UPPER
Unleashing the Potential of Public Transport in Europe

D4.2 PT operation toolbox. Innovative data capturing & sharing

WP4 Innovative solutions to increase the efficiency, reliability and attractiveness of PT

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CO: Confidential, only for members of the consortium (including the Commission Services);
EU-RES: Classified Information - restraint UE;
EU-CON: Classified Information - confidential UE;
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Abstract

This report outlines the activities conducted under Task T4.2 of the UPPER project, which aimed at implementing innovative methods for data capture and sharing within public transport (PT) operations to enhance efficiency and service quality. The UPPER mobility measures linked to this task are grouped around mobility planning, enriching mobility data lakes on the basis of new concepts applied to data exchange among federated mobility platforms (LEU_01, HAN_05), users data capture through applications provision for everyday trips optimization (ROM_07, VAL_07, VAL_09) and simulated data integration (IDF_02). The performed activities include a comprehensive review of European projects, identifying best practices such as the CIVITAS PORTIS initiative for improving port city mobility through intelligent transport systems, and the adoption of standards like the General Transit Feed Specification (GTFS) for data standardization. The report also discusses the use of Digital Twins in urban mobility planning and highlights tools like the Mobility4EU Roadmap and MOVE21, which support the development of data-driven, sustainable urban mobility solutions. The activities performed to support the cities in the mobility measures development, through a monitoring process guided by the tasks leaders is also described. Correspondingly, the results generated in the workshops participated by the cities, the horizontal partners, and in general all the partners involved in the task, are also described. Mainly two workshops can be distinguished: a first one focused on sharing experiences and good practices among cities involved in WP4, and a second one aimed to produce points of attention to be considered by the cities' teams when developing their measures. The report also presents the status of the measures' development at the release time of the document, presented in the measure development template.

Keywords

Data sharing platform, mobility data, data standardization, real-time data integration, PT services, digital twin, mobility measures, points of attention, measure monitoring template, horizontal partners, workshop.

1. Introduction

1.1. Scope of the Document

This document reports the activities performed within task T4.2 under the work package WP4 of the UPPER project. This task is focused on implementing innovative methods of capturing and sharing data intended for public transport (PT) operations. Setting such methods is complex due to the need for robust data governance and integration across various stakeholders, yet it is crucial for enhancing service efficiency, decision-making, and overall PT and mobility systems effectiveness.

This task has focused on the UPPER mobility measures designed to leverage various data sources ranging from real-world inputs like surveys and cameras to simulated data to understand mobility better and improve public transport operations. Thanks to this data, cities will develop new services for users and PT operators. This document presents the activities carried out in task 4.2, such as monitoring measures and animating workshops, and the cities' preparation process of these measures. During the monitoring phase of the measures, the task leaders were able to collaborate periodically within the Measures Support Leaders Group led by CERTH. In addition, leaders of T4.2 and T4.3 collaborated for the animation of Workshop 1 "PT service: Exploiting data for better planning and operation" in Rome.

The lead author would like to thank to all UPPER sites' representatives and their local collaborators for their active contribution, interest and information provided with respect to the steps followed to develop and prepare their measures. Likewise, the lead author would like to thank the horizontal partners that were involved in the appraisal of the measures to maximise their impact and on the execution of the workshops to identify cross-cutting recommendations. Lastly, an acknowledgement to all those who provided input, insights and comments to this document.

1.2. Intended audience

This document is intended for professionals involved in public transport (PT) enhancement, including mobility managers in municipalities, public and private sector companies, transport technicians, and regulators. It outlines various innovative methods for capturing and sharing data in PT operations, as defined and developed within the UPPER initiative by different European cities. These examples can serve as valuable case studies for mobility experts in other cities.

Additionally, the document provides a curated collection of reference materials, guides, and EU city mobility initiatives that promote the development of new services based on both static and dynamic data sources, making it a recommended resource for professionals focused on advancing sustainable urban mobility.

1.3. Structure of the document

The document is structured in six sections, starting with a brief introduction. The second section of the document presents the methodology followed to perform the different activities comprehended in task 4.2. The third section

presents the results generated in the task related to generate a collection of reference projects and initiatives, to support cities in the development of their mobility measures within UPPER project.

The fourth section of the document presents the results generated in the workshops participated by the cities, the horizontal partners, and in general all the partners involved in the task. Two workshops are described: a first one focused on sharing experiences and good practices among cities involved in T4.2 and T4.3 (and WP4 in general), and a second one aimed to produce *points of attention* to be considered by the cities' teams when developing their measures. The second workshop preparation included the mobility measures' appraisal (definition of points of attention), which are also reported within this section.

The fifth section is focused on describing the process followed to support the cities in the mobility measures development. This section reports the results generated along the monitoring process performed jointly by mobility measures' contact person and the task team.

The last section of the report comprehends a collection of conclusions related to the main activities performed in this task.

1.4. Measures included under task 4.2

As stated in subsection 1.1, this task has focused on implementing innovative methods of capturing and sharing data intended for public transport (PT) operations. Therefore, the mobility measures linked to Task 4.2 are:

- Data exchange among federated mobility platforms:
  - LEU_01: To exploit the existing mobility data to enhance the evolution of public transport policies.
  - HAN_05: Exploring monitoring options of the cities performance towards achieving the goals of the SUMP.
- Users' data capture through applications provision for everyday trips optimization:
  - ROM_07: Use of advanced technology to increase the efficiency and reliability of PT.
  - VAL_07: To provide the citizens with clear and accessible information before and during the trip.
  - VAL_09: Improving the efficiency of the bus service and comfort of PT users.
- Simulated data integration:
  - IDF_02: Setting-up of a dynamic Digital Twin of the territory.

2. Methodology

2.1. Supporting resources: A systematic review

A systematic review of reference projects and best practices in Europe related to implementing innovative methods of capturing and sharing data for public transport (PT) operations was conducted. This review covered relevant projects, their outcomes, and tools that can be adopted by cities to implement similar measures. Then, it focused on

public transport data-sharing standards systems and transport simulation platforms. An effort was made to identify and summarize the most relevant resources for task T4.2. However, the resources presented in this document are not exhaustive.

2.2. Measures support workshop series

2.2.1. Workshop 1: Barriers, challenges and good practices in the measures' preparation process

The Rome GA assembly, performed in month M13 (January 2024) of the UPPER project, was seen as an opportunity to share experiences among cities, on how the development process of mobility measures was progressing. The deliverable D2.2, released on month M8 (August 2023) included the review of all the measures description, tackled by a refinement process of measures' description. By performing this refinement process, it was revealed how some measures development was matured and very advanced, while others were still concepts, lacking tangible proposals.

It was clear that some cities could take benefit of the learnt lessons of others (those with fully developed measures), and the consortium partners agreed on the idea of organising a workshop during the Rome GA, where there was an exchange of experiences among cities when developing their mobility measures. During the meeting two workshops were held in parallel and meeting attendees could freely choose which session to attend. This workshop was jointly moderate with Factual and focused on PT service, data for better planning and operation. It conceived as a forum where cities were presenting some measures (highly developed vs low developed), followed by questions and an open discussion among participants (cities and UPPER partners).

2.2.2. Workshop 2: Points of attention for maximizing measures' impact

The process defined to support and to accompany cities in the development of mobility measures resulted in a monitoring process guided by the leaders of those tasks including mobility measures (i.e. T3.4, T3.5, T4.2, T4.3, T4.4, T4.5, T5.2, T5.3, T5.4). In this monitoring process, the cities had the support of task leaders, but the knowledge and know-how of horizontal partners participating in the tasks was missing. In order to correct this situation, and to get benefit of the mobility knowledge of PTAs and associations, including users, associations, cities associations and PTOs associations, the consortium proposed to organize an assessment process of the mobility measures, and a workshop to discuss on the results generated by the assessment. The aim of the workshop is to support cities in their tasks of developing UPPER measures, by challenging and improving their initial measure description (as presented in UPPER Deliverable 2.2 Annex). The process is structured around several steps that are common across all the UPPER tasks where measures are developed.

In the WP4 online workshop focus on data-driven mobility planning (duration 1,30h) horizontal partners presented the points of attention previously identified, together with potential recommendations or best practices of how these can be addressed. Representatives from the UPPER partners responsible for the development and subsequent measures actively reacted and participated.

CERTH, as WP4 leader, was the overall coordinator of the WP4 workshop. CERTH defined the main structure and contents of the workshop and, with the support from EMTA, EIT Urban Mobility Foundation and ICLEI, distributed the responsibilities for the workshop among the horizontal partners with resources in tasks T4.2, T4.3 and T4.5. EMTA led the event organization, including the preparation of the required material, set-up of the agenda and moderation

of the plenary sessions. EIT Urban Mobility Fundation coordinated the appraisal of the measures and follow up with reviewers (IFP, IFPEN, FACTUAL, ECF, UITP, EMTA, EITUMF, EPF, ICLEI) to ensure timely and adequate identification of points of attention. All the points of attention identified for T4.2 measures are included in "ANNEX 1: WORKSHOP 2 'POINT OF ATTENTION'".

The assessment was organized by collecting *points of attention* linked to the measures, basically issues to be considered by cities' teams when developing their mobility measures to maximise their impact. These *points of attention* were organized around topics (categories) relevant to the development process, some of them generic, like *stakeholder involvement*, some of them specific for mobility, like *Mobility as a Right*. The collected *points of attention* were analysed and discussed in a participated workshops with cities and horizontal partners.

2.3. The Measures Support Leaders Group

WPs 3,4 and 5 share common goals; to develop the UPPER tools and to make sure that all the necessary steps have been taken in order to get the 84 measures ready for implementation, in the framework of WP6. Having identified from the very beginning his common goal, the participating horizontal partners (WP and Task leaders) decided from the very beginning to join forces. More specifically, aiming to ensure that all partners involved in the development of the measures, including cities and horizontal partners, are aware of their responsibilities and the corresponding timeline, they decided to formulate a group, entitled "Measures Support Leaders Group" (MSLG) which was created at the beginning of the duration of these Tasks, in M8.

CERTH being the leader of WP4, under which most of the measures are prepared, was appointed leader of the MSLG. The group consisted of the leaders of the tasks under which the measures are developed (T3.4, T3.5, T4.2, T4.3, T4.4, T4.5, T5.2, T5.3, T5.4), while meetings were held in a monthly basis. The table below presents the UPPER partners forming the MSLG.

Task	Leader
T3.4 "Re-design the urban mobility space to promote the use of PT"	ETRA
T3.5 "Definition of new operational and policy-based measures and solutions regarding zonal and network-based UVAR and parking"	POLIS
T4.2 "New services for users and PT operators based on the existing mobility data collection and sharing"	IFPEN
T4.3 "Improved PT efficiency addressing specific needs and situations such as expected an unexpected events"	FACTUAL
T4.4 "Improved information and added-value services enhancing multimodality"	CERTH
T4.5 "Improved comfort, convenience, safety and attractiveness of transit services"	UITP
T5.2 "Incentivize PT offer and active modes in the living labs"	FACTUAL
T5.3 "Innovative strategies and solutions to improve public perception of PT"	FIT
T5.4 "Behaviour-change oriented mechanisms to promote the use of PT"	IBV

Table 1: Members of the Measures Support Leaders Group

The aim of the group may be summarized as follows:

- To meet the goals foreseen in the Grant Agreement, in relation to the aforementioned tasks.
- To provide meaningful support to the cities' representatives during the development of their measures.
- To ensure that all task leaders provide the same level of support to the cities developing measures under their task.
- For the cities to acquire a clear understanding of the steps needed to develop their measures and the support they will receive from task leaders (and other horizontal partners involved in the task).
- To monitor the progress of the measures' preparation process and timely identify any challenges/delays.

To achieve all these, a template entitled Monitoring Template was created and used in order to monitor the progress of all measures' development. The first draft was created by the group's leader but was then circulated among all members to review it. Once it was finalized, each member of the MSLG had to fill it in for all the measures under their Task. The aim of the template is to briefly present each measure and its expected outcomes (extensive measures' descriptions are included in D2.2) and to identify all steps needed to develop the measures. For each step a responsible partner is assigned as well as specific deadline. In addition, each step should be accompanied by a monitoring indicator; this indicator is not related to the evaluation process, but it refers to the main output of the step so that the step is considered completed. The fields to be defined for each step in the Monitoring template are shown in the figure below:

Steps to ready-to-demo measure

Steps	Description	Involved partners/externals	City contact person	Category of action	Deadline	Monitoring indicator	Comments
1	Define the step e.g., Definition of the area and the use cases	Define the partners responsible for this step	Email of the responsible person (Partner's name)	Choose from Data/Infrastructure/Legal/Safety/Social/ Technical/Software	Define the data when the step should be completed	Define what the output of the step will be e.g., Description of area and use cases	Include any clarifications etc.
2							
3							
4							
5							
LAUNCH OF THE DEMO (please fill in the date)							

Figure 1: Table of steps to be defined by Project partners in the Monitoring template.

Once the task leaders had filled the templates in, the templates were sent to the corresponding cities to review and finalize them. One monitoring template was created per measure. These templates were then utilized by each task leader to track the progress of the defined steps for the measures under their task. This was done through the following procedure: prior to each monthly MSLG meeting, each task leader contacted the partners responsible for the measures' development to ask about the progress of each measure under their Task. A short but concrete

presentation was then created and presented during the meeting in order to report the progress and any challenges or delays (if applicable).

The template of the monitoring template, along with the completed templates for the 6 measures prepared under Task 4.2 can be found in “ANNEX 2: MONITORING TEMPLATES OF T4.2 MEASURES”.

Moreover, to monitor progress in preparing the measures, a shared Excel file has been set up for each measure. The city contact updated the file each time progress was made, as shown in the example below.

Steps	Description	Involved partners externals	Category of action	Deadline	Monitoring indicator	Status	Comments
1	Determining the purpose and scope of the digital twin (who are the users, which area or region and which level of detail)	IFPEN, Ile de France	Technical	24/11/2023	Description of purpose and scope of the digital twin	Done	
2	Collection of relevant data such as administrative and demographic data (census, household travel surveys...), infrastructure data (roads, buildings, utilities, transportation systems...), sensory data (traffic counter, FCD...)	IFPEN, Ile de France	Data	15/12/2023	List of relevant collected data	Done	
3	Selection of an appropriate simulation platform that best suits the purpose and the scope of the study	IFPEN, Ile de France	Technical	15/12/2023	Digital twin platform	Done	
4	Processing collected data to generate simulator input data	IFPEN, Ile de France	Data	23/02/2024	Input data for the Digital twin platform	Done	
5	Updating of the digital twin with dynamic data	IFPEN, Ile de France	Software	26/04/2024	Digital twin platform calibrated	In progress	- 13/05/2024: We are awaiting the recovery of vehicle count data. - 11/06/2024: We have recovered the first count data and are in the process of analyzing them.
6	Integration of an accurate car fleet model	IFPEN, Ile de France	Algorithm	26/04/2024	Model of car fleet	Done	
7	Pollutant emission estimation integration add-on	IFPEN, Ile de France	Algorithm	31/05/2024	Model of pollutant emission	Done	

Figure 2: Example of the Excel file allowing to get the step status and more comments.

3.Supporting resources: Reference tools and guides

Various European projects and initiatives have implemented several innovative methods for capturing and sharing mobility data. This section presents the findings (outcome) from a systematic review of key projects, best practices, and tools focused on collecting and sharing mobility data to develop new services for users and public transport operators.

3.1. CIVITAS Initiative and the PORTIS project

Launched by the European Union, CIVITAS supports cities in implementing and testing innovative sustainable urban mobility solutions through several projects [1]. **CIVITAS PORTIS** [2]: Focused on improving collective and active transport by integrating different data sources for more efficient mobility services in port cities: Aberdeen, (UK), Antwerp (Belgium), Constanta (Romania), Klaipeda (Lithuania), and Trieste (Italy). This improvement was made possible by using intelligent transport systems and developing new data and IT solutions. These solutions have enabled the collection of real-time data from PT and traffic management systems. Three innovative data platforms

have been developed in the cities of Antwerp, Aberdeen, and Trieste [3]. This document summarizes the main challenges encountered and the solutions adopted by the cities in the framework of the implementation of their platform. Figure 3 presents a summary table of the smart data platforms and/or smart applications implemented.

Related UPPER mobility measures: ROM_05, VAL_07, and VAL_09

	ANTWERP	ABERDEEN	TRIESTE
Type of Smart Data Platform/ Smart Application	Website and route planner, marketed under the mobility brand 'Smart Ways to Antwerp', Available as app for smartphones (iOS/ Android)	Smart Journey Planner 'GoABZ', available as app for smartphones (iOS/ Android), but also as web app, ensuring that it is fully accessible	Transport Information platform 'Smart Trieste': Website, providing traffic information and information on urban development of old port area, including a related section for calls & projects and route planner, with specific apps: Tourist app & Parking app (iOS/Android)
Goal/ Contextual driver	Achieve a 50/50 Modal split in the Antwerp region, through informing & nudging of end users on sustainable mobility. Major infrastructure works need to ensure the accessibility of Antwerp city and port.	Specific objective: behaviour change. Strongly embedded in existing policies to foster active & more sustainable travel, which is a challenge as car-ownership in city and region is high.	Transform the Old Port of Trieste into a real urban area through a participatory and institutional process. This is the driver for the development of an approach for behaviour change, for which the route planner forms an important tool to support new sustainable mobility options implemented during PORTIS.
Features/ USP's	• Multimodality & intermodality: Pushing sustainable mobility through smart algorithms. 'Not push the fastest, but push the SMARTEST route', e.g. show walking options for distances < 2 km • Combining many mobility options in various ways • Information on road works and accidents, via a smart layer • Include both public and private transportation options; e.g. shared mobility providers • Smart map with points of interest, linked to mobility options	• Provide info on routing, options for travel and predictions on journey times by all modes • Include price-information for different mobility options • Include other traffic data such as journey times for all modes, car park guidance, variable message displays and air quality information • The Scottish roadworks data has been integrated into GoABZ too and points of interest and walking trails are being integrated-also helps with supporting business recovery in light of Covid-19.	• Information on road works made available to end- users by contractors • Information on the old port refurbishment project • Smart map with points of interest, linked to mobility options
Target groups	Residents & commuters	Residents & commuters	Mobility planners End users: Residents, Tourists
Innovative aspects	Cooperation & innovation/co-creation for, e.g., technological solutions through organised competition amongst providers: 'Marketplace for Mobility'	Co-creation process of the design & improve functionality of the app with end users (specific target-groups) to foster Inclusion, Useability and Acceptance	• Cooperation with internal stakeholders such as the mobility department and tourism office • Information of the tourist app will be prioritised/presented according to the specific needs of tourists (e.g. Points of Interest) • Road control management feature, with contractors being able to feed road works information into the transport information platform

Figure 3: Summary table of the smart data platforms and/or smart applications implemented by each city.

3.2. Best Practices for Public Transit Data Capture and Sharing

The rapid evolution of urban mobility requires public transport systems to be more efficient, reliable, and user-friendly. Achieving these goals heavily depends on the standardization of transport data and the seamless integration of real-time data. Standardization ensures that data is consistent, interoperable, and accessible across different platforms and services, while real-time data integration allows for dynamic updates and improved service management. Together, these elements are essential for enhancing public transport services' overall efficiency and quality.

Main key standards

The **General Transit Feed Specification (GTFS)** is an open standard developed by Google and designed to share essential information about transit systems with passengers [4]. It enables public transit agencies to release their data in a format that can be utilized by numerous software applications (Google Maps and Citymapper). Currently, the GTFS data format is widely adopted in various European cities to standardize PT schedule and route data. An extension of the GTFS standard, **GTFS Real-Time** allows transport agencies to share live data, including vehicle locations, service alerts, and estimated arrival times. This standard is essential for providing passengers with up-to-date information, enhancing the reliability and usability of public transport services.

The CEN (European Committee for Standardization) are established three technical standards for public transport information systems [5]:

- **Transmodel**, also known as the **European Standard EN 12896** is a comprehensive conceptual reference data model for public transport information systems. Transmodel provides a standardized framework for representing public transport operations' functional and informational aspects. It facilitates interoperability between different public transport systems, allowing for the seamless exchange of information across various platforms and services [6].
- The **Service Interface for Real-Time Information (SIRI)** is an XML-based protocol European standard designed to facilitate the exchange of real-time public transport information between operators and authorities. It supports various functions, including real-time journey planning, vehicle tracking, and incident management, making it a powerful tool for integrating data across different transport modes and operators [7].
- **NeTEx (Network Timetable Exchange)** is another XML-based protocol focusing on exchanging of scheduled public transport data. It is particularly well-suited for handling the complexities of European transport systems and is customizable to meet specific regional requirements. NeTEx covers a wide range of data, including timetables, routes, and fare information [8].

Tools

All these standards can be implemented using different tools such as:

- There is couple software available on the GTFS Resources web site [9]**.** For example, **IBI Data Tools** is web-based tool allows to create and edit GTFS feeds without needing advanced technical skills to *OpenTripPlanner*[1]. It simplifies the process of maintaining accurate and up-to-date transit data, making it easier for agencies to share their information in a standardized format [10]. **Gtfstools** provides a set of tools allowing to edit and analyze transit feeds in GTFS format in R [11].

[1] https://www.opentripplanner.org/

- **CHOUETTE** is an open-source software allowed to capture and exchange data in NeTEx and GTFS format through the Transmodel[2].

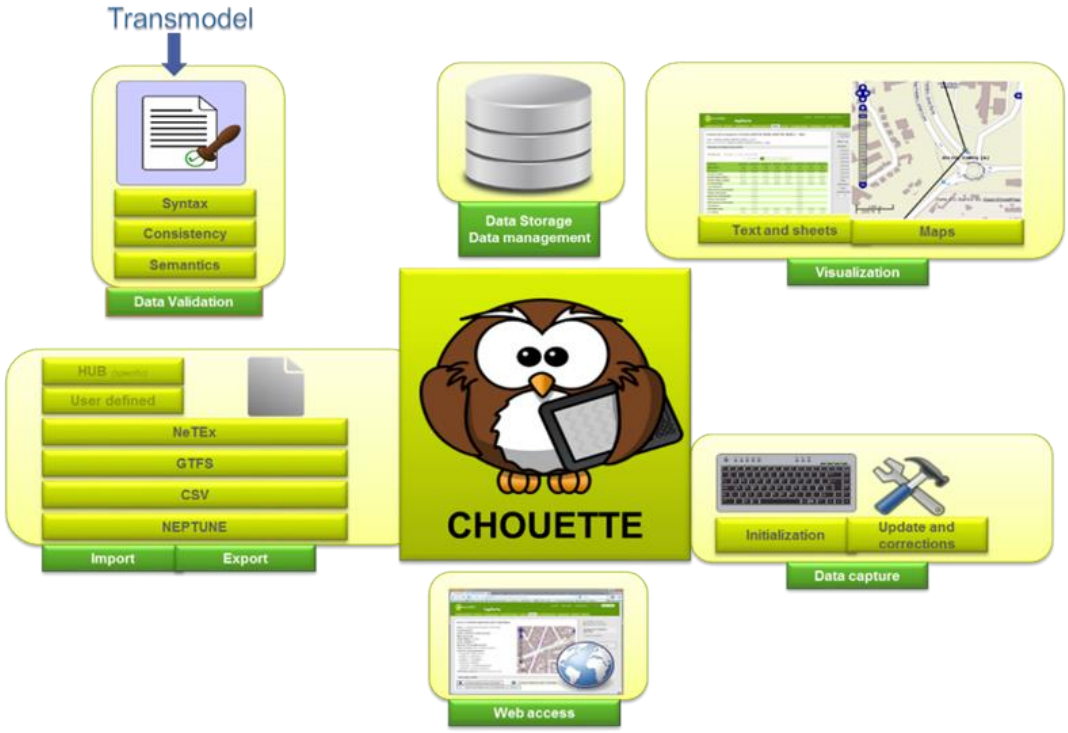


Figure 4: Main CHOUETTE functionalities, Source https://www.transmodel-cen.eu/chouette/

Example

There are several European cities that have leveraged GTFS to provide accurate and accessible public transit information, facilitating better service for residents and visitors alike.

- **Paris, France:** The public transit agency Régie Autonome des Transports Parisiens (RATP) and SNCF (French National Railways) provide GTFS data for the Paris metropolitan area's public transport, covering metro, buses, trams, and regional trains (RER)[3].
- **Berlin, Germany:** Berliner Verkehrsbetriebe (BVG), which operates public transportation in Berlin, offers GTFS data for the city's U-Bahn (subway), buses, trams, and ferries. This data supports a wide range of journey planning applications[4].

[2] https://github.com/afimb/chouette2

[3] https://prim.iledefrance-mobilites.fr/jeux-de-donnees/offre-horaires-tc-gtfs-idfm

[4] https://www.transit.land/operators/o-u33d-berlinerverkehrsbetriebe

- **Amsterdam, Netherlands:** Gemeentelijk Vervoerbedrijf (GVB), the public transport operator in Amsterdam, provides GTFS feeds that include data for trams, buses, metro, and ferries[5]. The data is utilized by multiple journey planning apps and services.
- **Madrid, Spain:** The Consorcio Regional de Transportes de Madrid (CRTM) offers GTFS data for Madrid's public transport system, covering buses, metro, and suburban trains[6]. This data is available for public use and supports various transit applications.

Related UPPER mobility measures: VAL_07 and VAL_09

3.3. Digital Twins for Urban Mobility

Digital Twins represent a significant advancement in urban mobility planning, offering a virtual replica of physical assets, systems, or processes. These digital models enable city planners, transport operators, and policymakers to simulate, monitor, and optimize urban mobility systems. Integrating Digital Twins into urban mobility planning has become increasingly essential for managing the complexities of modern cities, particularly in Europe, where cities strive to enhance sustainability, efficiency, and resilience [12].

Cities use various transportation simulation and 19ravelled tools to enhance their mobility planning efforts. These tools can be broadly categorized based on their licensing models:

- **Proprietary Software**: Some of the most widely used commercial platforms include **PTV Visum/Vissim**[7] and **Aimsun Next**[8]. These tools offer comprehensive features for traffic simulation, network travelled, and multimodal transportation analysis, making them popular choices among urban planners and traffic engineers.
- **Open-Source Software**: Free alternatives such as **MATSim**[9] and **SUMO**[10] provide cities with robust and flexible solutions for transportation simulation. These platforms are particularly valued for their adaptability and the active communities contributing to their ongoing development.

The use of open-source simulation platforms like MATSim, combined with the availability of open data, has facilitated the creation of transparent and reproducible simulation scenarios for regions such as Île-de-France [13] and Berlin [14]. The Île-de-France scenario, entirely built on open data, serves as a flexible model that can be adapted to other regions in France. The data used and the scenario generation steps are presented in Figure 5.

[5] https://www.transit.land/operators/o-u173-gvb

[6] https://datos.crtm.es/datasets/885399f83408473c8d815e40c5e702b7/about

[7] https://www.ptvgroup.com/en

[8] https://www.aimsun.com/editions/

[9] https://matsim.org/

[10] https://sumo.dlr.de/docs/index.html

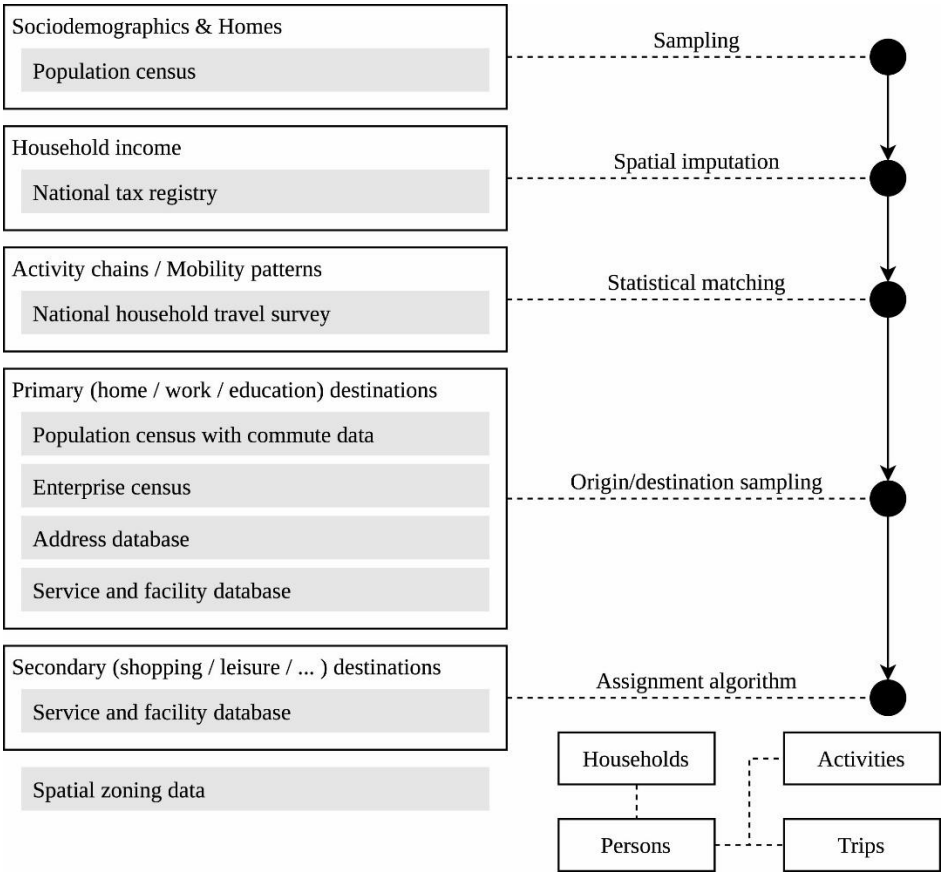


Figure 5: General setup and data of the synthesis pipeline, source [13]

Related UPPER mobility measures: IDF_02

3.4. Guides and Tools for Implementing Mobility Measures

This subsection presents two EU projects aiming to develop data-driven mobility solutions for more sustainable urban mobility: Mobility4EU Roadmap and MOVE21.

The Mobility4EU Roadmap is a strategic tool developed under the **Mobility4EU project,** which aims to guide European cities in creating a future-proof, user-centred, and data-driven mobility system[11]. The roadmap provides a comprehensive framework for integrating various mobility services, including public transport, by leveraging advanced technologies and data-sharing practices.

Related UPPER mobility measures: HAN_05, LEU_01, ROM_07, VAL_07 and VAL_09

[11] https://cordis.europa.eu/project/id/690732

MOVE21 is a project funded by the European Commission that aims to develop data-driven solutions for sustainable urban mobility, with a focus on integrating logistics and PT data. The cities involved are Oslo, Gothenburg, Hamburg, Munich, Rome, and Bologna [15].

To alleviate traffic and reduce emissions in the centre of Gothenburg, the city has implemented a mobility service that combines park-and-ride parking in outlying areas with the use of public transport, bikes, or other forms of micro-mobility to reach the urban centre [16]. Klippan, located 2 kilometres from Gothenburg's city centre, was chosen as the park-and-ride location. The Gothenburg Parking company explored expanding its mobile app (PGMA) to incorporate parking with public transport and micro-mobility services such as shared bikes and e-scooters. Initial efforts focused on evaluating the app's technical capabilities, drawing from the expertise of the Ruter team in Oslo, who are creating a new API (supporting the General Bikeshare Specification GBFS) to integrate micro-mobility services into MaaS applications. The analysis revealed that PGMA's current design couldn't fully accommodate free-floating transport services. As a result, an alternate solution was identified by integrating Styr & Ställ, a bike-sharing service with designated parking hubs. While displaying these parking areas in the PGMA was considered feasible, developing a more comprehensive MaaS integration within the existing app would require further investigation and was not achievable within the project's scope.

Related UPPER mobility measures: LEU_01

The table below provides a summary of the main resources identified that could help in the development of measures relating to T4.2. and WP4 in general.

Resources	Category	Main findings	Related Upper measures
PORTIS project [3].	ITS and data and IT solutions	- Experiences share - Three smart data platforms developed in the cities of Antwerp, Aberdeen and Trieste - Challenges/barriers encountered, and the solutions adopted	ROM_05, VAL_07, and VAL_09
GTFS [9], Transmodel [6], SIRI [7], NeTEx [8]	Data standardization	- Main standards to share PT data - Tools for editing PT data within different standards - Examples of PT operators sharing their data	VAL_07 and VAL_09
Open Ile-de-France MATSim scenario [13]	Simulations tools	- Main properly and opensource simulation platforms - Existence of an open and reproducible model in the Ile-de-France region and adaptable to VGP	IDF_02
Mobility4EU, MOVE21 [16]	Data-driven mobility solutions development	- roadmap providing a comprehensive framework for integrating various mobility services - Experience of the city of Gothenburg implemented a mobility service combining park-and-ride parking in peripheral areas with the use of public transport [16]	HAN_05, LEU_01, ROM_05, VAL_07, VAL_09, LEU_01

Table 2: Summary of the main resources identified that could help in the development of measures relating to T4.2.

4.Organization of workshops

4.1. Workshop 1: PT service: Exploiting data for better planning and operation in Rome

The workshop was held on January 31, 2024. The list of cities and measures relating to this workshop are presented in the screenshot below.

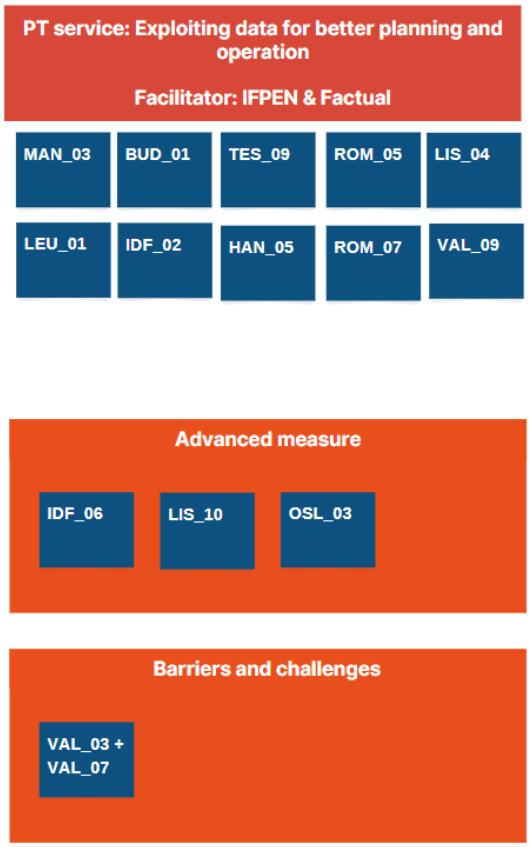


Figure 6: List of cities and measures relating to the workshop

It brought together representatives from 10 cities that have implemented mobility measures related to WP4 and, more precisely to the tasks T4.2 “New services for users and PT operators based on the existing mobility data collection and sharing” ((lead by IFPEN) and T4.3 Improved PT efficiency addressing the needs of targeted groups of users or situations” (lead by FACTUAL). The objective of this workshop was to discuss, on the one hand, the usefulness and importance of data in mobility planning. On the other hand, it dealt with improving PT services to meet the needs of specific groups or situations. For each sub-theme, cities and their partners presented well-matured and advanced measures and those encountering challenges and barriers.

The workshop structure consisted of a short presentation of the measures (5- 10 min) followed by an open discussion participated by all the attendees (10- 15 min). The moderator introduced the speakers, stimulated discussion, motivated attendees, and managed their intervention during the discussion. IFPEN and FACTUAL were in charge of moderating the workshop.

4.1.1. Results

Six measures were presented during the workshop by the cities and their partners: OSL_03, ROM_05, LIS_10, IDF_06, and VAL_03 and 07. Measures OSL_03, ROM_05, and LIS_10 were linked to the public transit services of task T4.3, while IDF_06, VAL_03 and VAL_07 focused to the use of the data in mobility planning (T4.2). This sub-section presents the results related to these measures.

- OSL_03 - Improved use and accessibility of public transport in conjunction with alternative mobility to reduce private car ownership

  This mobility measure was presented by the city of Oslo. The city of Oslo is a city with a generally high/decent public transportation utilization (30%). Through this measure, the city wants to increase the efficiency, reliability, and attractiveness of TC (buses). However, facing a dense and compact architecture, widening and building more bus lanes is very challenging. The city has, therefore, developed a new method based on the distribution function method with three hierarchical levels (city, area, and street).

  The main challenge is the closure of the central ring road, Ring Road 1, which could have unforeseen consequences on the bus lines that the city wants to improve. To address this, the city intends to focus on the effects and possible gains that this can have for the overall transport network. In addition, prioritization could generate friction between the different traffic groups. The function distribution method will show the potential to reduce friction between the other modes.

- ROM_05 - New LEV and ZEV bus fleet – network adaptation

  Rome faces high private car use (52%) with low frequency and quality of PT services. This measure aims to re-balance the modal share in favor of PT in Rome by taking the opportunity to procure Low-Emission Vehicle (LEV) and Zero-Emission Vehicle (ZEV) buses thanks to the RFF funds. The design and adaptation and integration of the new buses in the PT network will be an important part of this measure. Around 200 electric vehicles with suitable stations are expected.

- LIS_10 - PT service, data for better planning and operation

  This mobility measure was presented by Transportes Metropolitanos de Lisbona (TML). This measure is one of the most advanced and mature measures. The presentation focused on new ticketing products for large-scale events such as WYD. For this event, specific tickets were produced considering a certain period of days, WYD volunteers, and intermodality with other TP services...

  The main challenges encountered were managing the very high number of participants (around 1 million) and the high risk. The solutions and actions taken focused on ticketing design, including simulations to define different types of days and pricing. In addition, each operator was responsible for adapting its Ticketing systems. Finally, a revenue distribution mechanism was set up for all operators–

- IDF_06 - Advanced technology to optimize the PT offer in line with users' needs

This mobility measure aims of setting a **Mobility Observatory** by developing a dashboard to inform and provide support for cities in the knowledge and identification of possible actions to take on city planning and mobility for Versailles Grand Parc (VGP). RedLab presented the development progress of this measure. This is also a most advanced measure. This observatory includes mobility, air quality, and traffic conditions and three levels of observation: real time, playback, long term analysis.

The main challenges encountered during the development of the measure concerned the building of a **robust and replicable solution and access and collect relevant data for decision-making.** To deal with the first challenge, the developers adapted generic data models. They undertook the development of the open-source platform. For data collection, a collaboration with all partners and stakeholders is needed to ensure a large panel of data and the use of generated (dummies) data while waiting for the actual data. Moreover, during the discussion phase, it was suggested that the backup of the data collected from the different providers must be considered–

- VAL_03 - To optimise PT offer based on advanced technology //– VAL_07 - To provide the citizens with clear and accessible information before and during the trip

  These mobility measures were presented by EMT. These measures face many barriers and challenges. Barriers can be summarized as follows:

  1. Privatization of a public good and “data”,
  2. Lack of governance of the data,
  3. Lack of transparency and vision from the administrations.

  Challenges concerned the need for more refinement, many errors in the collected data, and the need for entities to cooperate to improve data governance.

  This presentation generated many comments during the discussion phase. Indeed, many cities mentioned the difficulty of sharing data in public administration. It is essential to work on data standardization by integrating all mobility stakeholders, the OEM, operators, etc. We need to create internal development and collaboration initiatives to integrate public data. Actions to raise awareness of the opening and governance of public data have been carried out for politicians by colleagues from the Polytechnic School of Valencia who work with the municipality. The European Union and some NGOs, such as Green City are, also pushing for all climate and environmental data to be put on the portal and for every company and anyone who wants to access it to be able to download it.

4.1.2. Conclusions

The workshop highlighted six mobility measures across various cities, focusing on enhancing public transport (PT) services and optimizing data usage in mobility planning. The measures from Oslo (OSL_03), Rome (ROM_05), and Lisbon (LIS_10) centred on improving public transit efficiency, reliability, and accessibility. Oslo faced challenges related to urban density and road closures, while Rome aimed to shift the modal share towards PT by integrating Low-Emission and Zero-Emission Vehicles into its bus fleet. Lisbon's approach revolved around advanced ticketing solutions for large-scale events, managing high participant volumes through innovative pricing and distribution mechanisms.

On the other hand, measures from Versailles Grand Parc (IDF_06) and Valencia (VAL_03/07) focused on leveraging advanced technologies for better PT planning and providing accessible information to citizens. IDF_06 emphasized

the creation of a Mobility Observatory, integrating real-time and long-term data analysis to support decision-making. Valencia's measures faced significant barriers, such as data governance issues and the need for enhanced collaboration among stakeholders.

The discussions underscored the importance of data standardization and governance in public administration, with a strong push from various entities, including the European Union, for open and transparent data sharing.

4.2. Workshop 2: WP4 Workshop Data-driven mobility planning

EMTA decided to organize the workshop to help cities refine their UPPER measures and improve their UPPER plans. The objectives of the workshop were to address the specific needs and questions of cities and regions that are implementing UPPER measures in the area of data-driven mobility planning. It should be noticed that the results described in this section refer to the measures developed not only on T4.2, but also on T4.3 and T4.5.

The workshop followed a consistent structure, similar to other workshops in WP3 and WP5. This consistency allowed participants to feel comfortable and familiar with the process by challenging and enhancing their initial concepts and by providing extra support for the difficult parts of their measures. The workshop offered tailored recommendations and shared best practices from the perspective of horizontal partners, ensuring that cities have access to expert guidance. In breakout sessions, city representatives had the opportunity to ask clarification or support where needed, while horizontal partners could offer additional recommendations and insights to help improve the measures. The workshop also created a space for participants to identify common points of attention and barriers that cities frequently encounter. Through collective reflections success factors were created contributing to a unified approach, setting the stage for WP8 activities. The insights gained in the workshop will be essential in drafting guidelines that resonate with and are applicable to cities across Europe. The insights sought to contribute to the lasting impact of UPPER by providing insights that can be transferred and applied across different regions, ensuring the broader relevance and sustainability of the initiative.

4.2.1. Recommendations per measures

The following presents recommendations as identified during the workshops and measure review process in preparation of the workshop as follows: Firstly, an excerpt from the substantial list of specific points of attention that were provided to all or specific Mobility Planning measures is provided as indication of the feedback provided to cities. Secondly a list of high-level recommendations is provided that is relevant to all cities in UPPER and any following city that intends to build on the UPPER measures in the future.

Excerpt from specific points of attention raised during the workshop process

For the city of Leuven, several key points of attention have been identified to enhance the effectiveness of their mobility initiatives.

- Capture all trip stages, including cycling and walking, especially when combined with public transport, to get a complete view of travel patterns.
- Include feedback on the entire multimodal experience, not just public transport, to improve overall journey satisfaction.

- Ensure data collection is inclusive and represents all population segments. Prioritize privacy and data protection in data collection, storage, and analysis.
- Test user responses to new incentive tools and collect data on walking from public transport hubs to final destinations for comprehensive insights.

For Valencia the following points of attentions have been identified:

- Ensure that digital services are accessible to people with visual impairments, the elderly, and those without smartphones. Provide real-time information in formats that all users can access, and address language barriers in public transport announcements and messages.
- Focus on making platforms and apps user-friendly and accessible. Implement user testing and feedback integration to optimize the usability and effectiveness of these tools.
- Explore how real-time public transport data can be integrated with broader urban planning strategies, such as improving pedestrian infrastructure and promoting cycling.
- Design the API to connect with various communication channels (e.g., screens, apps, websites). Ensure that information provided to passengers is up-to-date, reliable, and consistent across all channels.
- Be cautious with facial recognition technology due to potential privacy risks. Ensure data transfer is encrypted and cybersecurity measures are in place to prevent data breaches.
- Instead of displaying real-time CO2 data on buses, which may cause anxiety among passengers, focus on general public information about efforts to improve air quality and inform drivers on actions they can take.

In the case of Île-de- France:

- Modelling CO2 and other emissions will be a significant strength of the tool. However, it's crucial to make the right technical choices, as using overly simplistic models could lead to misleading results. For example, basic models might inaccurately suggest that lower speed limits lead to higher emissions, which is not reflective of urban traffic dynamics. To ensure the tool's effectiveness and acceptance in Île-de-France, it must accurately capture how various policy decisions impact emissions. Demonstrating that the tool can respond correctly to these decisions is essential for its successful adoption and integration.

In the context of Rome, several important considerations need to be addressed:

- Firstly, it's crucial to determine how real-time information will be communicated to end users. Effective communication channels are essential to ensure that users receive timely and relevant updates about public transport.
- Secondly, while a real-time digital twin and forecasting engine may not be top priorities for public transport operators, they offer significant potential. However, turning the vast amounts of data into actionable information requires substantial effort. Instead of simply creating a data lake, this is an opportunity to adopt the concept of European data spaces, which emphasizes distributed storage, data sovereignty, and security. Additionally, there is a need for compelling examples demonstrating how these tools can increase public transport ridership and enhance user satisfaction. These use cases are vital and should form the basis for developing effective smart city tools.

For Hannover, the following points of attention are crucial:

- Identify whether the tool is intended primarily for the administration or if it also targets citizens. If citizens are included, develop strategies to engage them effectively.
- Define how the Hannover administration will utilize the tool for improving its operations and decision-making.
- Provide comprehensive training and ensure tutorials are always available and easily accessible for all users.
- Manage the seamless integration of data from various providers and ensure timely data uploads by contributors. Consider incentives to encourage prompt submissions.
- Address the high costs of IT development for integrating multiple data sources, while exploring the use of existing standard components to minimize expenses.
- Verify that data on walking is accurately collected and incorporated into the tool to offer a complete view of mobility.

4.2.2. High-level recommendations

This should be the output of the workshops, while the previous point (recommendations per measures) focuses on the work carried out by the horizontal partners prior to the workshop.

The workshop highlighted several key points of attention that the city will address to improve its public transportation system.

Cities recognized the importance of making public transport accessible to everyone, regardless of their financial situation or technological access. To address this, cities must ensure that the cost of transportation, the need for digital tools, credit cards, or smartphones, do not become barriers for individuals. They will explore alternative payment methods and non-digital options to make transportation more inclusive.

Additionally, cities must apply a gender lens to the data collected, ensuring that the needs and experiences of all genders are considered to enhance public transportation services. There will be a stronger focus on understanding users' needs and mobility behaviours, which will guide the planning of more user-friendly transportation services.

When replanning routes, cities must actively involve pedestrians, cyclists, and local organizations representing walkers and persons with disabilities. Their input will be essential in creating a transportation network that meets the needs of all users. Citizen engagement will also be extended to those who are not digital users, ensuring their voices are heard in the planning process.

Cities acknowledged the challenges of ensuring that data collected through surveys, questionnaires, and focus groups is representative and of high quality. To address this, Cities will develop methods to enhance the representativeness of data, ensuring it reflects the diverse population. User engagement and feedback will be central to this process, with special attention given to understanding user characteristics during data collection.

The integration of this data into public transportation tools will be prioritized to improve service planning and delivery. Moreover, the city will implement strict measures to protect data privacy, ensuring that all collected data is securely stored and used responsibly.

Cities must implement discount periods and rewards as incentives to encourage more people to use public transportation. Understanding the target audiences will be crucial in tailoring communication strategies to effectively promote these incentives. A mechanism will be established to analyse how users respond to these rewards, allowing for continuous improvement.

Engaging new users, particularly those not already commuting sustainably, will be a key focus. Cities must create outreach programs to attract these users, ensuring that the messaging resonates with their needs and encourages a shift towards public transportation.

For cities like Valencia, Thessaloniki, Oslo, and Mannheim, where DRT services are planned, accessibility will be a priority. Recognizing that automation can exclude vulnerable users who may not have smartphones or credit cards, the city will ensure that both digital and traditional reservation systems coexist. This dual approach will make DRT services accessible to a broader range of users.

Before modelling routes and on-demand transport services, cities will analyse users' characteristics, needs, mobility behaviours, and perceptions of public transportation. This analysis will help in designing services that are truly responsive to the needs of the community. A coherent communication plan will be developed to reach the intended target audiences effectively.

Cities must further develop strategies to address environmental impacts, focusing on reducing CO2 emissions, energy use, and improving air quality. Additionally, more thought will be given to rewarding sustainable commuters, encouraging more people to choose eco-friendly transportation options. Further input will be sought to design public transportation systems that align with environmental goals, ensuring that the city's transportation network contributes positively to the environment.

By addressing these points of attention, the city aims to create a more inclusive, responsive, and sustainable public transportation system that meets the needs of all its residents.

5. Measures preparation process

5.1. Valencia

5.1.1. VAL_07: To provide the citizens with clear and accessible information before and during the trip

5.1.1.1. Description of the measure and main outcomes expected

This measure will develop a real-time information service for public transport, providing updates on factors that impact performance and travel time (traffic, road works, events, accidents, etc.). A platform will be created to deliver this information to transport operators, enabling them to manage the service and take corrective actions when necessary (route adjustments, frequency changes, etc.). Additionally, real-time performance information will be provided to public transport users through screens, apps, and other channels to enhance transparency and build trust in the service.

5.1.1.2. Preparation of the measure

Definition of the use cases

Comprehensive monitoring tool for bus operator (EMT)	
ID	VAL07_UC01
Description	The bus operator (EMT) observes delays in buses circulating along one of the main avenues of the city. Through the U-TWIN tool, the operator is able to visualize in a single interface real-time information related to bus operations (location, delays, occupancy...), as well as information unrelated to bus operations but with a direct impact on them (traffic situation, including the level of service of the roads, alerts and events, such as accidents, road closures, road works...). Based on the available information, the operator detects that the delays are due to an abnormally high traffic situation on that avenue, caused by a traffic accident. The bus operator quickly identifies the problem and activates a series of mitigation strategies (re-routes its buses and notifies the driver of the reason so that he/she can inform passengers).

Accurate and updated information before and during the trip for PT users	
ID	VAL07_UC02
Description	A user approaches a bus stop. He is not very used to using public transport, so he is grateful that the information offered at the bus stop is complete, useful, clear and up to date. Moreover, it is Fallas festivity time, so he understands that some buses may have altered their routes or could be delayed due to the large crowds typical of these days. He waits at the stop, but it has been 15 minutes since the information panel indicated the next bus would arrive in 2 minutes, leaving him uncertain about the remaining wait time. The user desires clear and transparent information regarding any diversions, incidents, or delays that could impact his choice of transportation. Finally, the bus arrives. When getting on the bus, he knows the name of the stop where he has to get off, but he is not familiar with Valencia and does not know how long it will take to get there. He would like to receive information during the journey about where he is on the route, if there is a deviation in the route or if the bus is going to skip a stop, as well as the time he has left to get to his stop.

Requirements definition

During the first stages of the measure preparation, a Serious Game was conducted in the framework of the UPPER project to identify the specific needs and requirements, in terms of information provision, of elderly people or users with disabilities (visually impaired, hearing impaired…). The following requirements were identified:

- Information provided before the journey should include upcoming buses and incidents, alerts, or abnormal situations such as diversions or temporary changes in routes or stops.
- Information should be provided through various means (at the stop's screens, through the app, on the website, etc.)

- The information should be provided in various formats (both visual and audio to ensure it reaches all users).
- The use of the app to provide updated information is ok, but not as exclusive means, as older people (or any user with low digital skills) are not accustomed to its use.
- Regarding onboard information during the journey, it needs to be provided both, visually and acoustically (ensuring that it is heard correctly).
- The information provided during the trip should be easy to understand. One option is to add details that users may be familiar with (adding references to well-known monuments or buildings as a complement to the stop's name itself).
- Include a button at stop to receive "on-demand" information about upcoming buses through audio (complementing the visual information provided through the screens).
- Include a speaker to provide real-time incident alerts (currently just notified through the APP).

Analysis of the data sources available in the city and data collection

Close collaboration has been established between ETRA and the multiple entities to identify the relevant data sources.

Company Name: **EMT** Type of vehicle: **Bus**
Static info: GTFS GTFS or API URL: https://www.transit.land/feeds/f-ezp8-emtvalencia https://opendata.vlci.valencia.es/dataset/ab058cf8-ad3e-4d9c-ac89-0c6367ecf351/resource/c81b69e6-c082-44dc-acc6-66fc417b4e66/download/google_transit.zip Authentication needed: NO Type of authentication (if so): - Credentials (if so): -
Dynamic info: GTFS-RT generated from EMT API with estimated arrival times (not standardized yet). Once GTFS-RT is available (potentially during 2025), it will be integrated API URL: https://apipre.emtvalencia.es/transportes/v1/sae/estimacion (EMT private web service) Update window time: (in seconds or minutes): 1 second Data format received: (JSON, GeoJSON, …): GeoJSON Data schema (example):

```
{
   "data": [
      {
         "disponible": true,
         "bus": {
            "adaptado": false,
            "numBus": 2202,
            "retraso": 0,
            "distancia": 724
         },
         "desviado": false,
         "itinerario": {
            "codigo": "2",
            "destino": "Cntr.Històric",
            "nombre": "Est.del Nord - Blanqueria",
            "ruta": {
               "codigo": "C1",
               "nombre": "CENTRE HISTÒRIC"
            },
            "nombreCorto": "C1"
         },
         "programado": false,
         "tiempos": {
            "minutos": 3.85836155590587,
            "segundos": 231,
            "fecha": "2024-05-17T12:03:20",
            "salidaViaje": "2024-05-17T11:49:00"
         }
      },
      {
         "disponible": false,
         "bus": null,
         "desviado": false,
         "itinerario": {
            "codigo": "3",
            "destino": "Natzaret",
            "nombre": "Porta de la Mar - Natzaret",
            "ruta": {
               "codigo": "4",
               "nombre": "NATZARET - PL. AJUNTAMENT"
            },
            "nombreCorto": "4"
         },
         "programado": true,
         "tiempos": {
            "minutos": 0,
            "segundos": 0,
            "fecha": "0001-01-01T00:00:00",
            "salidaViaje": "0001-01-01T00:00:00"
         }
      }
   ]
}
```


Company Name: **ATMV (PTA)**
Type of vehicle: **Peri urban bus**

Static info: GTFS
GTFS or API URL: https://nap.transportes.gob.es/Files/Detail/1325
Authentication needed: YES
Type of authentication (if so): - user/password (registration needed in the *mitma* webpage)
Credentials (if so): -

Dynamic info: Not yet available. GTFS-RT potentially available during 2025.
API URL: -
Update window time: (in seconds or minutes): -
Data format received: (JSON, GeoJSON, …): -
Data schema (example): -

Company Name: **FGV** Type of vehicle: **Metro / Tram**
Static info: GTFS GTFS or API URL: https://nap.transportes.gob.es/Files/Detail/967 https://transitfeeds.com/p/ferrocarriles-de-la-generalidad-valenciana/1039 Authentication needed: YES Type of authentication (if so): - user/password (registration needed in the *mitma* webpage) Credentials (if so): -
Dynamic info: Webservice. Once GTFS-RT is available (potentially during 2025), it will be integrated. API URL: - Update window time: (in seconds or minutes): - Data format received: (JSON, GeoJSON, …): - Data schema (example): -
Company Name: **Valenbisi** Type of vehicle: **Bike Sharing**
Static info: Lat-long & capacity of stations and total number of bikes GBFS or API URL: https://api.citybik.es/v2/networks/valenbisi https://valencia.opendatasoft.com/explore/embed/dataset/valenbisi-disponibilitat-valenbisi-dsiponibilidad/table/ Authentication needed: NO Type of authentication (if so): - Credentials (if so): -
Dynamic info: Availability and status of bikes API URL: https://api.citybik.es/v2/networks/valenbisi https://valencia.opendatasoft.com/explore/embed/dataset/valenbisi-disponibilitat-valenbisi-dsiponibilidad/table/ Update window time: (in seconds or minutes): 8-15 minutes Data format received: (JSON, GeoJSON, …): GeoJSON Data schema:

```typescript
interface License {
  name: string;
  url: string;
}

interface Location {
  city: string;
  country: string;
  latitude: number;
  longitude: number;
}

interface Extra {
  address: string;
  banking: boolean;
  bonus: boolean;
  has_ebikes: boolean;
  last_update: string; // Should be a valid date-time string
  slots: number;
  status: string;
  uid: number;
}

interface Station {
  empty_slots: number;
  extra: Extra;
  free_bikes: number;
  id: string;
  latitude: number;
  longitude: number;
  name: string;
  timestamp: string; // Should be a valid date-time string
}

interface JsonResponse {
  company: string[];
  href: string;
  id: string;
  license: License;
  location: Location;
  name: string;
  source: string;
  stations: Station[];
}
```

Company Name: **TomTom**
Type of vehicle: **Private vehicle**

Dynamic info:
API URL:

- Traffic incidents:
  Request schema:
  https://{baseURL}/traffic/services/{versionNumber}/incidentDetails?key={Your_Api_Key}&bbox={bbox}&fields={fields}&language={language}&t={t}&categoryFilter={categoryFilter}&timeValidityFilter={timeValidityFilter}
- Traffic flow:
  Request schema:
  https://{baseURL}/traffic/services/{versionNumber}/flowSegmentData/{style}/{zoom}/{format}?key={Your_API_Key}&point={point}&unit={unit}&thickness={thickness}&openLr={boolean}&jsonp={jsonp}

These url schemas allow, using HTTP POST request methods, to fetch information about the traffic flow and the traffic incidents. The information comes from TomTom provider, and is documented how to use each of the necessary variables here (https://developer.tomtom.com/traffic-api/documentation/traffic-incidents/incident-details) for the incidents and here for the traffic flow (https://developer.tomtom.com/traffic-api/documentation/traffic-flow/vector-flow-tiles)

Update window time: (in seconds or minutes): Real-time on demand
Data format received: (JSON, GeoJSON, …): JSON
Data schema:

- Traffic incidents:

```
{
  incidents{
    type,
    geometry{
      type,
      coordinates
    },
    properties{
      id,
      iconCategory,
      magnitudeOfDelay,
      events{
        description,
        code,
        iconCategory
      },
      startTime,
      endTime,
      from,
      to,
      length,
      delay,
      roadNumbers,
      timeValidity,
      probabilityOfOccurrence,
      numberOfReports,
      lastReportTime
      tmc{
        countryCode,
        tableNumber,
        tableVersion,
        direction,
        points{
          location,
          offset
        }
      }
    }
  }
}
```

- Traffic flow:


```
{
  "flowSegmentData": {
    "-xmlns": "http://lbs.tomtom.com/services",
    "-version": "traffic-service 2.0.004",
    "frc": "FRC2",
    "currentSpeed": 41,
    "freeFlowSpeed": 70,
    "currentTravelTime": 153,
    "freeFlowTravelTime": 90,
    "confidence": 0.59,
    "roadClosure": true,
    "coordinates": {
      "coordinate": [
        {
          "latitude": 52.40476,
          "longitude": 4.844318
        },
        {
          "latitude": 52.411312,
          "longitude": 4.8299975
        },
        {
          "latitude": 52.415073,
          "longitude": 4.827327
        }
      ]
    }
  }
}
```


Table 3 List of the data sources available in the city and data collection

Integration into U-TWIN of the standardized data sources linked to the bus operation and external factors affecting the bus operation

By the submission of this report, the tool is being implemented in Valencia city in order to monitor the transport network.

5.1.1.3. Challenges & Mitigations

The availability of real-time data is the main challenge faced in this measure. GTFS-RT is not available for all the transport options. However, transport operators have within their roadmaps the provision of GTFS-RT in the short-medium term (potentially during 2025).

5.1.1.4. Next steps towards implementation

The following steps to prepare the implementation of this measure involve developing the API to connect U-TWIN with the EMT third systems (potentially in the digital displays that will be installed in the near future in the new PT stops) to provide citizens with real-time information on the bus service and potential disruptions and delays. Moreover, EMT staff will be trained on how to use and manage the system.

Additionally, as anticipated, real-time data is not available (yet) for some transport modes. Thus, a specific development will be done to generate such GTFS-RT from EMT API with estimated arrival times. This development is expected to be finalized by September 2024. However, once the operators are able to provide GTFS-RT, this will be directly integrated.

5.1.2. VAL_09: Improving the efficiency of the bus service and comfort of PT users

5.1.2.1. Description of the measure and main outcomes expected

This measure aims to introduce a system that allows for accurate passenger counting within buses and tracks boarding and disembarking stops for each passenger, facilitating the calculation of transport Origin/Destination matrices. The measure involves developing and deploying an advanced camera-based passenger counting system with artificial intelligence on buses. The objectives of this measure include providing real-time bus occupancy data to EMT for responsive service adjustments and to third-party applications to enhance the overall passenger experience. Furthermore, the system will analyse patterns of passenger entry and exit to enhance the precision of detailed origin-destination matrices.

5.1.2.2. Preparation of the measure

Definition of technical requirements and architecture

The solution developed should be capable of accurately counting passengers inside a vehicle and identifying boarding and disembarking stops to complement the transport Origin/Destination matrices.

Figure 7: Overview of bus where the system will be installed.

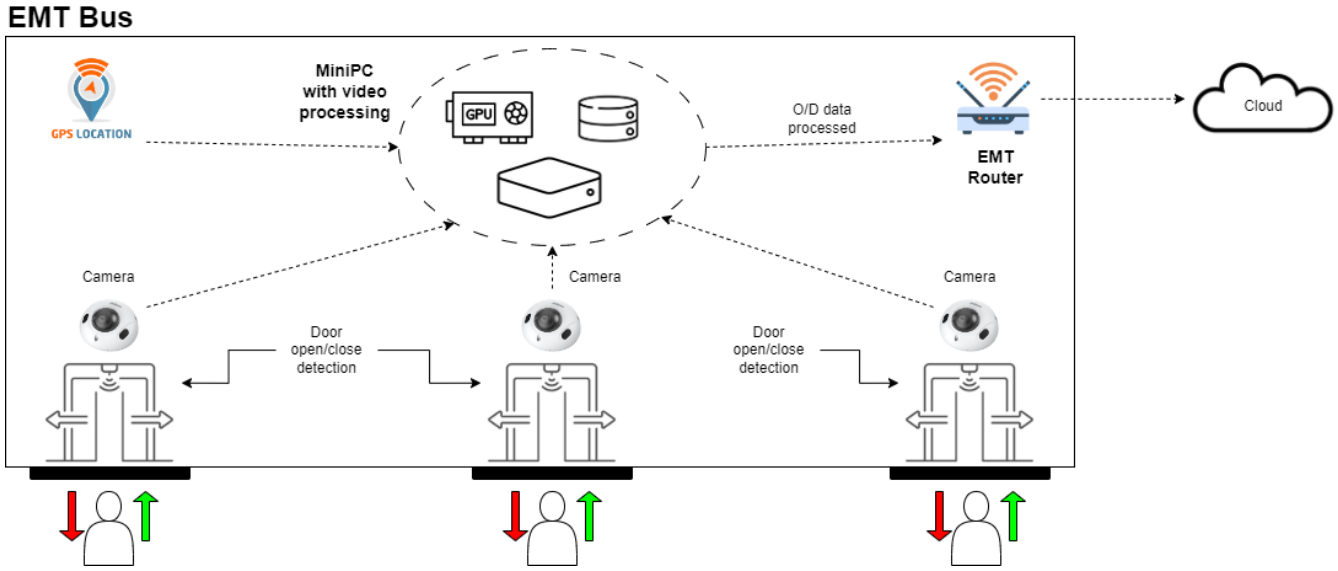


Figure 8: System Architecture Overview

Technically, the system requires installation of cameras and processing units on the vehicle. The system shall be composed of a camera for every boarding and disembarking gate of the vehicle and a processing unit.

These cameras will track identified individuals to re-identify them and detect when they exit the vehicle, thereby subtracting them from the total passenger count. Identification will not rely on facial recognition but on techniques to extract individual characteristics. The identification of the users will be carried out in the system itself by means of the hardware component designed for this function.

In addition to image recognition, the system will detect the bus location to link boarding and disembarking actions at specific stops, enabling accurate formation of Origin/Destination matrices. This linkage will utilize location data obtained from the bus itself or an integrated GPS device within the system.

Alternatively, this linking of identification/stop can be achieved through the unequivocal detection of the vehicle and the mounted system, by cross-referencing detections with the timestamps used in identification.

The specific requirements established for the solution are listed below.

ID	Technical Requirements	Category
VAL09_TR01	The system should use high-resolution cameras capable of capturing clear images in various lighting conditions, including low light and nighttime	Hardware
VAL09_TR02	The system should use robust and weather-resistant cameras designed to withstand the vibrations and environmental conditions inside a bus	Hardware
VAL09_TR03	The system must incorporate a processing unit capable of running AI algorithms locally to reduce latency and bandwidth usage	Performance
VAL09_TR04	The system must have sufficient processing power to handle real-time image analysis and counting tasks	Performance

VAL09_TR05	The system must have reliable connectivity options (e.g., 4G/5G, Wi-Fi) for transmitting data to central servers or cloud platforms	Performance
VAL09_TR06	The AI algorithms used must have high accuracy in detecting and counting passengers, even in crowded conditions	Performance
VAL09_TR07	The system must have a secure and efficient storage of counting data	Performance
VAL09_TR08	The system must ensure that no personally identifiable information is captured or stored by the system	Security
VAL09_TR09	The system must adherence to relevant data protection regulations, such as GDPR	Security
VAL09_TR10	The system should use secure and vibration-resistant mounting solutions for cameras and processing units	Security
VAL09_TR11	The system must have reliable power supply options, possibly integrated with the vehicle's electrical system	Performance
VAL09_TR12	The system should be designed to be easily scalable to accommodate new routes	Performance
VAL09_TR13	The cameras should allow to use Power over Ethernet (PoE) technology to eliminate the need for separate power supplies	Performance

Table 4: The specific requirements established for the solution

The mounted hardware system shall initially consist of:

- EDGECO
  - 1 Jetson Orin NX 16GB VRAM

  - 1 SD 128GB

- GPS receptor module

- DH-IPC-HDBW1430DE-SW
  - One camera connected to the EDGECO system for each of the vehicle's up and down doors.

Software development for AI-based passenger counting

To ensure a proper achievement of the measure VAL_09, an AI expert system has been developed, with the aim of being able to obtain a source-destination matrix in real time of all passengers that have used the current bus.

The system is composed by the following components:

- Line Drawer: In charge of defining the line in each of the bus doors to properly detect insertions and deletions of passengers.
- Persons Detector: In charge of detecting all persons in the bus using a neural network, assign an identifier to each detected person, with an own tracking algorithm, use the obtained id of each person to properly decide in which direction is crossing the line and discard the ones that are not in a crossing mode.
- Embedding Extractor: In charge of extract a representation of each person that has crossed the line in a 1D vector shape using another convolutional neural network.
- Manager: In charge of getting extracted embeddings and using another neural network based on re-identification to detect which persons have left the bus in each bus stop and send these results to the cloud in a source-destination matrix format (Format is pending to be defined in the future)

The software is ready to be able to accept disconnections in the hardware since it is always writing the results in the disk.

Finally, to be able to upload results in the cloud the system is connected to a MQTT queue which is receiving them and being read by another process to manage the results.

Software testing and validation

To test and enhance the accuracy of the recognition system, a preliminary pilot was conducted within ETRA's offices. The selected location for this pilot was a corridor and distribution area with dimensions (length and width) and pedestrian flow similar to that of a bus. This initial phase enabled fine-tuning of the detection system before progressing to the next stage – pilot test directly on a bus.

5.1.2.3. Challenges & Mitigations

No challenges were identified, the measure preparation went according to the plan.

5.1.2.4. Next steps towards implementation

The next steps towards implementation include:

- Software testing and validation: ETRA will conduct a technical visit to the EMT bus depot to prepare for deploying the solution on buses. Prior to the technical visit, both entities will sign an NDA. Initially, the solution will undergo testing on a single bus to assess detection accuracy in a real-world scenario. Any necessary adjustments to the algorithm will be made to enhance accuracy.
- Purchase of equipment: Following successful testing and validation, ETRA will proceed to purchase the necessary equipment for outfitting the remaining buses. Permits for installing the equipment on buses will be secured well in advance.

5.2. Rome

5.2.1. ROM_07: Use of advanced technology to increase the efficiency and reliability of PT

5.2.1.1. Description of the measure and main outcomes expected

The main objective of the measure is to implement new features in the Mobility Management Centre (MMC) of Rome (managed by RSM).

The renewed MMC will support the whole metropolitan area of Rome to unify, manage and take advantage of the information coming from all the actors involved in mobility and from the different ITS systems in the territory, to provide:

- Management and Monitoring: Near real-time reconstruction of the mobility of the Metropolitan City of Rome
- Regulation and control: Real time information to guide traffic for example in case of unexpected events.
- Forecasting: Using Artificial Intelligence and Machine Learning technologies to make short-term traffic forecast estimates
- Infomobility: Information to users on the current and projected status of mobility.

The upgrade of the MMC will provide mobility and TP operators with services for operators and citizens thanks to a platform that integrates:

- The devices for vehicles' detection installed in the territory.
- A Data Lake for information exchange processes.
- A fully integrated technology platform: GPS systems, digital sensors, cameras, wi-fi hot spots, internet of things, big data and data processing software.

In parallel two UPPER tools (U-SIM.live and U-TWIN) will be tested to evaluate a possible added value for the MMC or for the Operative Control Centre owned by PT operators.

5.2.1.2. Preparation of the measure

As first step "a state of the art of the different existing ITS systems on the territory" has been carried out: it is substantially an assessment of all ITS systems owned by RSM in order to list them and describe their functionality and requirements. For each system (so called Functional Area) the sources have been identified and functional requirements have been investigated. Among functional requirements we can read data requirements, data quality, Business analytics requirements, the historicization depth and data update frequency.

The investigated Functional Areas are the following ones:

1. Limited Traffic Zones (LTZ) and Infringement Process
2. Variable Message Signs
3. Traffic Lights systems and sensors
4. Accidents
5. Traffic Planning
6. Maps
7. Local Public Transport
8. Passenger Counts
9. Pedestrian Mobility
10. Floating Car Data
11. Car Sharing
12. Local Management Decisions
13. Permits
14. Maintenance

15. Taxi Call System
16. Event Reporting from Local Police
17. Traffic Monitoring via videocameras

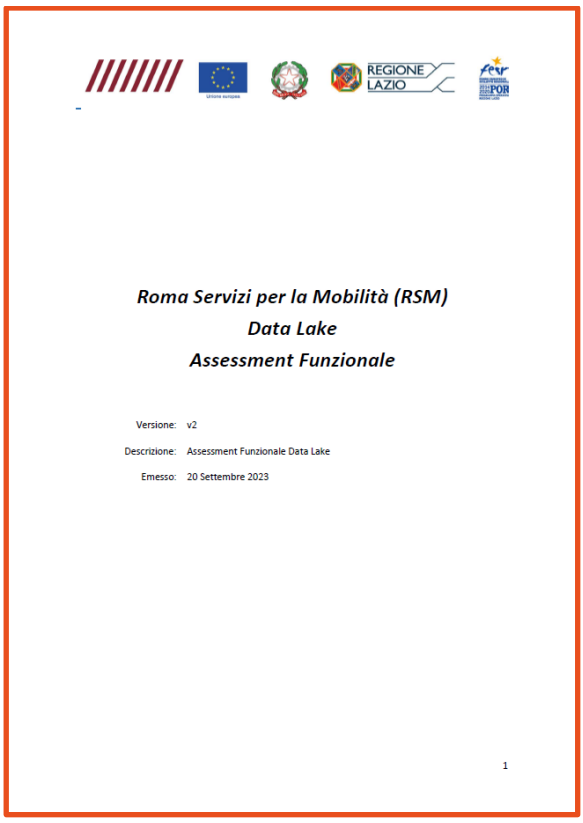


Figure 9: Cover of the Functional Assessment of RSM Data Lake in Italian language

The relative document has been completed in Italian language.

The second step is the “Design of the new data lake system on which the new Central Mobility will be based”. RSM with the support of Almaviva Company has substantially developed a first system level.

The ingestion process of several systems has been completed.

Data are available for the following systems:

1. Limited Traffic Zones (LTZ) and Infringement Process
2. Variable Message Signs
3. Traffic Lights systems and sensors
4. Local Public Transport
5. Car Sharing
6. Bike Sharing

7. Electric scooters Sharing
8. Local Management Decisions
9. Maintenance (system diagnostics)
10. Event Reporting from Local Police
11. Traffic Monitoring via videocameras

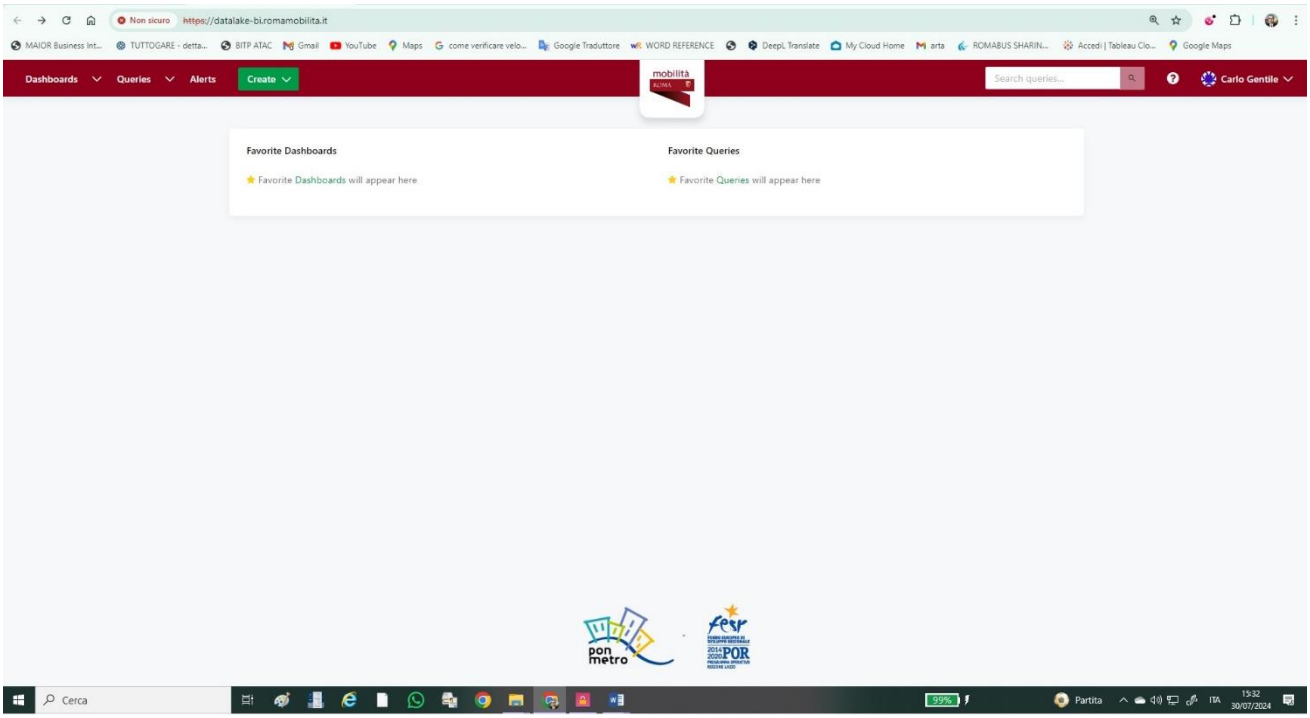


Figure 10: Data Lake Home Page (Restricted Access)

The Analytics section of the RSM Data Lake is accessible in a restricted way and shows Dashboard, Queries and Alerts.

At present it is only possible to create new dashboard and queries with SQL programming.

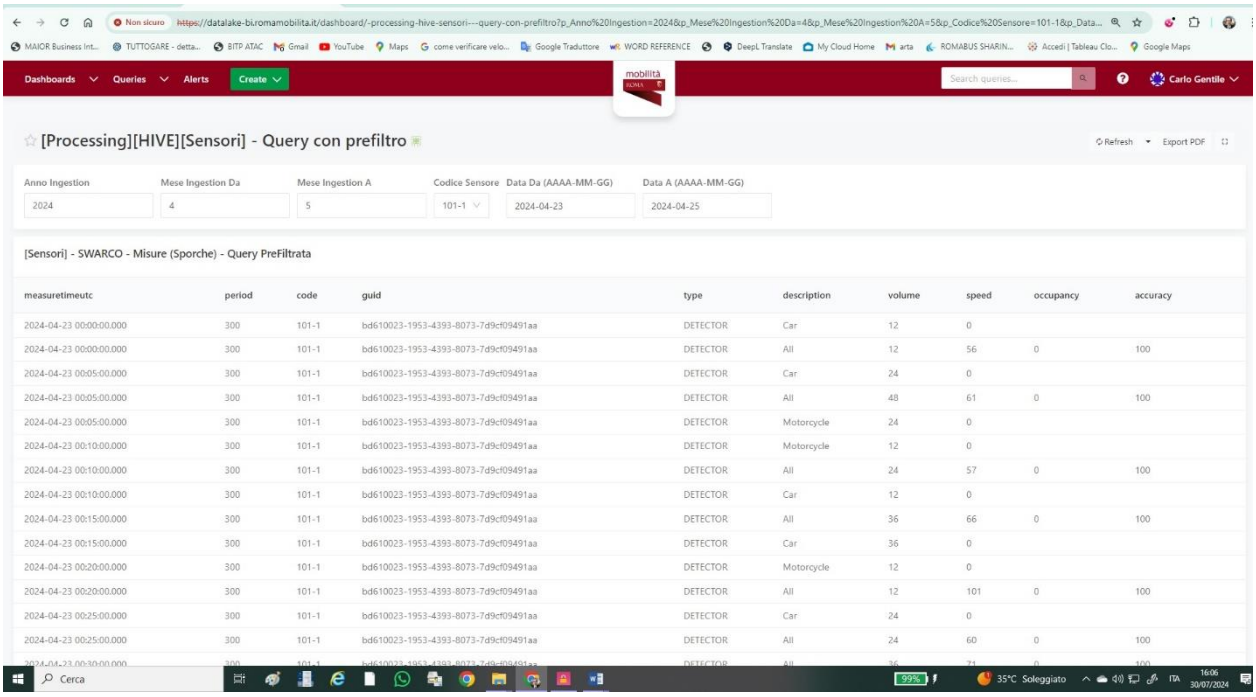


Figure 11: Traffic sensors dashboard

In Figure 11 an example of dashboard is shown: traffic data coming from video cameras are available in terms of volume, speed, occupancy and accuracy.

At this phase a data quality process has been undertaken in particular for the data coming from electronic gates of LTZ and traffic sensors. In the ingestion process to the data lake some process recorded a redundancy in terms of data duplication. For this reason, a data cleaning process is ongoing.

Moreover, further activities have to be carried out to switch the MMC from a trial phase to production phase. In particular a series of added functions has to be implemented for the full management of Variable Message Signs, the integration of further subsystems (cycle paths monitoring, Passenger counter system on board public transport vehicles, Passenger counting system at the turnstiles of the Rome urban subways) and the fine tuning of traffic light and VMS system diagnostics.

In the meantime, a new centre sub-system for the control of electronic gates has been implemented (SRI 4.0) and a new ingestion process has to be carried out to integrate it in the datalake.

The deadline of December 2024 for this step is still valid.

The third step is started (Development of the traffic management software). First of all, RSM has decided to purchase FDC data via a tender: an internal investigation and the drafting of the specifications is ongoing.

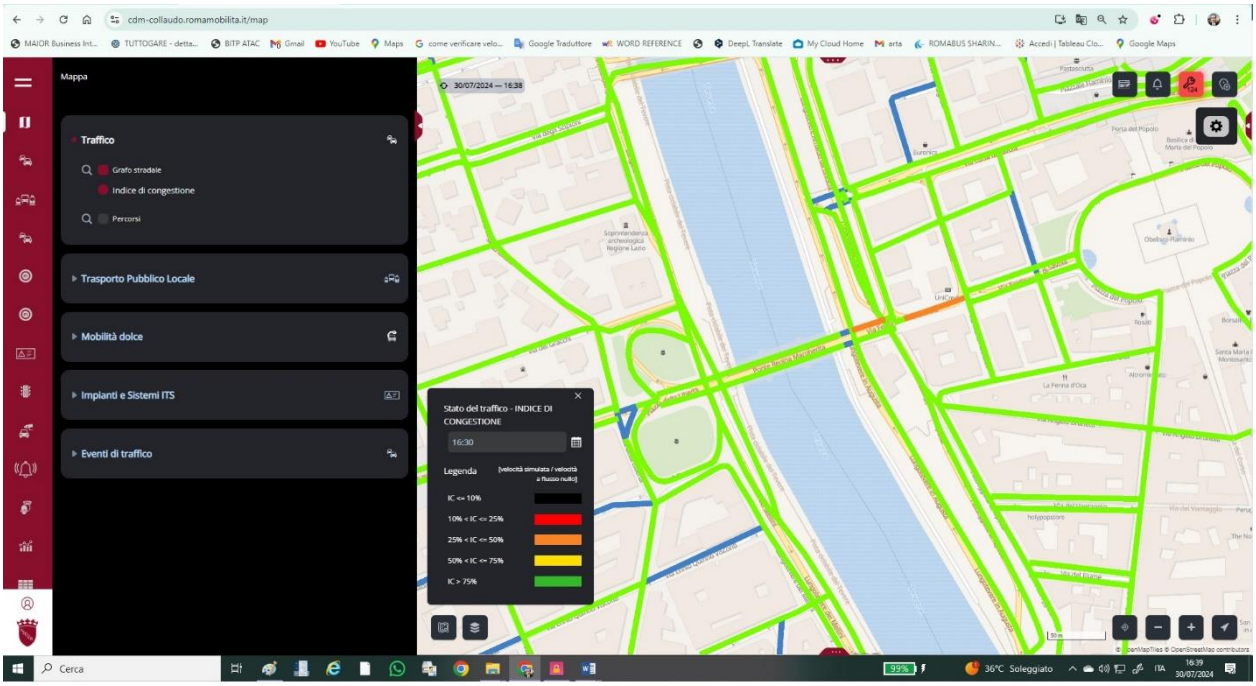


Figure 12: Real time traffic bulleting on RSM C&CR App (preview)

A specific software to provide real time traffic bulleting as in Figure 12 has been acquired. It is “Optima” software provided from PTV partner.

PTV Optima traffic management software connects to sensor data, including public transport. It helps operators identify the best scenarios to manage congestion, road closures and construction, and accurately simulate the resulting network performance.

In the Rome case this software will process data coming from FCD and traffic sensors. The result of a graph with congestion indexes will be shown on a Rome map as in Figure 12. The map will be inserted into the Command and Control Room application (C&CR app) that will be used directly by the operators of the Mobility Centre. We are currently working on a test version before bringing it to production.

As regards step 4 “Creation of the new MMC” RSM is testing a draft version of the software C&CR. Some updates are necessary before implementing it in a complete version. Only MMS operators will use this application both on their PCs and on Control Room Videowall.

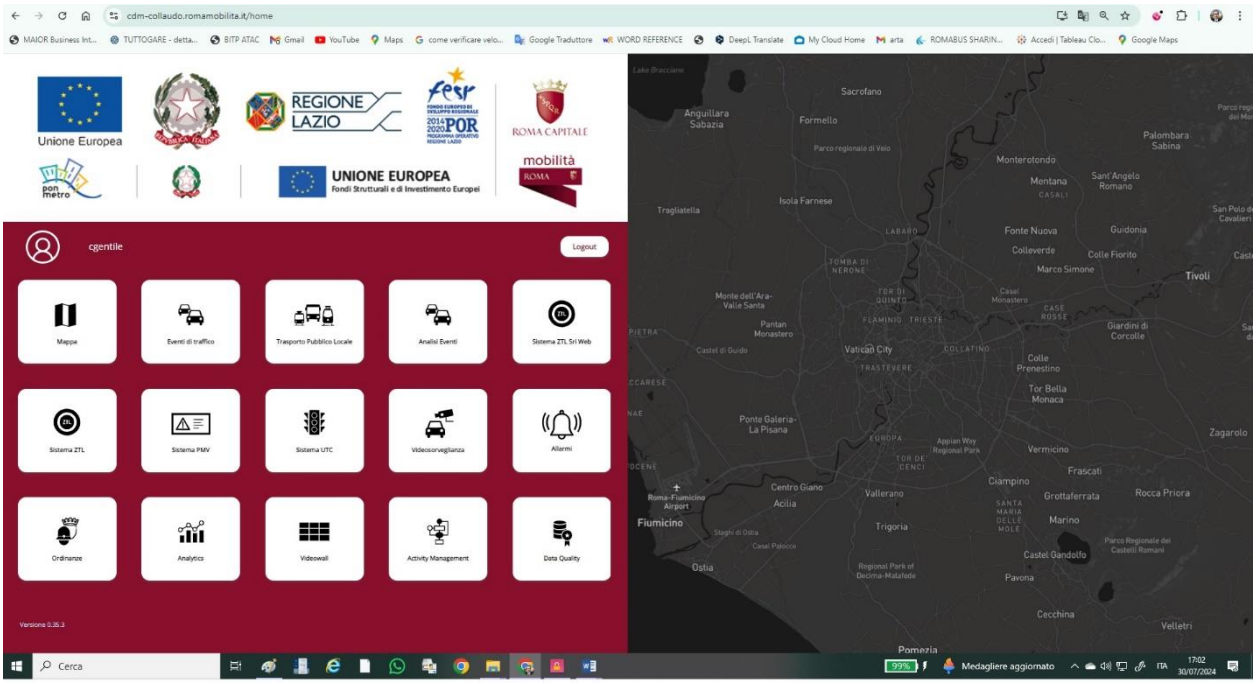


Figure 13: C&CR homepage (Restricted application)

5.2.1.3. Challenges & Mitigations

No challenges were identified, the measure preparation went according to the plan.

5.2.1.4. Next steps towards implementation

The step 5 (To enhance traffic forecasting and the management of near-real time information) will be influenced from the results of step 3. The Optima Software allows to provide traffic forecasting: PTV Optima software predicts future traffic conditions. Its approach combines machine learning and transportation models to effectively cover both planned and unplanned events. Get system up and running in less than an hour or deploy advanced features for the most complex use cases.

As concerns the step 6 (Develop and test the integration of traffic information for user in the Maas) and step 7 (Testing of the system) the activities has to start once the previous step will be ended. RSM has already completed a text for the Maas implementation in Rome and the Local Authorities are waiting for directives from the National Government to start in a broad way.

5.3. Versailles Grand Park– Île de France

5.3.1. IDF_02: Setting-up of a dynamic Digital Twin of the territory

5.3.1.1. Description of the measure and main outcomes expected

To better understand its transport system and evaluate future mobility scenarios in its territory, VGP wishes to acquire a modelling and simulation tool (digital twin) on the scale of its geographical area. Versailles Grand Parc – Île de France measure 02 consists of setting up a multi-agent simulation platform (MATSim) for journey' on the scale of VGP's territory. The tool will make it possible to observe mobility in the territory more precisely by simulating the chains of activities and trips of individuals and to provide estimations on specific non-measurable indicators such as pollutant emissions. Moreover, this tool will allow the design and assessment of new mobility policies, such as low-emission zones.

5.3.1.2. Preparation of the measure

Selection of appropriate digital twin

The first step during the preparation phase of measure 02 consisted of describing the objective and scope of the digital twin with VGP's partners. This phase was necessary to identify VGP's real needs and expectations regarding the simulation platform to be set up. In terms of functionalities, the digital twin should allow:

- To simulate as faithfully as possible the journeys of individuals on the scale of the VGP territory in terms of choice of transportation mode, origin/destination (O/D), and routes.
- To produce non-measurable indicators such as pollutant emissions.
- To evaluate the mobility policies already implemented and those to come such as the low-emission zones (LEZ).

After this step, the multi-agent simulation software MATSim was selected as the most appropriate digital twin. MATSim is an open activity-and-agent-based multimodal transportation simulation framework[12]. Agents in MATSim are utility maximisers. Each agent seeks to maximize its utility by performing all planned daily activities like work, education, leisure, or shopping, minimizing unproductive travel time by choosing appropriate travel modes, routes, and departure times. MATSim is suitable for large-scale simulations. There are MATSIM models for Berlin, Switzerland, and the Ile de France region.

Moreover, IFPEN has substantial experience and expertise using MATSim through various studies with the Greater Paris and Lyon Metropolises.

Data collection and processing

Different data sources have been collected and processed to generate the inputs necessary to carry out the MATSim simulations. Table 5 summarizes the primary data sources, including the production areas available in France, relative to their usefulness for simulating individual trips.

[12] https://matsim.org/

Field	Source	Provider	Usefulness
Travel	Household travel survey (EMD, EGT)	Local authorities, IDFM	Transport demand
	Census survey	INSEE[13]	
	Service and facility census (BPE)	INSEE[14]	Activity location
	Buildings database (BD TOPO)	IGN[15]	
	OpenStreetMap (OSM)	Geofabrik[16]	
Road network	OSM	Geofabrik[17]	Transport supply
PT network	GTFS	IDF mobilités[18]	

Table 5: Main sources of data on transport demand and supply in France.

Travel demand is typically derived from a synthetic population. This synthetic population is defined as a set of agents with attributes such as place of residence, age, gender, socio-professional category, and possession of transport cards/equipment. Travel demand groups the activities and trips performed by agents. It includes elements such as activity types and their location, activity start and end times, and travel mode. Finally, the above data is combined via the open-source EQASIM[19] to generate MATSim transport demand and supply.

Calibration

A first calibration phase of the tool was carried out to reproduce the current situation of individual mobility at the territorial level. This calibration phase was performed using travel survey data by considering the number of trips, modal shares, and distribution of travel distances and durations.

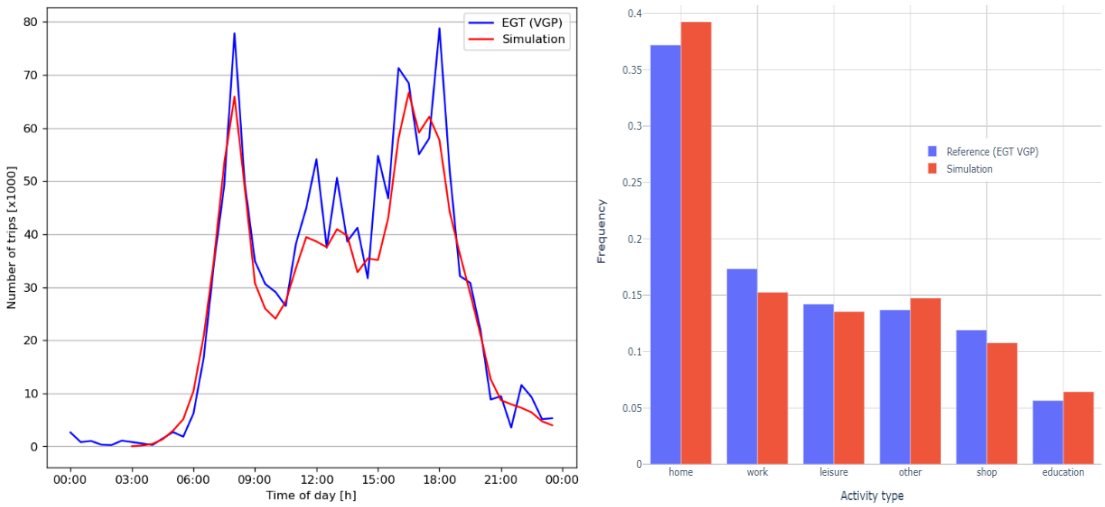


Figure 14: Comparison of departure time distributions and shares of activity types at ends of trips

[13] https://www.insee.fr/fr/information/8183122
[14] https://www.insee.fr/fr/statistiques/3568638
[15] https://geoservices.ign.fr/bdtopo
[16] https://download.geofabrik.de/europe/france/ile-de-france.html
[17] https://download.geofabrik.de/europe/france/ile-de-france.html
[18] https://prim.iledefrance-mobilites.fr/fr/jeux-de-donnees/offre-horaires-tc-gtfs-idfm
[19] https://github.com/eqasim-org/ile-de-france

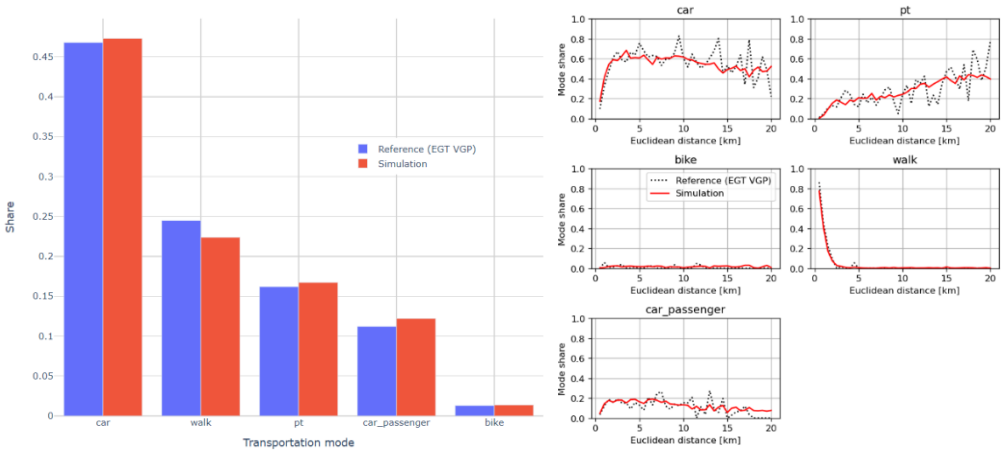


Figure 15: Comparison of global modal shares and according to the distance.

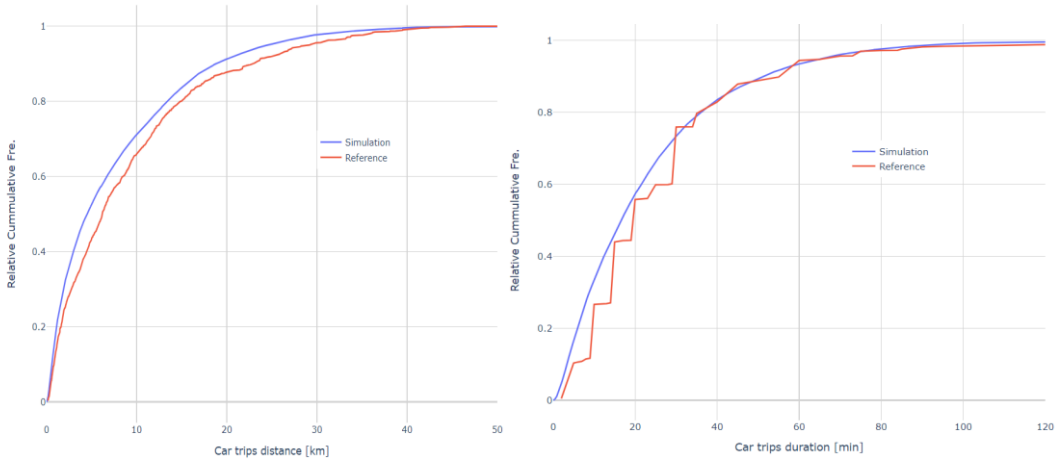


Figure 16: Comparison of beeline distance and duration of trips performed by car.

The simulation produced results that were very similar to those of the survey. The departure time distributions for simulation and survey have almost the same flow dynamics distributed between the morning, midday, and afternoon peak hours (left of Figure 14). The share of activity types at trip destinations is reproduced succinctly (right of Figure 14). Figure 15 provides the simulated mode shares after completing the mode choice calibration. The overall modal shares are on the left, while those according to the distance are on the figure's right. The simulation tends to slightly overestimate the use of the car on short distances, which results in a decrease in walking on these distances. Finally, distances and travel times match very well (Figure 16).

Emissions assessment

An emissions calculation module based on HBEFA factors[20] was integrated into MATSim to estimate CO2, PM, and NOx emissions within the VGP territory. These emissions come from all travel within the territory, both for residents and other users. However, it is essential to emphasize that these estimates do not consider logistics (freights) flows and other service traffic (e.g., craftspeople, mobile nursing service). Table 6 gives an overview of total emissions.

[20] https://www.hbefa.net/

Emissions	Unit	Total
CO2	Tones/day	796
NOx	Tones/day	1.66
PM	Kg/day	39.32

Table 6 Emissions from the digital twin

5.3.1.3. Challenges & Mitigations

One of the main difficulties encountered during the preparation phase of this measure concerned the availability of counted traffic and air pollution data on the VGP territory. Traffic counting data will come from video surveillance cameras. The change in the counting solution at VGP partly explains this absence of data availability. A new service provider has been identified, and the data should be available soon. In addition, atmospheric pollutant sensors will be installed next to specific cameras to obtain an estimate of the actual emissions from road traffic in this neighbourhood.

5.3.1.4. Next steps towards implementation

A second calibration/validation step will use dynamic counting data from cameras and atmospheric pollutant sensors. The VGP side is currently acquiring this data. This step will allow us to refine the quality of the simulation results, particularly on traffic dynamics and pollutant emissions.

5.4. Leuven

5.4.1. LEU_01: To exploit the existing mobility data to enhance the evolution of public transport policies

5.4.1.1. Description of the measure and main outcomes expected

This measure consists of research into the current use of public transport in Leuven, in particular in combination with peripheral parking lots and mobility hubs, based on existing data sources and newly collected data. The goal is to gather information on social patterns, obstacles and opportunities, to identify target groups and more detailed strategies to enhance the use of public transport, and to use in depth-analysis to study the potential impact of these strategies. Next to building on existing datasets on public transport use and satisfaction surveys, new qualitative data will be collected using surveys and a general participatory approach. Moreover, improvements in data-handling, management, reporting and visualization will be made, as well as more in-depth analyses and simulation. This measure will deliver a large-scale survey (1600 participants), additional PT user surveys, onboarding of additional data-sources in the city data warehouse, dashboarding for key mobility/PT indicators and an in-depth analysis of PT user satisfaction and perception, PT user typology and modal shift scenarios.

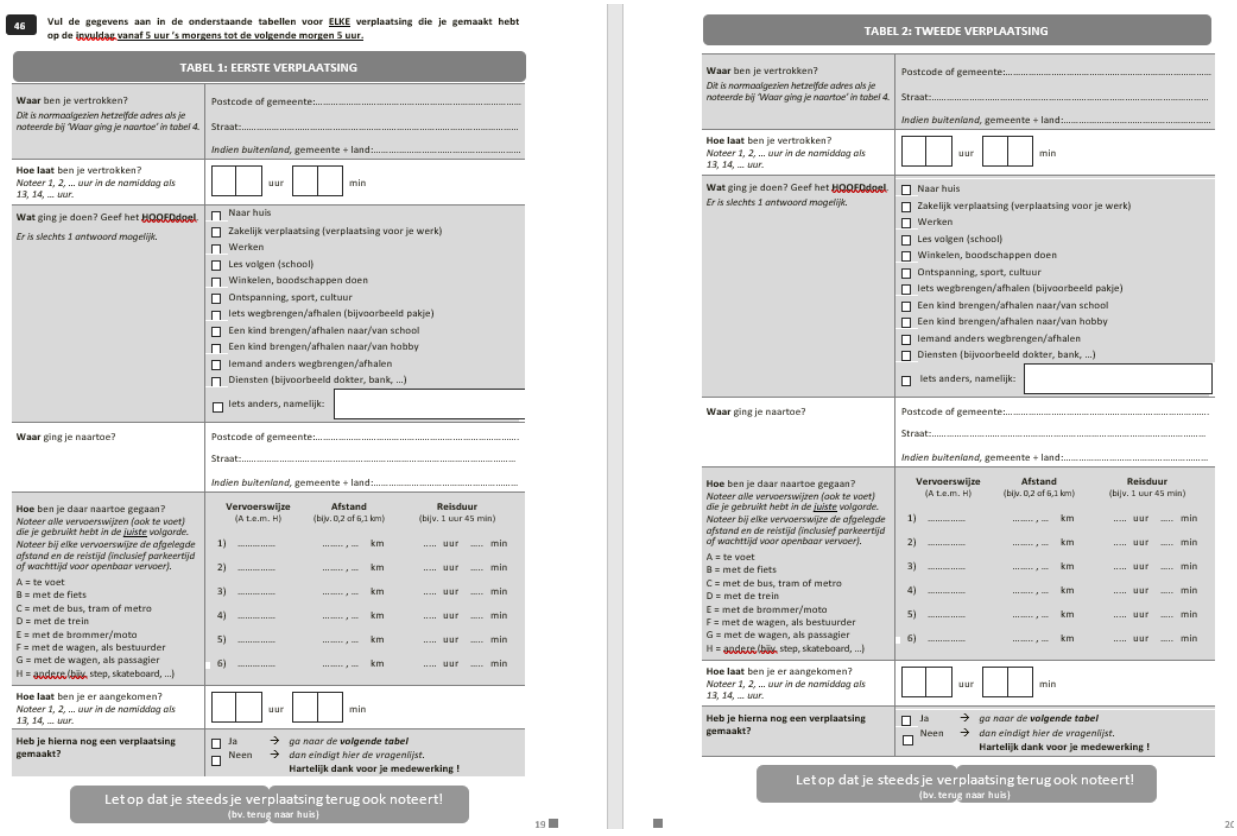
5.4.1.2. Preparation of the measure

A large-scale survey of travel behaviour of residents of the city has been prepared: a call for an external research partner was launched through a tendering process. A partner, MAS Research, was selected and the allocation of the tender has been approved by the city council. The content of the questionnaire has been drafted.

The survey is conducted among a representative sample of the Leuven population aged 10 years and over with the following characteristics:

- 1,600 respondents, proportional by gender, age category, neighbourhood, origin, household size
- allows representative statements to be made at the level of boroughs Leuven, Kessel-Lo, Heverlee and Wilsele/Wijgmaal
- both elderly people and people of non-Belgian origin should - according to their share in the population - also be sufficiently represented in the net (realised) sample

The survey contains a general questionnaire of 30 to 40 questions and a travel diary, following the model of the Onderzoek Verplaatsingsgedrag Vlaanderen[21]. In the travel diary, the respondent records all his/her displacements during one reference day. The survey can be completed online as well as on paper.



46 Vul de gegevens aan in de onderstaande tabellen voor ELKE verplaatsing die je gemaakt hebt op de invuldag vanaf 5 uur 's morgens tot de volgende morgen 5 uur.

TABEL 1: EERSTE VERPLAATSING

Waar ben je vertrokken? — Dit is normaalgezien hetzelfde adres als je noteerde bij 'Waar ging je naartoe' in tabel 4. — Postcode of gemeente:… Straat:… Indien buitenland, gemeente + land:…

Hoe laat ben je vertrokken? Noteer 1, 2, … uur in de namiddag als 13, 14, … uur. — uur min

Wat ging je doen? Geef het HOOFDdoel. Er is slechts 1 antwoord mogelijk.
- Naar huis
- Zakelijk verplaatsing (verplaatsing voor je werk)
- Werken
- Les volgen (school)
- Winkelen, boodschappen doen
- Ontspanning, sport, cultuur
- Iets wegbrengen/afhalen (bijvoorbeeld pakje)
- Een kind brengen/afhalen naar/van school
- Een kind brengen/afhalen naar/van hobby
- Iemand anders wegbrengen/afhalen
- Diensten (bijvoorbeeld dokter, bank, …)
- Iets anders, namelijk:

Waar ging je naartoe? — Postcode of gemeente:… Straat:… Indien buitenland, gemeente + land:…

Hoe ben je daar naartoe gegaan? Noteer alle vervoerswijzen (ook te voet) die je gebruikt hebt in de juiste volgorde. Noteer bij elke vervoerswijze de afgelegde afstand en de reistijd (inclusief parkeertijd of wachttijd voor openbaar vervoer).

	Vervoerswijze (A t.e.m. H)	Afstand (bijv. 0,2 of 6,1 km)	Reisduur (bijv. 1 uur 45 min)
1)	…..	….. , … km	…. uur …. min
2)	…..	….. , … km	…. uur …. min
3)	…..	….. , … km	…. uur …. min
4)	…..	….. , … km	…. uur …. min
5)	…..	….. , … km	…. uur …. min
6)	…..	….. , … km	…. uur …. min

A = te voet
B = met de fiets
C = met de bus, tram of metro
D = met de trein
E = met de brommer/moto
F = met de wagen, als bestuurder
G = met de wagen, als passagier
H = andere (bijv. step, skateboard, …)

Hoe laat ben je er aangekomen? Noteer 1, 2, … uur in de namiddag als 13, 14, … uur. — uur min

Heb je hierna nog een verplaatsing gemaakt?
- Ja → ga naar de volgende tabel
- Neen → dan eindigt hier de vragenlijst.

Hartelijk dank voor je medewerking !

Let op dat je steeds je verplaatsing terug ook noteert! (bv. terug naar huis)

19

TABEL 2: TWEEDE VERPLAATSING

Waar ben je vertrokken? — Dit is normaalgezien hetzelfde adres als je noteerde bij 'Waar ging je naartoe' in tabel 4. — Postcode of gemeente:… Straat:… Indien buitenland, gemeente + land:…

Hoe laat ben je vertrokken? Noteer 1, 2, … uur in de namiddag als 13, 14, … uur. — uur min

Wat ging je doen? Geef het HOOFDdoel. Er is slechts 1 antwoord mogelijk.
- Naar huis
- Zakelijk verplaatsing (verplaatsing voor je werk)
- Werken
- Les volgen (school)
- Winkelen, boodschappen doen
- Ontspanning, sport, cultuur
- Iets wegbrengen/afhalen (bijvoorbeeld pakje)
- Een kind brengen/afhalen naar/van school
- Een kind brengen/afhalen naar/van hobby
- Iemand anders wegbrengen/afhalen
- Diensten (bijvoorbeeld dokter, bank, …)
- Iets anders, namelijk:

Waar ging je naartoe? — Postcode of gemeente:… Straat:… Indien buitenland, gemeente + land:…

Hoe ben je daar naartoe gegaan? Noteer alle vervoerswijzen (ook te voet) die je gebruikt hebt in de juiste volgorde. Noteer bij elke vervoerswijze de afgelegde afstand en de reistijd (inclusief parkeertijd of wachttijd voor openbaar vervoer).

	Vervoerswijze (A t.e.m. H)	Afstand (bijv. 0,2 of 6,1 km)	Reisduur (bijv. 1 uur 45 min)
1)	…..	….. , … km	…. uur …. min
2)	…..	….. , … km	…. uur …. min
3)	…..	….. , … km	…. uur …. min
4)	…..	….. , … km	…. uur …. min
5)	…..	….. , … km	…. uur …. min
6)	…..	….. , … km	…. uur …. min

A = te voet
B = met de fiets
C = met de bus, tram of metro
D = met de trein
E = met de brommer/moto
F = met de wagen, als bestuurder
G = met de wagen, als passagier
H = andere (bijv. step, skateboard, …)

Hoe laat ben je er aangekomen? Noteer 1, 2, … uur in de namiddag als 13, 14, … uur. — uur min

Heb je hierna nog een verplaatsing gemaakt?
- Ja → ga naar de volgende tabel
- Neen → dan eindigt hier de vragenlijst.

Hartelijk dank voor je medewerking !

Let op dat je steeds je verplaatsing terug ook noteert! (bv. terug naar huis)

20

Figure 17: Extract from the travel diary accompanying the survey

[21] https://www.vlaanderen.be/mobiliteit-en-openbare-werken/onderzoekverplaatsingsgedrag-vlaanderen-ovg

Additionally, the city is currently conducting four distinct street surveys at various key locations in the city to gather input on travel behaviour and user satisfaction from visitors of the city centre. Over a two-week period, job students are surveying bus service users, users of peripheral car parks, users of city centre car parks, and visitors to the city centre at various key locations. The target is to collect at least 600 responses. Details of the survey content can be found in the table below. An analysis and conclusions are expected by the end of August.

Survey	Questions
Bus service	• How satisfied are you with De Lijn's public transport in Leuven? • Why did you come by bus? How important are the following factors in the decision to come to Leuven by bus (price/ proximity of final destination/ comfort/ length of time total journey)? • How often do you use a De Lijn bus? • What is the main purpose of your ride? • How satisfied are you with the information about your bus journeys? • Where do you look for information about getting around in and around Leuven by bus? • Is there any information you are missing? If so, which?
Peripheral parkings	• How satisfied are you with parking in Leuven in general? • You opted for a peripheral car park. Why did you choose this car park? How important are the following factors in the decision to park here (ease of access/ price/ proximity to final destination/ comfort parking/ length of time total traveled)? • How often do you use this car park? • What is the main purpose of your trip? • How did you find this car park? • Where is the final destination of your trip? • How do you get from the car park to your destination? • Do you know how to take the free bus to Leuven city centre? • How did you locate the car park? • How satisfied are you with the signage to the car park? • Where do you look for information to get around in and around Leuven? • Is there any information you are missing? If so, which?
City centre parkings	• How satisfied are you with parking in Leuven in general? • You chose a city centre car park. Why did you choose this car park? How important are the following factors in the decision to park here (ease of access/ price/ proximity to final destination/ comfort parking/ length of time total travelled)? • How often do you us e this car park?

	• What is the main purpose of your trip? • How did you find this car park? • Where is the final destination of your trip? • How do you get from the car park to your destination? How did you locate the car park? • How satisfied are you with the signage to the car park? • When would you consider a car park outside the city centre with a bus service? • Where do you look for information to get around in and around Leuven? • Is there any information you are missing? If so, which?
City centre visitors	• How satisfied are you with Leuven's accessibility in general? • What is the main purpose of your visit to Leuven? • How did you get to the city centre? Where do you look for information to get around in and around Leuven? • Is there any information you are missing? If so, which? • And additional questions depending on the chosen means of transport.

Table 7: Details of the survey content

In addition to the survey research, a dashboarding and data-analysis strategy has been worked out for the mobility data needs of the city of Leuven, including direct needs within the framework of the UPPER project but also in a more general and long-term perspective. This has resulted in a first version of a mobility data catalogue and a data roadmap. In the catalogue, all current datasets and desired datasets are described. Apart from technical aspects, the most important use cases per dataset are documented and an assessment was made of the dashboarding approach for each case. In the data roadmap, these assessments are further developed in an integrated, long term plan of action. Technical preparation including the onboarding of new data sources and the development of GIS and BI dashboards has started.

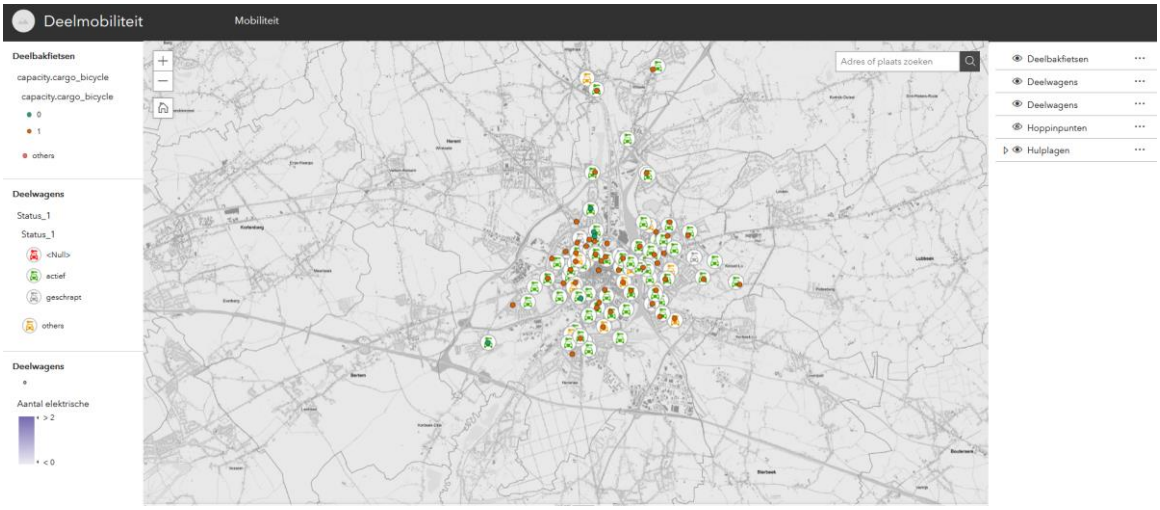


Figure 18: Alpha version shared mobility dashboard

5.4.1.3. Challenges & Mitigations

Due to some administrative difficulties the execution of the large scale survey has been delayed. To avoid lower response rates and atypical mobility behaviour associated with the summer season, the survey has been postponed until September and October 2024. For the analysis of the perception of the PT, data was requested from satisfaction surveys from the regional bus operator. The operator itself did not want to share their data, so the city had to conduct its own surveys. This caused a delay. It was decided to conduct street surveys with job students, but this was only possible during the summer holidays. Given that the analysis and conclusions of these surveys will not be available until the end of August 2024, a first analysis of the perception of the PT cannot be carried out until the beginning of September 2024.

5.4.1.4. Next steps towards implementation

The final data file from the large-scale survey will be delivered by the external research partner by mid-December 2024. Subsequently, together with the data from the street surveys, an in depth analysis can be made of PT user satisfaction, PT user typology to identify patterns, trends and correlations and possible modal shift scenarios by March 2025.

5.5. Hannover region

5.5.1. HAN_05: Exploring monitoring options of the cities performance towards achieving the goals of the SUMP

5.5.1.1. Description of the measure and main outcomes expected

The mobility plan was approved in the Hannover Region in 2023. The mobility plan includes relevant measures within the 17 thematic areas in order to achieve the political resolution of climate neutrality by 2035 in the Hannover Region. The mobility plan is based on the three strategies of sustainable mobility: Avoiding traffic, shifting traffic and handling traffic in a sustainable and safe manner.

Figure 19: Aims and strategies of the mobility plan

The aim of using the U-SUMP tool is now to monitor the implementation of the mobility plan and to visualize the associated path to climate neutrality. Various indicators from the different subject areas of the mobility plan and the modes of transport are used for this purpose. In this way, the progress of the plan and the associated measures for sustainable transport can be made understandable and visible to relevant stakeholders.

In the first instance, the tool will only be used internally. It is intended to support communication and coordination within the administration as the responsible body for the public transport system. In a second stage, a reduced version of the developed dashboard will also be made available to the public. The aim of the second phase is to incentivize people to switch to sustainable forms of mobility and perhaps leave their own vehicle at home even more.

5.5.1.2. Preparation of the measure

The first step was to create an overview of possible indicators based on the specific areas of sustainable transport planning mentioned in the mobility plan. This was then analysed and evaluated by various experts in the process of drawing up the mobility plan.

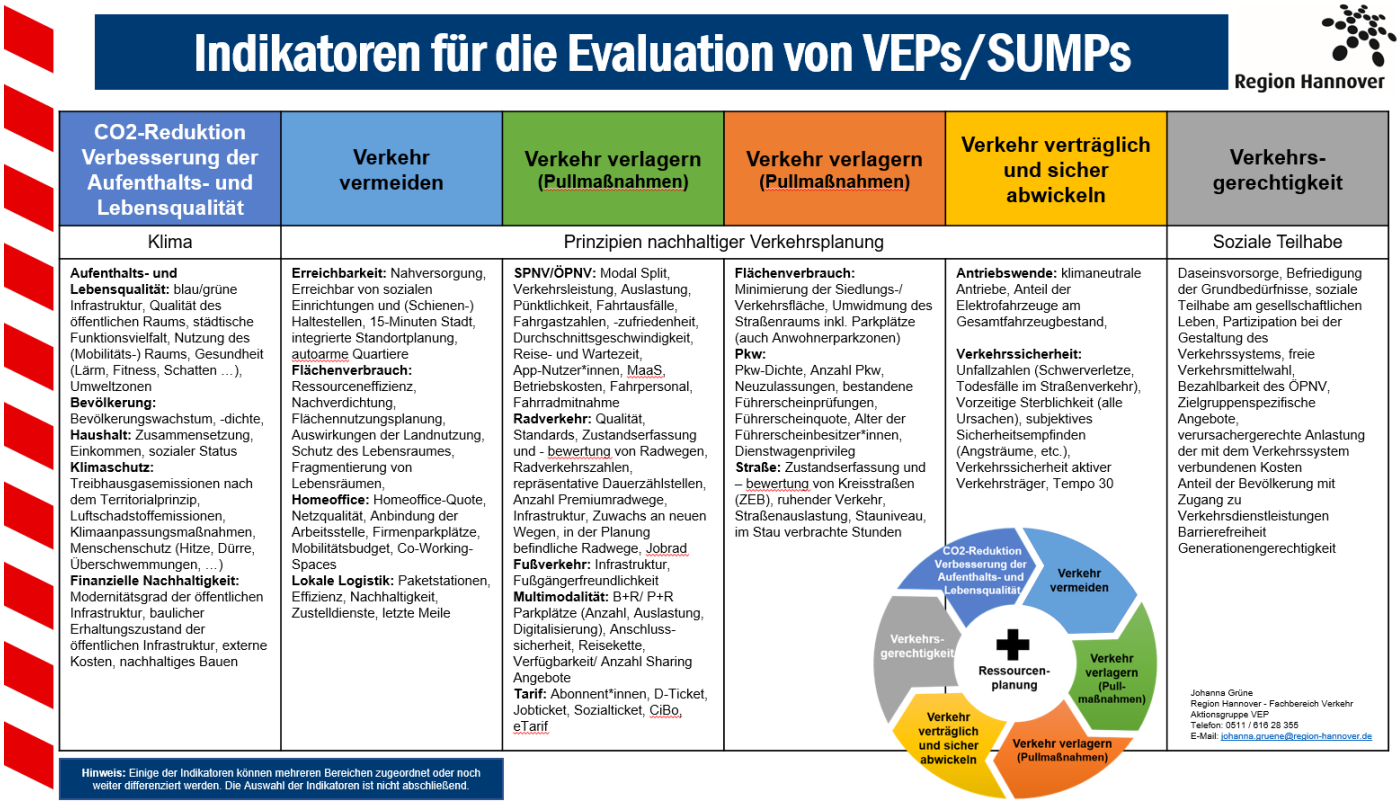


Figure 20: Overview of the list with Indicators

Within the administration, an "action group" was set up in the Mobility Department to implement the plan. It consists of various relevant stakeholders who are actively involved in the implementation of the mobility plan. The members of the "action group" were divided into various thematic groups (e.g. cycling, PT, tariffs, rail transport). Within these thematic groups, they then decided on their respective indicators to be worked on at the beginning of the monitoring of the mobility plan. This mainly involved questions such as data availability: currently available, or will be available within the current year.

As where possible, this data was summarised and placed in an overview (Figure 20). Data from 2017 was also used in order to be able to compare the data as closely to each other as possible. This year was chosen because it was the date of the last large, representative survey on mobility behaviour in Germany (MiD 20217). The year 2019 was chosen in order to have a status of the data before the coronavirus pandemic and the data from 2023 and 2024 reflects the current actual state.

Themengruppe	Indikator	2017	2019	2023	Entwicklung	Anmerkungen
SPNV	bestellte Zugkilometer (S-Bahn)	*x km*	*x km*	*x km*		
	5-Minuten Pünktlichkeit (S-Bahn)	*x,x %*	*x,x %*	*x,x %*		*2023 viele Baustellen*
	ausgefallene Fahrten (S-Bahn)	*x*	*x*	*x*		
	Fahrgastzahlen (S-Bahn)	*x*	*x*	*x*		
	Fahrgastzufriedenheit (S-Bahn)	*x,x*	*x,x*	*x,x*		*Anpassung der Methodik, Werte von 2023 sind nicht mit den Vorjahren vergleichbar.*
	weitere Netze SPNV	...	...	...	...	
Radverkehr	Zunahme Radwege an Kreisstraßen/Jahr	*x km*	*x km*	*x km*		
	Zunahme beschilderter Strecken im Netz/Jahr	*0*	*0*	*0*		*ab 2025*
	Entwicklung Teilnehmende an Aktionen wie (1) STADTRADELN	xx	xx	xx		
	(2) Schulradeln	0	0	xx		
	(3) fahrradfreundliche Arbeitgeber*innen	*x Unternehmen*	*x Unternehmen*	*x Unternehmen*		
	(4) Radkurse	0	0	x		
	(5) App-Nutzende	x	x	x		
	B&R an SPNV Stationen	xx	xx	xx		
	Mindestens zufriedener Zustand der Kreisstraßen und Radwege	xx (2014)	xx (2018)			*Daten aus 2023 liegen noch nicht vor*

Figure 21: Exemplary presentation of the data on the current status for the visualisation and the following evaluation (the concrete values and data cannot currently be presented to the public for reasons of competition)

Following this, the other existing plans within mobility planning (e.g. the local transport plan or the urban rail master plan) were also compared and categorised with the objectives and subject areas of the mobility plan.

Projekt/Maßnahme		Themengruppe	Ziele						
			70% Reduktion CO2	Verbesserung der Aufenhalts- und Lebensqualität	Verdopplung Rad-/ÖPNV Leistung	Halbierung PKW-Verkehr und Minimierung Anzahl Pkw	kurze Wege und sozial gerechte Mobilität für alle	mehr Platz für lebenswerte und sichere Straßenräume	flexible und vernetzte Mobilität
NVP 2026	Konzepte	*ÖPNV*	indirekt	indirekt	direkt	indirekt	direkt	indirekt	direkt
Masterplan Stadtbahn		*ÖPNV*	indirekt	indirekt	direkt	indirekt			direkt
Bahnknoten Hannover II		*SPNV*	indirekt	indirekt	direkt				direkt
Radverkehrskonzept (Handlungskonzept)		*Radverkehr*	direkt	indirekt	direkt	indirekt	direkt	indirekt	direkt
Radverkehrskonzept *(B+R im P+R/B+R Konzept)*		*Radverkehr*	direkt	indirekt	direkt	indirekt	indirekt	indirekt	direkt
autoarme Quartiere		*Siedlungsentwicklung*	indirekt	direkt	indirekt	direkt		indirekt	indirekt
Stadtbuskonzept		*ÖPNV*	indirekt	indirekt	indirekt	indirekt		indirekt	indirekt
P+R Konzept		*Intermodalität*	direkt	indirekt		direkt			direkt
...		...							

Figure 22: List of current plans and their connection to the mobility plan

While the data was being collected and organised, a requirements workshop on the U-SUMP tool was held at the same time with Rupprecht Consult and the tool developer SKOPOS. Together, the needs within the company's work environment were discussed and how the U-SUMP tool can support there. Questions about using the tool were also asked and discussed. This enabled RC and SKOPOS to gain an insight into the requirements of the Hannover Region for the tool and the Region was also able to become more specific in its thoughts on the tool. During the workshop, it was thus possible to develop something like a roadmap for the use of the tool. Building on this, the Hannover Region also took part in the workshop on U-SUMP at the project meeting in Valencia and developed the ideas further.

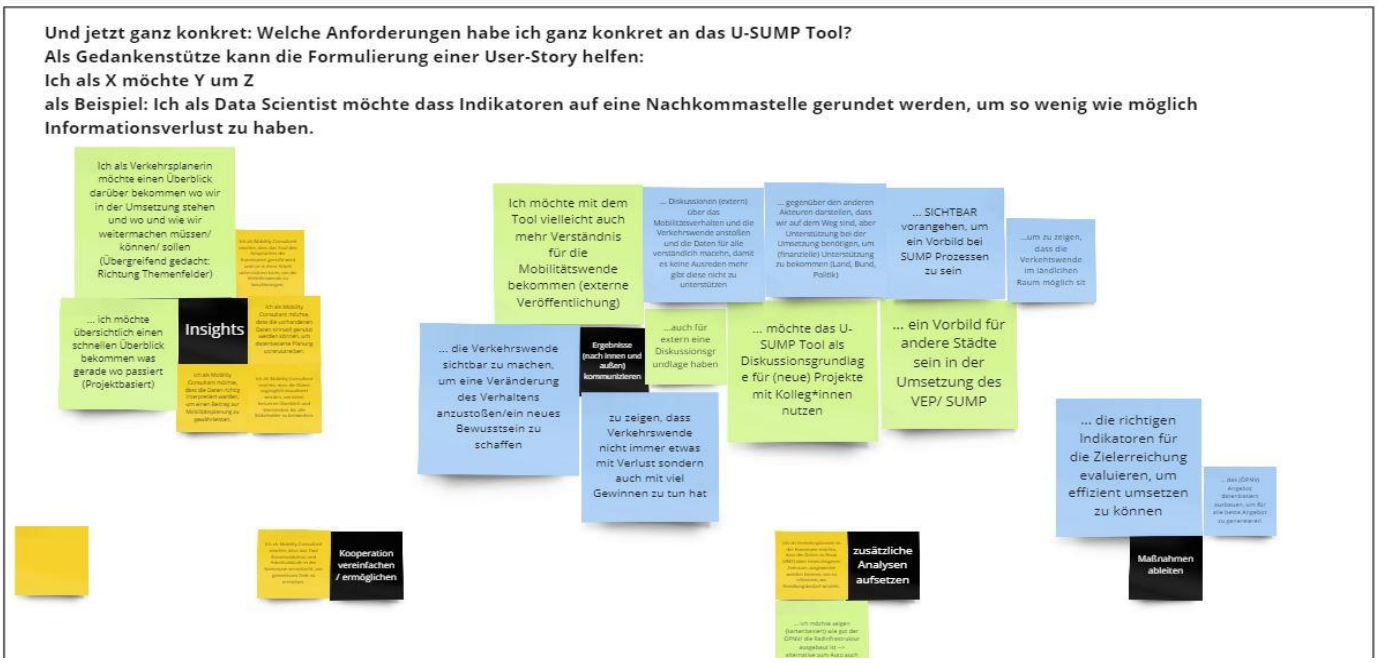


Figure 23: From the workshop: Specific requirements of the Hannover Region for the structure and features of the U-SUMP tool

5.5.1.3. Challenges & Mitigations

Continuous data availability

Some of the data used, or data that can represent interesting indicators, is not collected annually, while other data is not collected at the same intervals, i.e. at different times. This makes regular monitoring much more difficult.

Dependence on transport companies

Exclusively the transport companies collect a large amount of data for regular monitoring. In spring 2023, there was a major hacker attack. As a result, much of the historical data was lost and could not be restored.

"Secret data" due to competition

Some of the data collected is not allowed to be communicated to the public. This is for reasons of competition with other companies. In order to still be able to display such data within the U-SUMP tool, alternative forms of presentation must be considered. For example, it is possible to use a traffic light that shows green, yellow or red light for the indicator.

5.5.1.4. Next steps towards implementation

The next steps now involve further data collection, both within the Mobility department and from the transport companies. This data must then be further processed and inserted into the tables shown. Once the U-SUMP tool has

been finalized, the first data will be integrated and displayed there. The tool can then be used for initial decision-making processes and presented within the action group.

If it is possible within the U-SUMP tool, exemplary selected lighthouse projects should also be presented there. These still have to be selected in advance and profiles drawn up for them.

6.Conclusion

This document details the efforts undertaken in Task T4.2 of WP4 within the UPPER project, focusing on implementing innovative methods for data capture and sharing in public transport (PT) operations. The mobility measures linked to Task 4.2 are categorized into three main areas: i) data exchange among federated mobility platforms: LEU_01, HAN_05, ii) users data capture through applications provision for everyday trips optimization: ROM_07, VAL_07, VAL_09 and iii) simulated data integration: IDF_02.

The review of resources identified several innovative methods and best practices for capturing and sharing mobility data across European projects. This review includes key initiatives such as the CIVITAS PORTIS project, which improved mobility services in port cities through intelligent transport systems, and best practices like using the General Transit Feed Specification (GTFS) to standardize PT data. Additionally, the role of Digital Twins in urban mobility planning was highlighted, allowing cities to simulate and optimize their transport systems. The review also identified tools and guides like the Mobility4EU Roadmap and MOVE21, which support data-driven solutions for sustainable urban mobility.

To assist cities in preparing their measures, two workshop series were organized. The first, conducted during the 3rd General Assembly in Rome, allowed cities to share experiences, including the progress and challenges faced in developing their measures. The discussions emphasized the importance of data standardization and governance in public administration, emphasizing open and transparent data sharing driven by entities like the European Union. The second workshop, titled "WP4 Workshop on Data-Driven Mobility Planning", was organized by EMTA to address the specific needs and challenges of cities and regions implementing UPPER measures related to mobility planning. This workshop offered detailed feedback, including specific points of attention for various Mobility Planning measures, as well as high-level recommendations relevant to all UPPER cities and any future cities aiming to build on these measures.

Finally, the document presents the process of preparing the measures related to T4.2, highlighting the significant role of the cities in this development**.** It details the actions taken, challenges encountered, mitigation strategies, and next steps for implementation. It is important to note that this section was authored by the cities developing these measures.

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8. Annexes

ANNEX 1: WORKSHOP 2 'POINT OF ATTENTION' FOR T4.2 MEASURES

Measure ID	Appraised by	"Point of attention" category	Evaluation result: Point of attention/Comment	Solution you can present
LEU_01	ECF	Data management and privacy	For the general mobility survey, pay attention to trip stages in order to fully take into account the share of cycling and walking, also for combined trips with public transport. Satisfaction surveys should not only take into account satisfaction with PT itself, but also with multimodal experiences including walking and cycling.	
LEU_01	EITUMF	Active stakeholder engagement during measure development	Would be good to ensure inclusivity and representation in the data collection efforts for public transport .	
LEU_01	EITUMF	Data management and privacy	Worth to consider is the privacy and data protection aspects related to the collection, storage, and analysis of the gathered data	
LEU_01	FACTUAL	Tailored communication for increased acceptance and buy-in	What modal shift scenarios are tested? Could be interesting to test how users respond to new incentive tools.	
LEU_01	IFP	Mobility as a right: Universal accessibility leaving no one behind.	Will data on walking from destination to PT hub and to final destination will be collected?	Collect data for all segments (stages) of the trip
VAL_07	EPF	Mobility as a right: Universal accessibility leaving no one behind.	It is important to consider people who have difficulties using digital services; e.g., people with a visual impairment. They also need access to real-time information. Additionally, there are other groups who might have difficulties in using digital apps, for instance, the elderly, and people who cannot afford the purchase of smart phones. These groups risk being left behind. Not all applications are available in every country. Language barriers in the PT announcement, messages.	awareness raising and training for the handling of new technologies, including mobility technologies, should be reinforced. Be aware of the country restrictions of the application. Ensure that language translations are enabled on the applications. All of the solutions proposed in the measure description should be available to the same time and everywhere.
VAL_07	EITUMF	Data management and privacy	Might be good to ensure accessibility and user-friendliness of the platforms and apps provided to disseminate this information. Are there plans for user testing and feedback integration to optimise the usability and effectiveness of these tools?	
VAL_07	EITUMF	Data management and privacy	It might be beneficial to explore how focus on real-time data for public transport integrates with broader urban planning strategies. For instance, how does it align with efforts to improve pedestrian infrastructure or promote cycling as alternative modes of transportation.	

VAL_07	EPF	Tailored communication for increased acceptance and buy-in	Design the API to connect with the 'screens, apps (TBD) to be used by the PT users' - to decide indeed which communication channels are being used / will be used towards end-users (passengers). Make sure that the information provided to passengers is up-to-date, reliable and consistent across all channels (e.g., PTO app, website, Google maps if applicable, screens at bus stops, internal PTO monitoring).	Ensure consistency of information (real-time) across all channels to have a maximum positive impact
VAL_09	UITP	Data management and privacy	Facial recognition has the potential to be a threat to users' privacy as it allows for the collection and analysis of personal data without consent. In addition, as the data will be channelled via cloud/internet, cybersecurity safety measures to prevent cybercrime are required; the transfer needs to be encrypted to ensure there is no data breaches, especially of individuals related data.	Ensuring compliance with regulations on legal and ethical aspects of the measure person-recognition, concretely regulations on data privacy.
VAL_09	UITP	Active stakeholder engagement during measure development	Facial recognition has the potential to be a threat to users' privacy as it allows for the collection and analysis of personal data without consent.	Passengers must be informed on the measure, its purpose, and the implications on their privacy.
VAL_09	EPF	Tailored communication for increased acceptance and buy-in	It might be a better approach to inform the public more generally about the efforts done to improve air quality on the bus, plus to inform drivers so they can take action if needed - rather than showing real-time data (on CO2?) on board of the vehicles. On the one hand, since the peak of the pandemic is over, this is not a big concern anymore to most passengers; and on the other hand, showing increased values e.g. when buses are crowded might actually create more rather than less anxiety, and deter people from using public transport.	Consider how to communicate in a positive way to passengers without drawing attention to increased CO2 measures on buses which might have an unwanted negative effect on perceived air quality
IDF_02	EMTA	Other	A digital twin is costly to maintain. Surveys that capture the changing PT interactions with other mobility options are expensive. What can we do now to maximize the chances that the tool will be supported financially after launch?	
IDF_02	EMTA	Other	Restricting a model to subset of a wider urban area is a choice that raises many questions. When testing various scenarios, how will the model depict the real-world mechanisms that are best modelled at the scale of the region, for instance the redistribution of trip destination and the re-routing of through traffic? Failing to address these will result in a model that lacks elasticity: it will exaggerate road congestion caused by bus priority measures for instance. Such model behaviour would favour status quo by discouraging political leaders from investing in bus priority, low-traffic neighbourhoods, etc.	EMTA could seek help from TfL (Transport for London) whose modelling practices have historically involved sub-regional models + have been improved following recent low-traffic neighbourhood scheme implementations and evaluations + have been used in the simulation of LEZ effects.

IDF_02	EMTA	Environmental impacts on CO2 emissions, energy use, and air quality.	The modelling of CO2 and other emissions will be a key strength of the tool. Yet results could be grossly misleading if the wrong technical choices are made. The most basic models should not be used as they are misleading in urban traffic: they would associate a lower speed limit with higher emissions. Demonstrating that the tool is sensitive to such policy decisions, and reacts in the right manner, is essential to guarantee its adoption!	
IDF_02	IFP	Data management and privacy	Digital twin includes catchment areas?	Include catchment areas
ROM_07	FACTUAL	Tailored communication for increased acceptance and buy-in	How will the real tome information communicated to the end users?	
ROM_07	EMTA	Other	A real-time digital twin and forecasting engine is rarely what PT operators put high on their wish-list. Also the list of data inputs is impressive, and yet much work will be needed to turn data into information. It would be an opportunity to embrace the concept of European data spaces (distributed storage, data sovereignty and security, etc.) rather than create a data lake. What is lacking is a set of convincing examples of how the tools could help grow PT ridership and PT user satisfaction. Such use-cases are essential: they should serve as the foundation on which to develop smart city tools.	EMTA could make a presentation on data space principles. OECD smart city report can be critical of advanced tools that serve little purpose. Exposure to such critics in advance could help avoid common pitfalls. https://www.oecd.org/publications/how-can-smart-cities-boost-the-net-zero-transition-bc554887-en.htm
HAN_05	EITUMF	Active stakeholder engagement during measure development	Is the administration of Hannover the primary target audience for this measure, or are citizens also intended to use this tool? If citizens are meant to use this tool, how do you ensure engagement with them? How will the administration of Hannover utilise this tool?	
HAN_05	EMTA	Other	Take training into consideration for anyone using the tool. Make tutorials always available and accessible	
HAN_05	EMTA	Data management and privacy	Requires seamless integration of data from different providers, raising the data sharing question. Incentives to make sure contributors to the tool always upload the data online on time.	EMTA could share the example of Amsterdam data on lift availability from various stakeholders is fed into an app for journey planning using wheelchair-accessible routes. How to secure the agreement of stakeholders for data sharing – and the maintenance of sensors? Is it included in a PSO contract? Challenges faced? Solutions found? Who bears the development costs? Who turns data into information?

HAN_05	EMTA	Data management and privacy	Integrating various data sources requires lots of IT development cost, whereas some standard building blocks may exist	EMTA could present the concept of mobility data space to facilitate the use of standard trust layers, privacy protection layers, contract templates, user authentication layer, etc.
HAN_05	IFP	Data management and privacy	Is walking properly collected?	Include walking as trips and as stages of a trip

ANNEX 2: MONITORING TEMPLATES OF T4.2 MEASURES

Monitoring template for Measure HAN_05 "Exploring monitoring options of the cities performance towards achieving the goals of the SUMP"

Objectives of the measure

- Increasing the visibility of progress towards climate neutrality
- Improve the tracking and assessment of the impacts of SUMP measures in public transport.
- Improving the capacity of authorities to track the implementation of SUMPs
- (Public) dashboard to communicate positive developments towards climate protection and a shift in mobility to citizens.
- Further development of SUMP tool for administration
- Better planning opportunities
- Better communication of SUMP Goals/ Measures to citizens

Description of the measure

To monitor their own SUMP goals, Region Hannover will explore options like the U-SUMP tool, give their suggestions from a city's authority and planning perspective, implement the tool and possibly advance it further for internal use.

Measure outputs:

This measure will deliver:

- Competence Map of a Mobility Dashboard through the use of U-SUMP Tool
- Data tasting workshop
- Detailed monitoring/ Evaluation of the SUMP goals on public transport
- Implementation and testing of the monitoring tool

Related UPPER tools:

U-SUMP

Steps to ready-to-demo measure

Steps	Description	Involved partners/externals	City contact person	Category of action	Deadline	Monitoring indicator	Comments
1	Specify which indicators are to be displayed in the U-SUMP tool	Region Hannover		Data	05/06 2024	List of indicators	
2	Define of Data needed for tool	Region Hannover		Data	05/ 2024	Identification of data sources	
3	Specify which projects are to be displayed in the tool	Region Hannover		Technical	06/2024	Display of at least 5 projects	Not sure yet if U-SUMp Tool can Display different ongoing projects
4	Data integration for U-SUMP Demo	Region Hannover		Data	05/2024 - 08/2024	Integration of data sources	
5	Definition of the area and the use cases of the service	Region Hannover		Data	07/08 2024	Description of at least 5 use cases	
			LAUNCH OF THE DEMO (May 2024 – with integration of U-SUMP Tool?)				

Monitoring template for Measure IDF_02 "Setting-up of a dynamic Digital Twin of the territory"

Objectives of the measure

- Facilitate the detailed observation of mobility on the territory with in particular the PT interactions with the other mobilities.
- Facilitate the estimation of the non-measured information (carbon footprint and local emissions, ...).
- Facilitate decision-making by providing a framework allowing to assess prospectives mobility scenarios.
- Improve the understanding of mobility at the scale of the territory.
- Assess the impact of the implementation of the current or future (prospective) mobility actions or scenarios.
- Estimate non-measured information (carbon footprint and local emissions, ...) for the current and future mobility scenarios.

Description of the measure

The work will consist in restricting this simulator to the scale of the territory and setting up modules allowing to calibrate the model in a dynamic way with the help of the available data. This digital twin will allow to obtain a more complete observation of mobility on the territory with the PT interactions with the other mobilities, to follow the impact of the implementation of the actions and to provide estimates of the non-measured information (carbon footprint and local emissions, ...).

Measure outputs:

This measure will deliver:

- Calibrate simulation framework allowing to analyse the current mobility (traffic flow, use of PT, emissions...).
- Simulation framework to access prospective scenarios as specified in the IDF_03 (e.g., low emission zones).

Related UPPER tools:

U-TWIN:

U.SIM (and more specifically, U-SIM.plan)

Steps to ready-to-demo measure

Steps	Description	Involved partners/externals	City contact person	Category of action	Deadline	Monitoring indicator	Comments
1	Determining the purpose and scope of the digital twin (who are the users, which area or region and which level of detail)	IFPEN, Ile de France		Technical	24/11/2023	Description of purpose and scope of the digital twin	
2	Collection of relevant data such as administrative and demographic data (census, household travel surveys…), infrastructure data (roads, buildings, utilities, transportation systems…), sensory data (traffic counter, FCD…)	IFPEN, Ile de France		Data	15/12/2023	List of relevant collected data	
3	Selection of an appropriate simulation platform that best suits the purpose and the scope of the study	IFPEN, Ile de France		Technical	15/12/2023	Digital twin platform	
4	Processing collected data to generate simulator input data	IFPEN, Ile de France		Data	23/02/2024	Input data for the Digital twin platform	
5	Updating of the digital twin with dynamic data	IFPEN, Ile de France		Software	26/04/2024	Digital twin platform calibrated	
6	Integration of an accurate car fleet model	IFPEN, Ile de France		Algorithm	26/04/2024	Model of car fleet	
7	Pollutant emission estimation integration add-on	IFPEN, Ile de France		Algorithm	31/05/2024	Model of pollutant emission	
8	Carrying out simulations with the digital twin platform to accurately represent the current state of the territory	IFPEN, Ile de France		Technical	28/06/2024	Output of the digital twin simulation	
9	Visualization and analysis of the simulation results	IFPEN, Ile de France		Technical	16/08/2024	Accuracy of the mobility simulation output descriptors	
10	Definition of prospective scenarios to evaluate	IFPEN, Ile de France		Social	26/04/2024	Description of prospective scenarios	
		LAUNCH OF THE DEMO (please fill in the date)					

Monitoring template for Measure LEU_01 "To exploit the existing mobility data to enhance the evolution of public transport policies"

Objectives of the measure

- To improve data-collection efforts regarding PT
- To get more use out of existing mobility data
- To provide a strong data-driven foundation for public transport policy making
- To contribute to the professionalization of data management.

Description of the measure

This measure consists of research into the current use of public transport in Leuven, in particular in combination with peripheral parking lots and mobility hubs, based on existing data sources and newly collected data. The goal is to gather information on social patterns, obstacles and opportunities, to identify target groups and more detailed strategies to enhance the use of public transport, and to use in depth-analysis to study the potential impact of these strategies. Next to building on existing datasets on public transport use and satisfaction surveys, new qualitative data will be collected using surveys and a general participatory approach. Moreover, improvements in data-handling, management, reporting and visualization will be made, as well as more in-depth analyses and simulation.

Measure outputs:

This measure will deliver:

- Large scale survey (1600 participants), additional PT user surveys, ideation by crowdsourcing
- Onboarding additional data-sources in city datawarehouse, dashboarding for key mobility/PT indicators
- In depth analysis of
  - PT user satisfaction and perception,
  - PT user typology,
  - Modal shift scenarios

Related UPPER tools:

U-GOV: participatory approach to data collection and ideation

U-SUMP: reporting and visualization of KPIs

U-SIM: in depth analyses

Steps to ready-to-demo measure

Steps	Description	Involved partners/externals	City contact person	Category of action	Deadline	Monitoring indicator	Comments
1	Survey tendering process preparation			Legal	31/12/2023	Tender documents ready	
2	Survey tendering			Legal	31/1/2024	Tender awarded	
3	Survey execution	external survey partner		Data	1/6/2024	Results processed	
4	Survey results analysis	KULeuven		Data	1/9/2024	Analysis report	
5	Definition of expected indicators to be monitored and integrated into dashboards	KULeuven, Ruprecht		Data	30/4/2024	List of requirements	
6	Work out dashboarding strategy	KULeuven, Ruprecht		Software	30/4/2024	Dashboarding strategy	Quid U-SUMP?
7	Work out analysis strategy			Technical	31/08/24	Analysis strategy	Quid U-SIM?
8	Onboarding data-sources in city data warehouse and computation of the KPIs	KULeuven, Ruprecht		Data	30/6/2024	Creation of databases	
9	Development of the API for the KPI and data access	KULeuven, Ruprecht		Software	31/7/2024	Test and operation of the API	
10	Development of the dashboard	KULeuven, Ruprecht		Software	31/08/24	First version of the dashboard	
11	Testing of the new dashboard and associated documentation			Technical	31/08/24	All set for the demo	
		LAUNCH OF THE DEMO (please fill in the date)					
12	Analysis of PT user satisfaction, PT user typology (identify patterns, trends, and correlations)	U-SIM?		Data		Statistical outputs and indicators	
13	Launch of internal dashboard						
14	Collect internal feedback and Iterative further development of dashboard						
15	Analysis of Modal shift scenarios						

Monitoring template for Measure ROM_07 "Use of advanced technology to increase the efficiency and reliability of PT"

Objectives of the measure

- Implementing new features in the MMC (Mobility Management Centre) of Rome (managed by RSM).
- Enhance traffic forecasting and the management of near-real time information.
- Improve the efficiency in transport operations.
- Guaranteeing management and use of the information coming from all the actors involved in mobility and from different ITS systems present on the territory.
- Equipping the city of Rome with technologically advanced tools in a Smart City perspective.
- Reduce traffic congestion and pollution.
- Reduce travel times and increase the efficiency of PT.

Description of the measure

The Traffic Management Centre has evolved during the years to be up to date with the technological developments. The MMC ensures the technological oversight- spanning from the design to management of mobility services, of systems for traffic monitoring, regulation and control, infomobility and automatic sanctioning of traffic violations.

The renewed MMC will support the whole metropolitan area of Rome to unify, manage and take advantage of the information coming from all the actors involved in mobility and from the different ITS systems in the territory, to provide:

- Management and Monitoring: Near real-time reconstruction of the mobility of the Metropolitan City of Rome
- Regulation and control: Real time information to guide traffic for example in case of unexpected events.
- Forecasting: Using Artificial Intelligence and Machine Learning technologies to make short-term traffic forecast estimates
- Infomobility: Information to users on the current and projected status of mobility.

Measure outputs:

The upgrade of the TMC will provide mobility and TP operators with services for operators and citizens thanks to a platform that integrates:

- The devices for vehicles' detection installed in the territory.
- A Data Lake for information exchange processes.
- A fully integrated technology platform: GPS systems, digital sensors, cameras, wi-fi hot spots, internet of things, big data and data processing software.

Related UPPER tools:

U-SIM.live: to test a different forecasting tool

U-TWIN: to test a different forecasting tool, to monitor in real-time different mobility assets (buses location, traffic, roadworks, incidents,

Steps to ready-to-demo measure

Steps	Description	Involved partners/externals	City contact person	Category of action	Deadline	Monitoring indicator	Comments
1	Study (state of the art) of the different existing ITS systems on the territory	Rome, RSM		Technical		Reports with different data sources	
2	Design of the new data lake system on which the new Central Mobility will be based	Rome, RSM		Technical	Dic 2024	List of requirements	Almaviva Company supports RSM in creating the DataLake Design
3	Development of the traffic management software	Rome, RSM		Software	Dic 2025	Traffic Management Software	We have to decide to purchase FCD data
4	Creation of the new MMC	Rome, RSM		Software	Dic 2025	Mobility Management Center	
5	To enhance traffic forecasting and the management of near-real time information	Rome, RSM		Software	Dic 2025	Specialized predictive models	
6	Develop and test the integration of traffic information for user in the Maas	Rome, RSM		Software		Test and operation of the service and the APPs	
7	Testing of the system	Rome, RSM		Software		Test and operation of the system	
			LAUNCH OF THE DEMO (please fill in the date)				

Monitoring template for Measure VAL_07 "To provide the citizens with clear and accessible information before and during the trip"

Objectives of the measure

- Ease the understanding of the PT system of the city.
- Anticipate and mitigate service disruptions and problems, such as delays caused by accidents, congestion, construction works and so on.
- Improve the efficiency of the public transport service.
- Facilitate the real-time monitoring of the service operation and improve the decision-making process for PTOs.
- Increase users' satisfaction by providing accurate, relevant and trustable information to the citizens on the PT service.
- Increase efficiency of public transport system.
- Reduce private vehicle usage in favour of PT.

Description of the measure

This measure will create a service to collect and display real-time information on relevant issues directly or indirectly affecting the performance and travel time of public transport. This includes real-time information on traffic, road works, special events, accidents, or abnormal situations. Additionally, a platform will be developed to provide this information to PTOs to manage the service and initiate corrective actions if needed (adapt bus routes, increase frequencies, etc.).

This real-time information on the performance of public transport will also be provided to the PT users through screens, apps, etc. (before and during the trip) so as to increase transparency and users' trust in public transport service. Users will be able to make more informed decisions about when and how to use public transport, which in turn will increase the level of users's satisfaction.

Measure outputs:

This measure will deliver:

- A platform for PTOs including:
  - Real-time interactive maps showing detailed information on the bus operation (location, occupancy, delay,…), along with information on traffic status and service disruptions.
  - Real-time alerts informing PTOs about relevant delays, disruptions, abnormal occupancy levels,….
- API to provide information on the bus operation to the citizens through screens, APPs, Twitter…(to be decided).

Related UPPER tools:

U-TWIN offers real-time and standardized information on different transport modes (real-time location, incidents, delays, occupancy level,…) together with traffic information, weather information and so on. U-TWIN can: (1) facilitate real-time information on the PT offer and PT operation to the citizens and; (2) inform the PTOs about incidents, alerts, inefficiencies,…, help them understanding the reasons behind (traffic, special event,…) and allow them to initiate corrective actions.

U-SIM.live: Estimate passenger volume & Forecast passenger volumes: For journey planner, assess station and line congestion; for pt operators, anticipate issues and assess impacts. It also allows simulating corrective actions when an alert is shown in U-TWIN.

Steps to ready-to-demo measure

Steps	Description	Involved partners/externals	City contact person	Category of action	Deadline	Monitoring indicator	Comments
1	Definition of the use cases of the service	EMT, ETRA		Social	M13	Description of area and use cases	
2	Determining the types of information (schedules, delays…) that PTO and citizens require	EMT, ETRA, IBV		Social	M13	List of requirements	Serious Game and hackathon
3	Analysis of the data sources available in the city and data collection	EMT, VALENCIA, ETRA		Data	M16	Identification of data sources, standards and requirements for integration	
6	Integration into U-TWIN of the standardized data sources linked to the bus operation and external factors affecting the bus operation	ETRA		Software	M20	Permits requested. Integration of data sources	This depends on the readiness of U-TWIN
7	Testing the system in a controlled environment to ensure that it meets the technical specifications and functions as intended	ETRA		Software	M22	Test and operation of the system	
8	Develop and test the API connecting U-TWIN with the screens/APPs/(TBD) to provide citizens with real-time information on the bus service and potential disruptions/delays,…	ETRA, EMT		Software	M22	Test and operation of the service and the APPs	
9	Training of the PTO staff on how to use and manage the system	EMT		Social	M24	Staff selected and trained	
10	Planning of dissemination strategy for the demo	EMT		Social	M22	Advertising campaigns	
		LAUNCH OF THE DEMO (M25)					

Monitoring template for Measure VAL_09: Improving the efficiency of the bus service and comfort of PT users

Objectives of the measure

- Improve the quality of bus service
- Better understand the mobility patterns of bus passengers
- Enhance user satisfaction and passengers' comfort during travel

Description of the measure

This measure aims to carry out a development that enables passenger counting within a vehicle, as well as the possibility of locating the boarding and disembarking stops of each passenger to calculate the Origin/Destination matrices of the transport. To that aim, this measure will implement an advanced camera-based passenger counting system with artificial intelligence on buses. The output of this measure will allow:

- Providing real-time information on bus occupancy to EMT (so as to adapt the offer, if needed) and to third applications (to improve passengers' experience during travel).
- Identify passenger entry and exit patterns to feed/improve the calculation of detailed origin-destination matrices.

Measure outputs:

This measure will deliver:

- An advanced camera-based passenger counting system with artificial intelligence

Related UPPER tools:

None

Steps to ready-to-demo measure

Steps	Description	Involved partners/externals	City contact person	Category of action	Deadline	Monitoring indicator	Comments
1	Definition of technical requirements and architecture	ETRA		Technical	November 2023	List of requirements and architecture of the system defined	Done
2	Revision of EMT of ETRA's proposal	ETRA, EMT		Technical, social	January 2024	Proposal validation	Done
3	Software development for AI-based passenger counting	ETRA		Software	June 2024	Software developed	
4	Software validation	ETRA		Software	September 2024	Software tested and validated	
5	Purchase of equipment	ETRA		Infrastructure	December 2024	Equipment purchased	
6	Permits request to install the equipment on the buses	EMT		Legal	December 2024	Permits given	
			LAUNCH OF THE DEMO (January 2025)				