Information provided	Integration of societal goals	Implemented incentives in order to achieve the goal
KomBus GmbH	Public	1, 12	Regional	Web, App	Trip planning	4, 6, 12, 7, 3, 8, 11	2, 4, 5, 9	2.3
Bus & Bahn Thüringen e.V.	Public	1, 13, 12, 7	Regional	Web	Trip planning	4, 6, 3	2, 13	2.3
Regionalbus GmbH	Private	1, 7	Regional	Web	Trip planning	4, 6	0	-
Verkehrsunternehmen Wartburgmobil (VUW) gkAöR	Public	1, 13, 9, 7	Regional , National	Web, App	Trip planning, Booking, Ticketing, Payment	4, 11, 3, 7, 12, 6, 8, 5	1, 2, 5, 11	2.5, 4.1
RBA Regionalbus Arnstadt GmbH / WerraBus	Private	1	Other, Regional	Other	None	0	0	-
EW Bus GmbH	Private	1, 7	Regional	Web	Trip planning	4, 6	0	-
Verkehrsbetriebe Nordhausen GmbH	Private	1, 7	Regional	Web	Trip planning	4, 6	0	-
Ilm-Kreis Personenverkehrsgesellschaft mbH	Public-private partnership	1, 7, 12, 13	Regional	Web	Trip planning	3, 4, 6	0	-
PRG Greiz	Public-private partnership	1	Regional	Web	None	4	0	-
Verwaltungsgesellschaft des ÖPNV Sömmerda mbH	Public	1, 7	Regional	Web	Trip planning	4, 6, 3	2, 5	2.3
Erfurter Verkehrsbetriebe GmbH (EVAG)	Public	1, 7, 13	City	Web, App	Trip planning, Ticketing, Payment	4, 11, 3, 7, 12, 6, 8	1, 2, 5, 9, 13, 11	2.3
Jenaer Nahverkehr GmbH	Public	1, 7, 12, 13	City	Web, App	Trip planning, Ticketing, Payment	4, 11, 3, 7, 12, 6, 8, 13, 2	1, 2, 5, 9, 11	2.3
GVB Verkehrs- und Betriebsgesellschaft Gera mbH	Public	1, 7, 12, 13	Regional	Web	Trip planning	4, 6, 3, 8, 7, 12, 11	1, 2, 5, 9, 11	2.3
Nextbike	Private	0	City, National	Web, App	Booking, Payment	2, 7, 9	2, 5, 12	2.2
teilAuto	Private	3	City, National	Web, App	Booking, Payment	2, 9, 10	2, 5	2.2
Sixt	Private	2	National	Web, App	Booking, Payment, Invoicing	7, 9	0	-
Europcar	Private	2	National	Web, App	Booking, Payment, Invoicing	7, 9	0	-
Taxi.eu	Private	11	National	App	Trip planning, Booking, Payment, Invoicing	7, 3, 9	0	-
Taxi Deutschland	Private	11	National	App	Trip planning, Booking, Payment, Invoicing	7, 3, 9	0	-

Level 2 MaaS services:

Name of MaaS-Operator	Function of MaaS-Operator	Integrated transport modes	Regional scope/Geographic coverage	Type of Platform	Available Functionalities	Information provided	Integration of societal goals	Implemented incentives in order to achieve the goal
DB-Regio AG, Regio Südost	Public	1, 13, 12, 7	Regional , National	Web, App	Trip planning, Booking, Ticketing, Payment, Invoicing	4, 11, 3, 7, 12, 6, 8, 5	1, 2, 5	2.3, 4.1
Verkehrsgemeinschaft Mittelthüringen (VMT)	Public	1, 7, 12, 13	Regional	Web, App	Trip planning, Ticketing, Payment	4, 6, 3, 8, 7, 12, 11	1, 2, 5, 9, 11	2.3
Mitteldeutscher Verkehrsverbund GmbH (MDV)	Public	1, 7, 12, 13	Regional	Web, App	Trip planning, Ticketing, Payment, Invoicing	4, 11, 3, 7, 12, 6, 8	1, 2, 5, 9, 11, 13	2.2, 4.1

Stockholm

Level 0 MaaS services:

Name of MaaS-Operator	Function of MaaS-Operator	Integrated transport modes	Regional scope/Geographic coverage	Type of Platform	Available Functionalities	Information provided	Integration of societal goals	Implemented incentives in order to achieve the goal
EUBIKE	Private	0	City	App, Web	Payment	7, 9	0	
Elbilio	Private	3	City	App, Web	Payment, Booking	7, 9, 10	0	
M (Volvo cars) (previously Sunfleet)	Private	3	City	App, Web	Payment, Booking	7, 9	0	
Bilpoolen.nu	Private	3	City	Web	Payment, Booking	7, 9	0	
Move About	Private	3	City	App, Web	Payment, Booking	7, 9	2, 5	1.1
Aimo	Private	5	City	App, Web	Payment	7, 9	0	
Aimo	Private	3	City	App, Web	Payment	7, 9	0	
Voi	Private	5	City	App, Web	Payment	7, 9	2, 13	4.3
Tier	Private	5	City	App, Web	Payment	7, 9	10	3.2
Bird	Private	5	City	App, Web	Payment	7, 9	9, 12	2.4
Lime	Private	5	City	App, Web	Payment	7, 9	9, 12	2.4
Moow	Private	5	City	App, Web	Payment	7, 9	0	
Wheels	Private	5	City	App, Web	Payment	7, 9	9, 12	
Free Now	Private	9	City	Web, App	Trip planning, Payment, Booking	3, 4, 9, 7	1, 8	2.5, 4.1
Uber	Private	9	City	App, Web	Trip planning, Payment	3, 4, 9, 7	10, 6, 1, 8	3.1, 4.1
Bolt	Private	9	City	App, Web	Trip planning, Payment	3, 4, 9, 7	5, 8	1.1, 2.5
Taxi Stockholm (TAXI STHLM)	Private	11	City	Web, App	Trip planning, Payment, Booking	3, 4, 9	1	4.1
Taxi Kurir	Private	11	City	Web, App	Trip planning, Payment, Booking	3, 4, 9	1	4.1
Sverige Taxi	Private	11	City	Web, App	Trip planning, Payment, Booking	3, 4, 9, 7	8	2.5
Cabonline	Private	11	City	Web, App	Trip planning, Payment, Booking	3, 4, 9, 7	8	2.5

TOPCAB	Private	11	City	Web, App	Trip planning, Payment, Booking	3, 4, 9, 7	8	2.5
Flygbussarna	Private	1	City	Web, App	Trip planning, Payment, Booking	3, 7, 4	2	2.1
Arlanda express	Private	12	City	Web, App	Trip planning, Payment, Booking	3, 7, 4	2	2.1
SnappCar	Private	3	City	Web, App	Trip planning, Payment, Booking	9, 3	8, 5	
GoMore	Private	3	City	Web, App	Trip planning, Payment, Booking	9, 3	8, 5	4.3
SJ	Public	12	National	App, Web	Trip planning, Payment, Booking	7, 3, 4, 6	2, 9	4.3
Flixbus	Private	1	National	Web, App	Trip planning, Payment, Booking	6, 4, 7	1	4.1
MTR Express	Private	12	National	Web, App	Trip planning, Payment, Booking	6, 4, 7	2, 9	2.1, 4.3
Vy tåg	Private	12, 1	National	Web	Trip planning, Payment, Booking	6, 4, 7	2	2.1
Snälltåget	Private	12	National	Web	Trip planning, Payment, Booking	6, 4, 7	2	2.1
Bolt	Private	5	City	App	Payment	7, 9	13	1.1, 2.5

Level 1 MaaS services:

Name of MaaS-Operator	Function of MaaS-Operator	Integrated transport modes	Regional scope/Geographic coverage	Type of Platform	Available Functionalities	Information provided	Integration of societal goals	Implemented incentives in order to achieve the goal
Google maps	Private	1, 11, 12, 7, 0, 5, 8, 6, 13	National	Web, App	Trip planning	3, 4	0	-
SL (Stockholm Public Transport)	Public	1, 12, 13, 6	Regional	Web, App	Trip planning, Ticketing, Payment, Invoicing	7, 3, 4, 6	2	2.1

Level 3 MaaS services:

Name of MaaS-Operator	Function of MaaS-Operator	Integrated transport modes	Regional scope/Geographic coverage	Type of Platform	Available Functionalities	Information provided	Integration of societal goals	Implemented incentives in order to achieve the goal
Ubigo	Private	13, 1, 2, 10, 6, 13, 12, 0	City	App, Web	Trip planning, Payment	3, 4	2, 5	2.1, 3.1
Resplus (via Samtrafiken)	Public, Private	2, 1, 13, 12, 11, 6	National	Web	Trip planning, Payment	3, 4	3, 6, 11	4.2
Movingo	Public	1, 12	Regional	App, Web	Trip planning, Payment, Booking	6, 4	2, 9	2.1, 4.2

Tampere Region

Level 0 MaaS services:

Name of MaaS-Operator	Function of MaaS-Operator	Integrated transport modes	Regional scope/Geographic coverage	Type of Platform	Available Functionalities	Information provided	Integration of societal goals	Implemented incentives in order to achieve the goal
Tier	Private	5	City	App	Payment	9, 3, 10	0	
VOI	Private	5	City	App	Payment	9, 3	13	4.3
Easybike	Private	0	City	App	Payment, Booking	9, 3	2	2.1
Moovy	Private	14	National	App	Payment, Invoicing	2, 7, 3	0	
Tuomi Logistiikka	Public	1, 11	Regional	Other	Booking	1, 7	1	2.1
Tampereenliikenne.fi	Public	14	City	Web	Other	11, 3, 12, 2	0	
NääsMaaS	Public-private partnership	1	City	App	Trip planning, Booking	7, 3	9, 5	1.2
BloxCar	Private	3	National	Web	Booking, Payment, Invoicing	7, 9	0	
24Rent	Private	3	National	Web	Booking, Payment	7, 9	0	
Sixt	Private	2	National	Web	Booking, Payment	7, 9	0	

Level 1 MaaS services:

Name of MaaS-Operator	Function of MaaS-Operator	Integrated transport modes	Regional scope/Geographic coverage	Type of Platform	Available Functionalities	Information provided	Integration of societal goals	Implemented incentives in order to achieve the goal
Google Maps	Private	1, 6, 7, 8, 12, 13	National, Other	Web, App	Trip planning	3, 4, 12	0	
Nysse public transport	Public	1, 12	Regional	App, Other	Trip planning, Payment, Ticketing	7, 4, 3, 6	1, 2	1.2, 2.1

Level 2 MaaS services:

Name of MaaS-Operator	Function of MaaS-Operator	Integrated transport modes	Regional scope/Geographic coverage	Type of Platform	Available Functionalities	Information provided	Integration of societal goals	Implemented incentives in order to achieve the goal
ALPIO	Public-private partnership	1, 11	Regional	App, Other	Booking, Payment	1, 7, 3	1	2.1

South East Scotland

Level 0 MaaS services:

Name of MaaS-Operator	Function of MaaS-Operator	Integrated transport modes	Regional scope/Geographic coverage	Type of Platform	Available Functionalities	Information provided	Integration of societal goals
Tripshare SEStran	Public	10	Regional	Web	Trip planning	14,9	-

Level 1 MaaS services:

Name of MaaS-Operator	Function of MaaS-Operator	Integrated transport modes	Regional scope/Geographic coverage	Type of Platform	Available Functionalities	Information provided	Integration of societal goals	Implemented incentives to achieve the goal
Forth Bike	Public-private partnership	0	Regional	App	Booking, Payment	13, 2, 7, 9	0	-
Just Eat Cycles	Public-private partnership	0	City	App	Booking, Payment	2, 9, 7, 13	0	-
Enterprise Car Club	Private	3	City	Web, App	Trip planning, Booking, Payment	1, 13, 2, 7, 9	0	-
Borders Buses	Private	1	Regional	App	Trip planning, Booking, Ticketing, Payment	7, 3, 4, 6, 8	0	-
First Buses	Private	1	Regional	App	Trip planning, Booking, Ticketing, Payment	7, 3, 4, 5, 8, 6, 1	0	-
Stagecoach App	Private	1	National	App	Trip planning, Booking, Ticketing, Payment	7, 3, 4, 5, 8, 6	0	-
ScotRail App	Public-private partnership	12	State	App	Trip planning, Booking, Ticketing, Payment	7, 4, 8, 6	0	-
Uber	Private	9	City	App	Trip planning, Booking, Payment	7, 3	0	-
Transport for Edinburgh (TfE) Bus and Tram app	Public-private partnership	1, 13	City	App	Trip planning	3, 4	0	-

TfE M-Tickets	Public-private partnership	1, 13	City	App	Ticketing, Payment	7	0	-
Moovit	Private	1, 6, 12, 0	State	App	Trip planning	3, 7, 4	1	4.1
Traveline Scotland	Public-private partnership	1, 4, 12, 13, 6, 8, 7, 14	State	Web, App	Trip planning	7, 4, 3, 8, 6	0	-
Google maps	Private	1, 4, 6, 7, 8, 12, 13, 14	National	Web, App	Trip planning	11, 12, 3, 4, 8, 6	0	-

Level 2 MaaS services:

Name of MaaS-Operator	Function of MaaS-Operator	Integrated transport modes	Regional scope/Geographic coverage	Type of Platform	Available Functionalities	Information provided	Integration of societal goals
Trainline	Private	4, 12	National	Web, App	Trip planning, Booking, Ticketing, Payment	7, 4, 3	-
National Rail Enquiries	Public-private partnership	12	National	Web, App	Trip planning, Booking, Ticketing, Payment	7, 4, 3	-

Level 3 MaaS services:

Name of MaaS-Operator	Function of MaaS-Operator	Integrated transport modes	Regional scope/Geographic coverage	Type of Platform	Available Functionalities	Information provided	Integration of societal goals	Implemented incentives in order to achieve the goal
NaviGoGo	Private	12, 11, 7, 0, 1, 2	Regional	App	Trip planning, Payment, Booking, Ticketing	3, 7, 4	9, 8, 2, 12	4.3