Unleashing the Potential of Public Transport in Europe

D3.5 UPPER Urban Vehicle Access Regulation toolbox

WP3 Supporting tools and solutions to plan and develop user-centric and PT

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

This deliverable provides guidance for city and regional planners with regards to Urban Vehicle Access Regulations (UVARs) and their optimal integration with Public Transport (PT) systems, along with traffic management measures prioritising public transport services. It addresses pricing measures, spatial interventions, vehicle characteristics based measures (weight, dimensions, drive train), and digital traffic monitoring and management.

It refers to task T3.5 of the UPPER project, which supported the preparation of 14 measures in 8 cities in Europe, who were partners of the UPPER consortium. As part of the task, an extensive review of existing support material was conducted and compiled, exploiting partners' knowledge of reports, researches, tools and manuals related to the topics of UVARs, parking policies, traffic and road space management. Aside from this review, workshops and exchange opportunities between the eight cities were organised in a way that relevant content from ongoing efforts and faced obstacles would be shared and used as a ground for discussion and brainstorm on potential solutions and optimisation. In parallel, a detailed description is provided of all 14 measures prepared within this task and the different activities conducted to ensure efficient implementation within the project lifetime.

The deliverable is structured in seven parts, addressing first the objective of the document and the context of its development, second the methodology used for each three parts mentioned above, thirdly the supporting resources compiled, fourthly the exchange opportunities set up, fifthly the work development for each measure structured by topic and demonstration site, sixthly the conclusion of this work, and seventhly the references used in the drafting of this document.

The main outcomes of this work are content and experience sharing to inform future initiatives with similar objectives as the UPPER demonstration sites: to increase PT ridership and user satisfaction with the improvement of PT systems thanks to vehicle access regulation, parking management, PT traffic prioritisation in urban transport infrastructure, and their integration within a comprehensive urban mobility plan.

This deliverable relies on previous work done in the UPPER project and will be followed by measures' implementation reports. It is a supporting document and reports on the work done to facilitate cities' and regions' work, in parallel to the development of enabling tools in other UPPER tasks. The UPPER partners remain available for any additional guidance.

Keywords

BRT: Bus Rapid Transit

LEZ: Low Emission Zone

LoS: Level of service

LTZ: Limited Traffic Zone

PT: Public Transport

PTO: Public Transport Operator

P&R: Park and Ride

RFF: Recovery and Resilience Facility

SUMP: Sustainable Urban Mobility Plan

TSP: Transit Signal priority

UVAR: Urban Vehicle Access Regulation

WtP: Willingness to Pay

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1.Introduction

1.1. Scope of the Document

The deliverable D3.5 aims to document the efforts undertaken in task T3.5, which seeks to address the importance of traffic regulation as a propeller for Public Transport (PT), under the form of connected and dynamic traffic infrastructure and management, as well as access and parking rules and implementation. In particular, this task is focused on the developments required by each of the pilot sites to implement measures around two main topics:

- **Traffic Management and PT prioritisation** – These measures involve traffic monitoring and in some cases infrastructure adaptation to support the improvement of PT operations. Identifying traffic challenges and their locations, these measures aim at improving the implementation of existing PT prioritisation rules on one side, and defining new rules where needed on the other side. Through the set up and enforcement of dedicated lanes or priority at crossings with connected systems, the speed and regularity of PT trips increases, raising PT users' satisfaction and encouraging PT ridership over private car use.
- **Urban Vehicle Access Regulations (UVARs) and Parking policies** – This category covers the measures regulating the access and the parking of cars in urban areas, through the implementation of so-called "low emission zones" allowing limited vehicle access based on CO2 emissions, but also through charges of car drivers at specific times and in specific zones, and of car owners in the case of parking charges. Some of these measures focus on the analysis of policy implementation's impact on PT ridership, while others assess the consequences on urban transport's environmental impact.

This task looks at reference guides, tools and initiatives helpful for the partners involved in the development of this type of measures. Likewise, it also carries out collaborative workshops to favour the exchange among cities and to identify good practices and recommendations to support the preparation of such measures.

This task builds on the work done in WP2, especially in tasks T2.2, where the scope and objectives of the measures were defined in detail, as well as in task T2.4, where the requirements to be fulfilled by each of them were detailed. This information forms the basis of the work carried out in this task, where these measures progress from being a concept/idea (WP2) to being fully developed (WP3, WP4, WP5) until they are ready to be demonstrated (under WP6).

This deliverable is a key outcome, first of all, for the UPPER consortium, since it details the steps undertaken by the demo sites to develop their measures and establishes the basis for their subsequent implementation and demonstration, which will take place under WP6. Secondly, it becomes a key outcome of the project for any professional (outside the UPPER consortium) willing to implement similar measures in their city, since it contains reference documents, guides and tools, high-level recommendations identified by experts in the field, and as already mentioned, step-by-step description on the process followed to develop measures of that type.

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

The intended audience of this document is all those professionals involved in the PT improvement and urban planning, including mobility managers in municipalities, public companies and private companies, transport operators and authorities.

This document presents the measures developed within the framework of the UPPER project aimed at prioritising public transport through traffic management and pushing public transport efficiency and ridership with urban access regulation and parking policies. The detailed description of the steps taken to prepare these measures, along with recommendations derived from collaborative workshops, can serve as case studies for other mobility and urban planning professionals seeking to implement similar measures in their respective cities.

In addition, the collection of reference documents, guides and tools are also recommended reading for professionals seeking to transform urban environments to favour public transport and improve traffic efficiency through equipment connectivity, priority rules, low emission zones, and parking management.

1.3. Structure of the document

This document is divided into six sections, starting with a brief introduction. The second section details the methodologies used for conducting various activities within the task. This includes the systematic review methodology used to gather reference guides and tools, methodologies followed for conducting two collaborative workshops, and the process for supporting demonstrator sites as they prepare their measures.

Sections 3, 4, and 5 present the outcomes of the task. Section 3 provides a concise overview of the systematic review conducted by consortium members to identify tools, guidelines, and best practices beneficial for cities and regions looking to redesigning urban space around public transport, and enhancing multimodality and seamless connectivity between transport modes.

Section 4 directly reflects the results from the two workshops conducted under task T3.5, and 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 T3.5, and a second one aimed to produce ‘points of attention’ to be considered by the demo sites to maximise the impact of their measures. This section not only presents the outputs of these workshops but also provides a series of cross-cutting recommendations useful for stakeholders interested in implementing similar measures.

Section 5 offers a detailed description of the steps taken by the demonstrator sites to develop and finalise the process of preparing their measures for subsequent implementation and demonstration.

Measures have been grouped thematically in this section (Traffic Management and PT prioritisation on one side, Low Emission Zones and other traffic regulations on the other side) to aid readers in finding pertinent information. Each measure includes a step-by-step description of its preparation process, results achieved during such steps, challenges encountered, mitigation strategies employed, and next steps to conclude the preparation process.

The final section presents the conclusions drawn from the activities conducted in this task.

1.4. Measures included under Task 3.5

This task addresses the preparation of 14 measures aimed at exploiting traffic management to prioritise PT and improve operations or defining vehicle access and parking rules to reduce congestion and urban transport environmental impact, and to favour PT use as well. In particular:

- In the category “**Traffic Management and PT Prioritization**”, the following measures have been prepared:
    - **VAL_04**: Reduce travel time through implementation of a dedicated bus lane
    - **ROM_04** : Design the new high frequency and high-capacity PT infrastructure (tram & metro lines, stops, and vehicle procurement)
    - **LIS_02**: Promote, extend services and prioritise PT (data collection & improvement simulations)

- **BUD_06**: Improve the existing PT prioritizing tools in Budapest
- **LEU_07**: Increase PT services quality through traffic management and dedicated lanes for PT
- **TES_03**: Improve transit services through dynamic multimodal management of PT corridor
- **TES_06**: Social optimum-based traffic management to reduce PT travel times and increase user satisfaction
- **OSL_07** : Pilot V2X to prioritize public transport (Smart speed bump to increase PT user satisfaction)

- In the category "**Low Emission Zone (LEZ) / Congestion and Pollution Charging Scheme / Smart Parking Management**", the following measures have been prepared:
  - **ROM_01**: Reduce private vehicles by implementing a 'pollution charge' scheme in the core part of Rome Zone 2
  - **ROM_02**: Promote modal shift towards PT with the implementation of a LEZ in Rome Zone 3
  - **IDF_03**: Impact evaluation and future design of low emission zones and restricted traffic zones
  - **LEU_02**: Study the needs of parking and public transport in different areas of the city
  - **TES_04**: Influence modal shift through congestion sensitive parking pricing
  - **LIS_01**: Restrict car access in the city (around schools)

2.Methodology

2.1. Supporting resources: A systematic review

A systematic review of reference projects and best practices (knowledge coming from inside or outside the consortium) has been carried out to identify relevant tools and guides that can support cities in implementing measures aimed at prioritising PT in traffic management and supporting PT and environmental footprint reduction with UVARs and parking management.

The systematic review was aimed at generating a collection of guides, reference projects, tools and initiatives, useful for the cities carrying out mobility measures linked to T3.5, as references to support the definition, design and development of their related measures. A specific focus was made on the projects ReVeAL and PARK4SUMP, which had already been identified in the UPPER Grant Agreement, with the essential tools they produced to support decision-making processes in the domain of UVAR and parking for better integration and promotion of PT. The partners involved in the systematic review were: POLIS, ICLEI, UITP, ETRA, and Rupprecht Consult.

The approach followed to categorize the identified relevant resources follows the structure established in the "CIVITAS Urban Mobility Tool Inventory." This tool inventory facilitates filtering information according to various parameters, including

- **Tool type** (Guidance document / Manual; Hardware; Indicator set; Method / Approach; Application; Option generator; Serious game; Software; Project).
- **Thematic area** (Active mobility; Behavioural change & mobility management; Clean fuels and vehicles; Collective passenger transport & shared mobility; Demand & urban space management; Integrated and inclusive planning; Public involvement; Road safety and security; Smart & connected mobility; Urban logistics).

- **Application area** (Analysis, scenarios and measure selection; Appraisal and assessment; Data gathering; Dissemination and communication; Evaluation and monitoring; Exploitation and business plans; Financing, procurement, legal aspects, measure implementation).
- **Language.**

For each of the resources identified, the following information has been retrieved:

- Name of the supporting resource.
- Brief description of the supporting resource.
- Latest update.
- Assistance required.
- Assistance data.

Even though the systematic review produced a large list of relevant tools and guides, it was decided to limit the list to a maximum of 15 entries, trying to select the ones better fitting with the measures being developed by the cities in the scope of the UPPER project and, in particular, of the task T3.5. The tools identified as most relevant to measures developed within T3.5 were coloured in green and listed at the top of the table after a thorough review, and are the ones included in this deliverable. Other supporting resources identified will be included in the UPPER U-KNOW tool gathering all the knowledge developed in the project and collected from all partners, structured by topics and thematic areas as well.

2.2. Measures support workshop series

2.2.1. High-level approach

The UPPER project has a great potential to build on a legacy of best practices on how to improve PT through defined measures. This potential relies on the cities and regions involved in the project and developing 84 PT PUSH & PULL measures, but also on the horizontal partners supporting them with monitoring, expertise, and above all structured exchanges bilaterally and with each other. To leverage on this second aspect, workshops were organised with dedicated goals, participants, and agendas. In the framework of T3.5, two workshops were organised, for which the methodology is described below.

2.2.2. Workshop 1: Challenges and good practices to prepare measures

The aim of this workshop was to foster an open reflection and discussion session whereby city representatives self-evaluate their progress in developing measures within a task. They then present their progress, with a focus on what they consider as enabling factors for measure development and on challenges faced. Project partners who develop measures in the same category, as well as issue-based advocacy organisations within the project were expected to have faced broadly similar challenges within their respective contexts. As all partners attended with at least one staff member, the UPPER General Assembly organised in Rome in January 2024 was selected as an opportunity to run a workshop session to exchange good practice on the topic. During the meeting two workshops were held in parallel and meeting attendees could freely choose which session to attend. Due to the large number of measures developed in the framework of task 3.5, two such workshops were organised: the first one focused on the design, deployment & monitoring of UVARs, and the second one addressed traffic management and PT prioritisation measures. POLIS moderated both workshops related to T3.5 and shared summaries with the consortium afterwards.

2.2.3. Workshop 2: Aspects to be considered to increase the measures' impact

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:

- Horizontal partners with expertise related to the various tasks were asked to **critically review the measures** proposed by the cities. The partners decided among themselves which measures to review based on their previous work, knowledge, etc. In conducting the critical review of the measures, horizontal partners have taken into account the various documents already produced in UPPER, including but not limited to the user personas and experience notebooks of D2.1, the SWOT analysis included in D2.2, or the supporting policy frameworks and policy requirements in D2.4.
- Based on the critical review of the measures to be developed within Work Package 3, the horizontal partners commonly agreed on a **limited number of "Points of attention"**, areas where they consider the cities and measures should be focusing more attention, and should be addressed moving into the implementation phase. The goal of these "Points of attention" is to extract common challenges that are shared in the design/development of several measures within the same work package, rather than a checklist per measure. The full list of "Points of attention" per measure category can be found in Annex 1.
- In the WP3 online workshop (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 implementation of the measures actively reacted and participated. The general coordination was ensured by Rupprecht Consult, the event was organised by EUROCITIES and UITP, and the measures' evaluation was coordinated by IBV. The main objectives of the workshop were to **(1) Reflect on selected points of attention identified as common importance during the appraisal exercise**, and **(2) Generate exchange among city representatives and horizontal partners to propose recommendations and solutions moving to the implementation phase**.
- Cities had the opportunity to see in advance the points of attention referring to the measures they are developing and to respond to and actively engage with the horizontal partners. Following a plenary introduction of the points of attention, 4 breakout sessions were organised in parallel, thus fostering engagement and a lively exchange between the participants.
- Each session was run and moderated by two horizontal partners identified based on their experience on the topic. Rupprecht also created a Miro board to structure the inputs during the breakout sessions. The online workshop was recorded, and a short report was prepared to be included in the deliverables of the WP3 tasks. Some sections/presentations may also be used as part of the communication tasks of the project or included in the U-TRANSFER/U-KNOW tools.

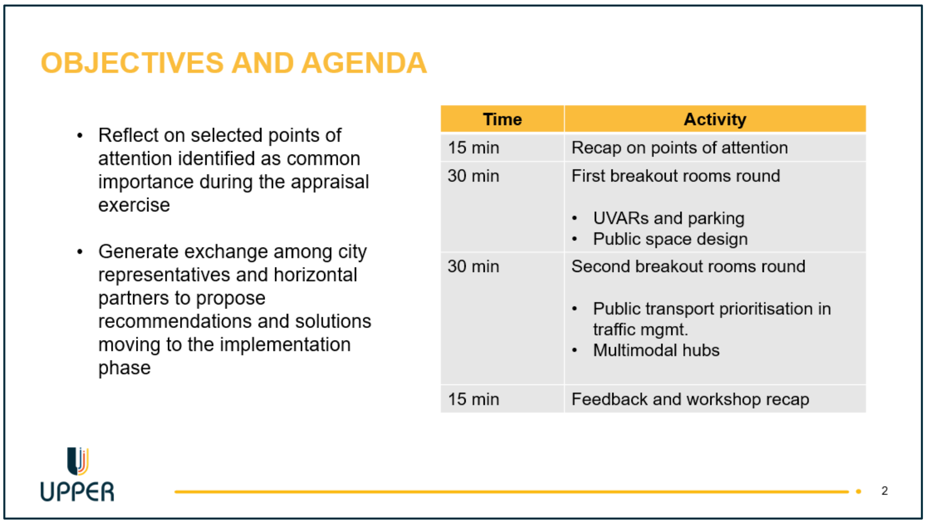

Figure 1 UPPER 2nd workshop supporting WP3 measures' preparation

	UVARs and parking	Public space design
First round	Hannover	Lisbon
	Leuven	Manheim
	Rome	Valencia
	Versailles	Budapest
	Thessaloniki	Oslo
	Moderators: Laura and Javier	**Moderators: Holger and Mario**
	Traffic prioritization in PT	**Multi-modal hubs**
Second round	Hannover	Lisbon
	Leuven	Manheim
	Thessaloniki	Oslo
	Valencia	Rome
	Budapest	Versailles
	Moderators: Lottie and Juan	**Moderators: Mario and Katie**

Figure 2 Breakout sessions of the UPPER 2nd workshop for measures related to WP3

2.3. The Measures Support Leaders Group

Task T3.5 producing this deliverable focuses on developments required to implement UPPER measures around PT prioritisation in traffic management and vehicle access regulations. This task belongs to Work Package 3 (WP3), which shared common goals with WPs 4 and 5; 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 these common goals, the participating horizontal partners (WP and Task leaders) decided 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.

2.4. Measures preparation process: Formulation and use of the monitoring template

To achieve all the MSLG objectives, 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 3 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 3 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 14 measures prepared under Task 3.5 can be found in Annex 2.

3.Supporting resources: Reference tools and guides

In this section, the main documents and reference projects identified regarding the prioritisation of PT through traffic management measures and the definition and implementation of UVARs and parking policies to better integrate urban traffic with PT and thus increase PT ridership are listed. The original documents are accessible on the website following the references included in the table.

#	Tool Short Name	Description	Lang.	Latest update	Assistance required	Assistance data	Tool Type	Thematic Area	Application area	Link
1	eBRT2030 State of the art: On the road to a concept for BRT	The eBRT2030 publication describes the high-level bus rapid transit (BRT) system architecture and the status of the key areas of characterisation, from the interviewed cities and from systems outside Europe.	EN	2023	No	No	Guidance document / Manual	Collective passenger transport & shared mobility - Service improvement	Appraisal and assessment	https://cms.uitp.org/wp/wp-content/uploads/2024/02/eBRT2030_OnroadtoconceptBRT_final.pdf
2	NACTO Action plan to improve bus services	Move! That! Bus! Tactics for Transforming Transit in Two Years provides decision-makers—elected officials, transit board members, department and agency executives—an action plan for improving bus service and reducing transportation-related emissions in the short time we have left to avert the worst impacts of climate change.	EN	2021	No	No	Guidance document / Manual	Collective passenger transport & shared mobility - Service improvement	Analysis, scenarios and measure selection	https://nacto.org/move-that-bus/
3.1	MORE project's Roadspace allocation appraisal tool	This tool helps assess and prioritise road design options by performing an appraisal of roadspace reallocation alternatives among users. It compares the performance of each option considering the movement and place function of roads, and broader economic, social, and environmental objectives.	EN	2022	No	Road design, movement function, place function and wider impacts (economic, social, environmental)	Method / Approach	Integrated and inclusive planning - Spatial/land-use planning	Analysis, scenarios and measure selection	https://discovery.ucl.ac.uk/id/eprint/10144317/
3.2	MORE LineMap	LineMap is used to create and enhance design options by designers and other professionals. The output are digital design options, displayed as road markings or as coloured blocks. LineMap is an application for creating and managing road marking designs. Using a library of national standard road markings, LineMap can create detailed representations of markings, compatible with computer-aided design (CAD). A high-level view of any design can be created using blocks of colour, matching those employed in the Street Layout Toolkit. The LineMap application is hosted in the Buchanan Computing Cloud and provided as 'Software as a Service'. The application can be accessed via any browser.	EN	2022			Software	Integrated and inclusive planning - Spatial/land-use planning	Analysis, scenarios and measure selection	Description: https://morewebsite.wpenginepowered.com/wp-content/uploads/2022/04/MORE-D4.6-Tools-for-stakeholder-engagement.pdf
3.3	MORE Traffweb	Web mapping application with tools for public consultation and stakeholder engagement. It consists of a public area where stakeholders can feed back on issues within the study area, as well as comment on proposed designs. A private area of the website, accessed by designers, allows dashboard reporting on consultation feedback, as well as control over the consultation period.	EN	2022	No	No	Software	Integrated and inclusive planning – Spatial/land-use planning	Data gathering	https://www.roadspace.eu/results/traffweb

#	Tool Short Name	Description	Lang.	Latest update	Assistance required	Assistance data	Tool Type	Thematic Area	Application area	Link
4	Austroads' On-Road Public Transport Priority Tool (ORPT)	The report details a practical process (referred to as a 'tool') to guide practitioners through the selection of On-Road Public Transport (ORPT) priority treatments for any road scenario. The tool is a step-by-step process that assists practitioners in identifying the need for some form of ORPT priority, selecting the ORPT treatment with appropriate justifications, and handing over the decision to the project development group for prioritisation and implementation or incorporating it into planning permit approvals.	EN	2020			Guidance document / Manual	Integrated and inclusive planning - Spatial/land-use planning	Planning and implementing measures	https://austroads.com.au/_data/assets/pdf_file/0022/390055/AP-R645-20_On-road-Public_Transport_Priority_Tool.pdf
5	Transport for NSW Bus Priority Infrastructure Planning Toolbox	This Bus Priority Infrastructure Planning Toolbox provides strategic planning guidance on bus priority infrastructure that improves the overall travel time and reliability outcomes for bus customers, particularly on the Rapid Bus Network.	EN	2021			Guidance Document / Manual	Collective passenger transport & shared mobility - Service improvement	Analysis, scenarios and measure selection	https://www.transport.nsw.gov.au/system/files/media/documents/2021/Bus-Priority-Infrastructure-Planning-Guide.pdf
6	PTV Vissim	PTV Vissim is a microscopic multi-modal traffic flow simulation tool. Whether comparing junction geometries, analysing public transport priority schemes or considering the effects of certain signalling – PTV Vissim allows you to simulate traffic patterns exactly. PTV Vissim not only simulates private transport, but also public transport lines (rail and buses), different vehicle types, timetables, stops, stop types and dwell times. Modeling coordination with signal timing controls enables you to simulate different variants of public transport prioritizations and analyze the effects on public and private transport.	EN, FR, DE, IT, PL, PT, RU	2024	Training courses are recommended.	Network description (including Public Transport supply and intersection control); Demand (split into different modes)	Software	Integrated and inclusive planning - Spatial/land-use planning	Analysis, scenarios and measure selection	https://www.ptvgroup.com/en/products/ptv-vissim#freetrial
7	CIVITAS. Prioritisation of public transport in cities: Policy Advice Notes	Different measures were implemented within CIVITAS II (2005–2009) with the purpose of prioritising public transport within traffic and the urban transport system. The European cities, which introduced these innovative tools, had different experiences both in the planning and implementation phases; these experiences form the basis for the useful know-how that is summarised in this Policy Advice Note.	EN	2010			Guidance document / Manual	Integrated and inclusive planning - Cooperation of policy fields and stakeholders	Analysis, scenarios and measure selection	https://civitas.eu/sites/default/files/civitas_ii_policy_advice_notes_07_public_transport_priority.pdf

#	Tool Short Name	Description	Lang.	Latest update	Assistance required	Assistance data	Tool Type	Thematic Area	Application area	Link
8.1	PARK4SUMP: Parking Standards as a Steering Instrument in Urban and Mobility Planning	The Park4SUMP project addresses parking standards for new developments, which are also called parking requirements or norms. The paper concentrates on standards for new residential areas and mixed-use spaces, excluding purely commercial areas.	EN	2021	No	No	Guidance document / Manual	Integrated and inclusive planning - Spatial/land-use planning	Analysis, scenarios and measure selection	https://park4sump.eu/sites/default/files/2021-02/EN%20%28web%29.pdf
8.2	PARK4SUMP: PARKPAD tool	This is a locally applied audit process that helps cities to review parking policies, achieve consensus on improvements and finally develop an action plan that fits the cities SUMP. The PARKPAD tool optimises proven approaches in quality assessment of cycling policies (BYPAD) and SUMPs (QUEST).	EN	2022	Required assistance from your country's Auditor	Information on parking and motor vehicles in a city, public participation, promotion	Method / Approach	Demand & urban space management - Parking management & pricing	Analysis, scenarios and measure selection	https://parkpad.eu/
9	ReVeAL toolkit	AccessRegulationsForYourCity is a tool to help cities that are considering putting urban vehicle access regulation (UVAR) measures in place. The tool uses the responses to filter the 33 UVAR building blocks identified in the ReVeAL project to suggest the ones that are likely to suit the local context. The output of the tool is a short list of suggested UVAR building blocks that may be worth considering for the input town or city. For each suggested UVAR building block, the respondent will be redirected to a fact sheet that includes enforcement options; considerations on timing, phasing and scaling; gender and equity issues to keep in mind; and a selection of other building blocks that may combine well with it and a case example.	EN	2022	No	Scope, Characteristics of the area, Mobility services already in place, Objectives for the area	Guidance document / Manual	Integrated and inclusive planning - Spatial/land-use planning	Analysis, scenarios and measure selection	https://civitas-reveal.eu/tool/
10.1	UVARBox UVAR State of Play report	The 'UVAR State of the Play' - Report of the UVAR Box project provides knowledge on the current and planned UVAR (Urban Vehicle Access Regulation) policies at the local, regional, and national level.	EN	2021	No	No	Guidance document / Manual	Integrated and inclusive planning - Spatial/land-use planning	Analysis, scenarios and measure selection	https://uvarbox.eu/wp-content/uploads/2022/01/UVARBox_WP1_Deliverable1.1_V4_09-2021_FINAL.pdf
10.2	UVARBox tool to digitise UVARs	The UVAR Box Tool support cities and regions to efficiently digitise already available UVAR data, and provide a usable solution for future processes in view of sharing information on UVARs in force in a given location.	EN	2021	Assistance from UVAR Box technical partners	UVAR information in any format (see tool's description)	Software	Smart & connected mobility - Real-time road user information	Dissemination and communication	https://uvarbox.eu/uvarbox-tool/

#	Tool Short Name	Description	Lang.	Latest update	Assistance required	Assistance data	Tool Type	Thematic Area	Application area	Link
11.1	UVAR Exchange Recommendations on improving data sharing to enforce UVARs in a cross-border context	The UVAR Exchange Recommendations foster cross-border data exchange not only to improve the 'enforcement of' UVARs but also to support 'compliance with' UVARs. The goal is to both inform city authorities about different mechanisms through which they can seek data, relevant for enforcing UVARs, concerning foreign vehicles and drivers, and inform EU citizens about emerging technologies and EU initiatives that can empower them to share their data in a cross-border context to prove compliance with local rules.	EN	2022	No	No	Guidance document / Manual	Smart & connected mobility – ITS for traffic	Evaluation and monitoring	https://uvarbox.eu/wp-content/uploads/2023/12/Panteia_Annex4_Report_task_2.3_clean.pdf
11.2	UVAR Exchange Guidelines for UVAR Variable Message Signs	The UVAR Exchange Guidelines explore the potential of Variable Message Signs (VMS) and how the information provided can be standardised and harmonised regarding UVARs' applications.	EN	2022	No	UVAR information	Guidance document / Manual	Smart & connected mobility - Real-time road user information	Dissemination and communication	https://uvarbox.eu/wp-content/uploads/2024/07/Panteia_Annex2_VMS_Task1_3_clean_new.pdf
12.1	SUMP Topic guide on UVARs	This document describes to an audience of urban transport professionals and planners how to relate UVARs to processes in SUMPs. It provides an UVAR definition and typology, explanation of links to policy objectives, and steps for inclusion in SUMPs as well as case material.	EN	2019	No	No	Guidance document / Manual	Integrated and inclusive planning - SUMPs	Analysis, scenarios and measure selection	e785523a-b62f-4f36-8c33-4ba0528236ef_en (europa.eu)
12.2	SUMP Topic Guide on Parking	This topic guide is based on the outcomes of the Horizon 2020 project Park4SUMP (2018-2022) and focuses on the potential integration of parking management into SUMPs. It reviews the benefits of parking management and different measures that can be implemented. It also provides case studies and discussion of innovation in this field.	EN	2022	No	No	Guidance document / Manual	Demand & urban space management - Parking management & pricing	Analysis, scenarios and measure selection	4ae9e061-dfc9-4f92-afe2-30d70de76580_en (europa.eu)
12.3	SUMP Topic Guide on Decarbonisation of urban mobility	This guide aims to help planners and decision-makers responsible for tackling climate change and for developing transport plans, at all levels, to understand which measures to introduce within Sustainable Urban Mobility Planning (SUMP) and the types of impact that are to be expected from those measures, to achieve the relevant GHG emissions reduction targets. It focuses on personal mobility.	EN	2022	No	No	Guidance document / Manual	Integrated and inclusive planning - SUMPs	Analysis, scenarios and measure selection	https://civitas.eu/resources/sump-topic-guide-decarbonisation-of-urban-mobility

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#	Tool Short Name	Description	Lang.	Latest update	Assistance required	Assistance data	Tool Type	Thematic Area	Application area	Link
13	SUMP-Plus Carbon Reduction Strategy Support Tool	The transition to achieve net-zero carbon targets by 2050 requires radical and urgent change to existing policies. However, cities often lack the knowledge and expertise to understand how different scales and timings of policy strategies impact on carbon emissions, especially when dealing with such long timescales as up to 2050. The Carbon Reduction Strategy Support Tool has been developed to fill that knowledge gap and assist cities in identifying a suitable mix of high-level policy strategies, and their timings, that will achieve carbon targets while also respecting and supporting the other objectives that cities are looking to deliver. The tool provides a 'backcasting' frame to identify strategies needed to reach the desired future, rather than 'forecasting' from the current situation.	EN	2022	No	No	Method / Approach	Integrated and inclusive planning - SUMPs	Analysis, scenarios and measure selection	https://sump-plus.eu/resource?t=Carbon%20Reduction%20Strategy%20Support%20Tool
14	e-smartec Handbook on mobility measures' marketing strategies	This handbook describes a set of engagement tools and methods, providing success tips, "how-to-do" guidelines and examples of best practises for not only raising awareness but also for facilitating the dialogue between multiple stakeholders as well as for identifying bottlenecks and revealing opportunities during the SUMP development process, including road space reallocation and access regulations.	EN	2020	No	No	Guidance document / Manual	Behavioural change & mobility management	Analysis, scenarios and measure selection	https://projects2014-2020.interregeurope.eu/fileadmin/user_upload/tx_tevprojects/library/file_1611912931.pdf

4.Measures support workshop series

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

4.1.1. Results

4.1.1.1. Measures related to traffic management and public transport prioritisation

The workshop on measures related to traffic management and PT prioritisation took place on January 31 in Rome. POLIS ensured the introduction, summarising the seven measures allocated to this topic and the different levels of advancement of the preparation processes (the measure OSL_07 was added to this topic after the Rome General Assembly). The measures cover various traffic management aspects, from implementation of dedicated bus lanes and traffic signal priority systems, to the installation of enforcement mechanisms and the development of tools and methods to assess potential PT prioritisation impacts, and inform decision-making. But common challenges emerged from the presentation of the cities of Budapest and Lisbon, which were then discussed with other demonstration sites in the audience.

<u>BUD_06 Improve the existing PT prioritizing tools in Budapest</u>

Various tools to prioritize PT already exist in Budapest, categorized between active (traffic signals) and passive (bus corridors): bus lanes improve bus traffic flow by 4/5 minutes, and a bridge limits access of individual private vehicles. A system called "Futar" follows vehicles using GPS to communicate with traffic lights when buses approach. PT efficiency is assessed in some cases with standard deviation between buses' theoretical and real time schedules, and a traffic macro-model.
The objective of the measure BUD_06 is to find a monitoring system that allows to uniformly measure the impact of the PT prioritisation & traffic management on PT efficiency. This would be included in a unified guidance to inform decisions on location and tools or measures to adopt for PT prioritisation.

During the discussion, CERTH recommended to assess all existing methodologies and tools that monitor traffic to define a comprehensive guidance and make sure the most relevant ones are used in the most relevant cases, while IFP highlighted the need for integration of pedestrian perspective in traffic management and PT prioritisation – this comment was then enlarged to all road users, including cyclists.

<u>LIS_02 Promote, extend services & prioritise PT</u>

CARRIS (Lisbon PTO) plans to use on-board cameras on buses to monitor bus lane enforcement, to solve the congestion problems impacting PT speed and reliability as well as road safety. But no market-based technologies can fulfil all their needs, and local regulation does not allow to collect private vehicles' data or data from a moving camera. In addition, fines and enforcement can only go through police services and not the PT operator themselves.

During the discussion, it was shared that the cities of Rome and New-York (USA) have experience on moving cameras for what concerns the technical part. The Valencian PT operator EMT informed that they use vehicles with cameras and would be willing to exchange with CARRIS on the topic – this was planned for the Valencia General Assembly of June 2025.

Concerning the regulation challenge, experts in the audience suggested that EU law could support a definition of use cases and existing gaps. In addition, participants reflected upon the option of fixed on-street cameras for public space occupation monitoring, considering it could be easier to obtain a license for them, although they cannot have the same coverage as on-board cameras and still require collaboration with authorities for installation. Finally, the potential inclusion of an anonymization service in the on-board camera system was mentioned.

When it comes to the collaboration necessity with the police services, EMT Valencia state that they cannot issue fines themselves either, and have therefore developed an application to seamlessly communicate with the police. They have a good assessment of this solution.

4.1.1.2. Measures related to low emission zones and other traffic regulations

The workshop on measures related to low emission zones and other traffic regulations took place on January 30, in Rome as well. POLIS ensured the introduction, summarising the six measures allocated to this topic and the different levels of advancement of the preparation processes. The measures cover multiple types of UVARs, including congestion charging schemes, low emission zones, and limited traffic zones, but also parking policies. They also have various objectives, from the implementation of enforcement equipment to the set up of a pilot and the simulations and impact assessment in defined areas. Again, the presentation of Rome's and Leuven's measures objectives and preparation steps raised common challenges and enabled the emergence of potential solutions for several demonstration sites.

ROM_01 Reduce private vehicles by implementing a 'pollution charge' scheme in the core part of Rome Zone 2 & ROM_02 Promoting modal shift towards PT with the implementation of a LEZ in Rome Zone 3

Rome has a very high private car modal share and a national car-centric industry. Citizen behaviour change is required to comply with EU air quality requirements, decongest the city and reduce road accidents. Therefore, the city progressively implements six areas with increasing constraints on private mobility, enforced with electronic gates. The measure ROM_01 implements additional e-gates to enforce the Zone 2 (rail ring) access regulation, and adds environmental criteria to this regulation from 2025 onwards. Specific permits are delivered to residents, coaches, buses, logistics trucks. Payment is required to acquire these permits. The measure ROM_02 implements an electronic system to enforce the Zone 3 LEZ, for which equipment is installed thanks to previous EU and national funding. With national authorisation, the system should operate in November 2024.

During the discussion, the social acceptance challenge was mostly discussed. Since it is very low for these measures, it can be increase through progressive implementation and postponement of different steps, which helps prepare the car users to new regulations. In addition, incentives for sustainable mobility such as mobility or car scrapping budgets can be adopted in parallel to the measure implementation. Finally, assessment and communication on the regulations' consequences on environment and health are very useful too.

LEU_02 Study the needs of parking and public transport in different areas of the city

Leuven has one peripheral car park, including a free bus service on weekends. This measure LEU_02 aims to analyse how to further increase the use of peripheral parking combined with public transport. This analysis will form the basis for a parking policy plan.

The discussion highlighted that most UPPER cities have on-street parking in city centres, while peripheral parking is not well developed. Rome mentioned that they have 27 P&Rs in connection with its UVAR zones, which caused a lot of polemics among citizens, and must be moved following new UVAR implementation. Thessaloniki informed that they have congestion sensitive on-street parking, and incentives to limit public space occupation through private car parking. CERTH raised the use of models & origin/destination data to define best parking services, size and location outside city centres. Further insights included comprehensive parking cost evaluation and multimodal P&R conception.

4.1.2. Conclusions

4.1.2.1. Measures related to traffic management and public transport prioritisation

Inclusiveness of PT prioritising traffic management measures was identified as a common point to raise with experts in the course of the measures' development. Institutional cooperation was identified as a key enabler, and technical and legal challenges were defined as points of exchange between demonstration sites in the UPPER project to support optimal implementation of measures.
The measures' preparation started in the months following the Rome General Assembly, with different objectives, from implementation to data collection and methodology development. POLIS informed the follow-up started in 2023 would continue until the preparation completion by end of August 2024, with the support of monthly monitoring exchanges, and the organisation of ad hoc workshops with project partners who have expertise on identified challenges.

4.1.2.2. Measures related to low emission zones and other traffic regulations

The main challenge identified for all measures related to this topic was social acceptance. Diverse solutions were discussed, from incentive models to co-creation and engagement in measure definition, including awareness raising and information sharing. Tools supporting these processes were included in the supporting resources and shared with cities, although their application would come at a later stage. Indeed, the measures related to UVAR design, deployment and monitoring were planned to start preparation in 2024 for most of them.
POLIS informed the follow-up started in 2023 would continue until the preparation completion by end of August 2024, with the support of monthly monitoring exchanges, and the organisation of ad hoc workshops with project partners who have expertise on identified challenges.

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

4.2.1. Traffic prioritisation of PT

The measures addressing 'Traffic prioritisation of PT' were critically reviewed by project partners and the points of attention were grouped according to 7 main categories listed in Figure 4. The parking prioritisation measures refer to: BUD_06, LEU_07, LIS_02, OSL_07, ROM_04, TES_02, TES_03, TES_06. As we can see in the Figure, the two categories that partners identified most for attention were "Tailored communication for increased acceptance and buy-in" and "Social impact: Health and well-being, Coexistence & Living peacefully, Safety & Security".

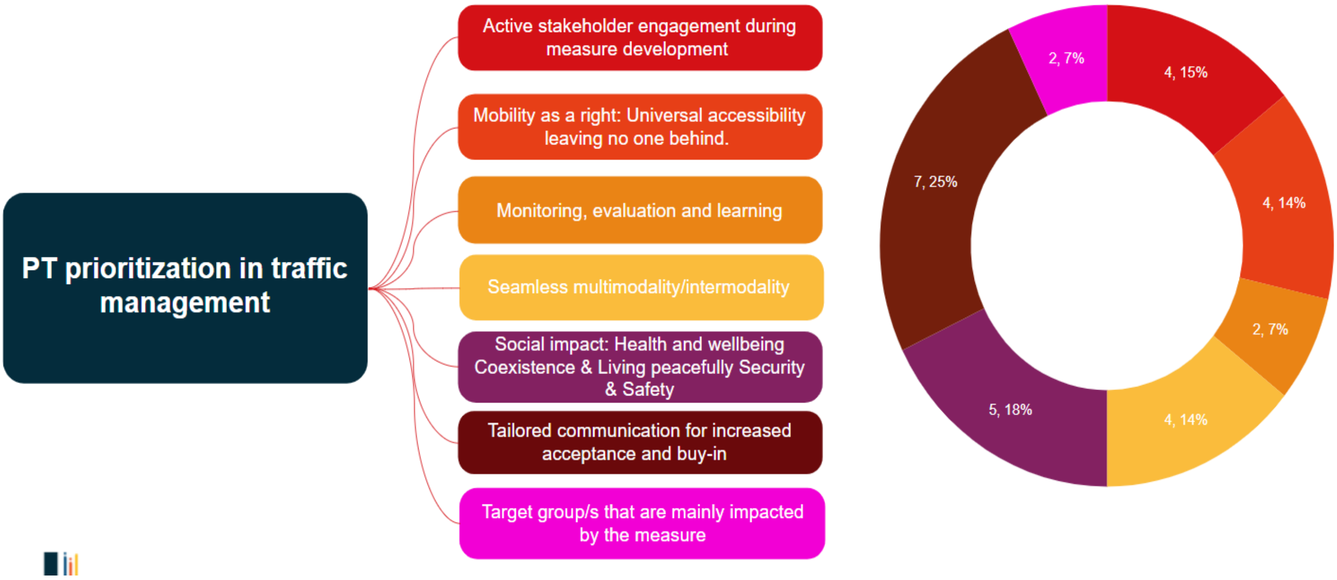

Figure 4 Public transport prioritisation and traffic management measures, reviewed according to points of attention

Considering the results from categorising points of attention, three discussion points focused on identifying challenges and solutions from the cities. Below, the guiding questions are presented with the reflections from city representatives.

1. How do you redesign the network and infrastructure in a way that is efficient and safe for all road users?

In Thessaloniki, PT is the bus network. The metro system is in development. Currently, feasibility studies are being conducted to improve bus stop locations and safety for all users. The bus stops are old and accessibility level is low, especially for wheelchair users. Through the studies, the operator is identifying new locations for the stops and avoiding risks such as narrow streets and inaccessible locations for users. However, they are finding that users are reluctant to change bus stop locations as it is deemed disruptive to their travel patterns. More needs to be done to educate and communicate why stops and bus network lines are changing.

In Valencia, there is already a good network for bike users, and the city has been redesigning bike lanes, for example on the major Blasco Ibañez avenue to give even more space to cyclists. Dedicated, segregated bike lanes have been built with dedicated road space, giving more space for pedestrians and improving safety for all vulnerable road users.

2. How can digital tools offer solutions to support network redesign? How are you using and implementing such tools? What challenges do you face, especially with improving service quality and disincentivising private, car usage?

In Budapest, BKK, the public transport authority, collects data from PT vehicles using onboard sensors, camera-based analysis with the use of artificial intelligence, and also data from travel planner applications. A concrete example is cooperating with companies that produce navigation software, where the optimal route recommendation algorithms can be used to reduce the through-traffic on residential streets and low-traffic neighbourhoods. BKK uses data to help evaluate, plan and introduce changes in the PT and road traffic network and infrastructure.

In Thessaloniki, they are improving road infrastructure for cyclists, to encourage more people to cycle rather than driving their car through the city centre. To ensure safety for cyclists and avoid disruption to the bus network, the tool VISUM is being used to redesign the city traffic. In addition, electronic tickets will be launched for buses and the to-be-launched metro system. It is expected that the e-tickets will provide additional data on PT performance and aid evaluate the network design and future planning. In doing so, the operator hopes to improve service quality and meet customer needs.

4.2.2. UVARs & Parking

The measures addressing 'UVARs and parking' were critically reviewed and the points of attention were grouped according to 7 main categories listed in Figure 5. The UVARs and parking measures refer to: IDF_03, LEU_02, LIS_01, ROM_01, ROM_02, TES_04. And the most addressed categories are related to 'active stakeholder engagement during measure development' and 'social impact on public health and wellbeing'.

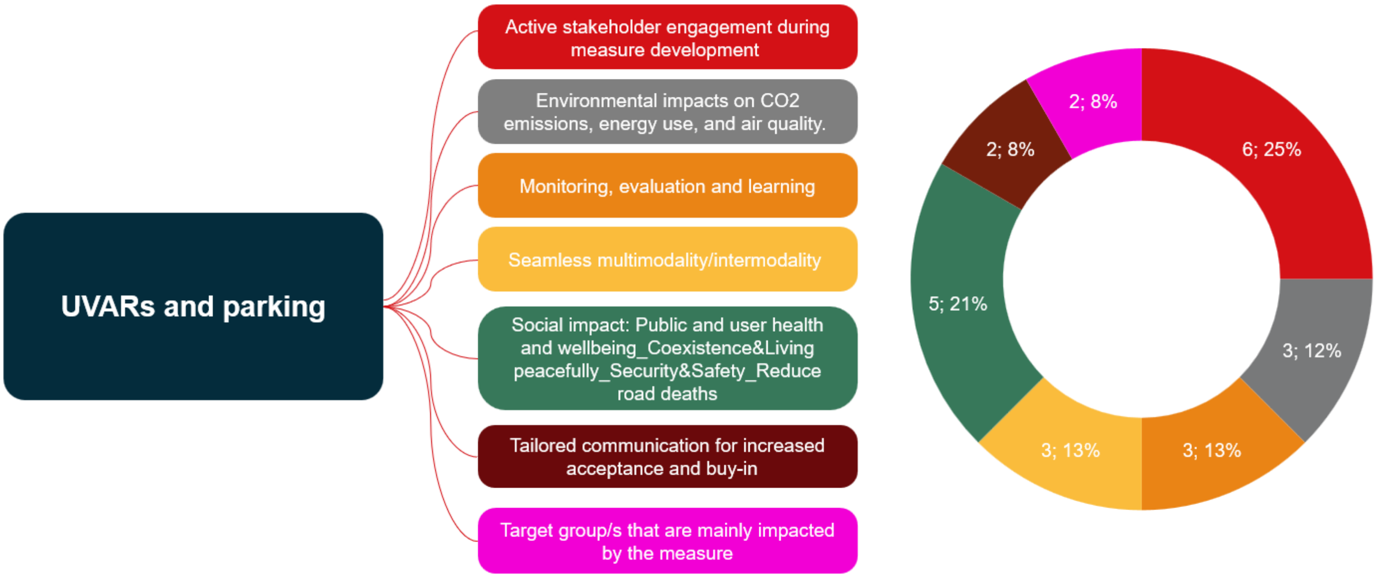

Figure 5 UVARs and parking measures reviewed according to points of attention

The revision and appraisal of the measures led to specific guiding questions for the cities. Hereinafter the respective questions and reflections are reported.

1. With the planned restrictions on private vehicle access, what specific transport alternatives are being proposed? For example, will bike-bus hybrids, shuttle services, or preferential public transport tickets exist?

In Rome, the local authority is establishing a new traffic zone, a green area with limited access in the objective of traffic reduction. As a consequence, there is a strong opposition due to the car traffic restrictions. The push and pull measures are seen as an alternative to balance certain car restrictions and provide other means of transport, for instance, the investment and improvement of public transport options, e.g., renewal of the bus fleet, implementing tramway lines, improving the supply of public transport. Other measures in discussion are communication and campaigns addressing environmental issues and health problems related to transport.

Representatives of Hannover mentioned a balance between push & pull as an important factor. In their case, the city is planning parking spaces, and a better offer of public transport.

2. What strategies and key messages regarding public health, emissions, and road safety are being/will be employed to promote your measure and secure support? How are these messages customised and targeted to specific groups?

Horizontal partners and representatives of the cities reflected that one of the pillars of the measures' implementation relies upon communicating with citizens about the new mobility plans and interventions, and correlating the objectives of active mobility to health, and a better quality of life.

The suggestions of horizontal partners encompass implementing campaigns to promote active mobility in combination with measures that improve infrastructure for cycling and walking, and set apart cyclists and pedestrians from the road to increase safety and enjoyability.

On this note, Rome mentioned the development of a bike lane network, with the objective to increase accessibility and reduce the car road space.

3. What are the particularities of the access and parking system outlined in your measure, and how have pricing and timetable dynamics been determined based on previous experience and assessment of your local context/target groups?

Representatives of Rome described some particularities regarding the restrictions of the access of vehicles in their measures. In certain areas, authorised vehicle users, such as residents, have no restrictions, while other vehicle users have restricted access given specific time periods, and in case of infringement, a fine is applied. The funds collected from fines are reinvested in public transport, according to the city legislation.

Regarding vehicle restrictions, exceptions contemplate people with reduced mobility and disability, public fleets, freight vehicles, and others.

Rome also highlighted the importance of using technology as an asset to enforce the circulation restriction. In that sense, the authorities will continue expanding the network of electronic gates.

On other hand, representatives of Hannover shared that they are currently looking into updating the existing parking ticket management and increase the tariff. This “push” measure will eventually dissuade use of private cars and/or charge car drivers more accurately for the use of public space.

Final reflections on the Workshop revolve around the necessity of balancing restrictive measures with alternative transport solutions, as highlighted by the participating cities. The emphasis on active stakeholder engagement and addressing social impacts, particularly regarding public health and well-being, is crucial for the successful implementation of UVARs and parking measures.

5.Measures preparation process

5.1. Traffic management and Public transport prioritisation

5.1.1. Demo site: Valencia

5.1.1.1. Measure VAL_04: To reduce travel times through the implementation of dedicated bus lanes

5.1.1.1.1. Description of the measure and main outcomes expected

The primary goal of VAL_04 is to reduce travel times through the implementation of dedicated bus lanes. To achieve this goal the measure will ensure traffic light prioritization on Blasco Ibáñez Avenue. Traffic light priority elements installed on Blasco Ibáñez Avenue will be integrated to give EMT buses, such as line 81, preferential treatment at traffic signals. This system will use traffic light prioritization beacons to detect the approach of the buses. When a bus nears an intersection, the system communicates with the traffic signal controller to either extend the green light or shorten the red light, allowing the EMT buses to pass through with minimal delay. Measure VAL_04 is integrated into BRT Blasco Ibáñez funded by Next Generation funds, as an independent demonstrative project.

To achieve this, this measure will launch a public contract for the supply and installation of traffic light priority elements for public transport (traffic light prioritization beacons). Subsequent validation of the installed elements.

5.1.1.1.2. Preparation of the measure

Step 1: Preliminary assessment

Identify the need for traffic light prioritization and establish the goals of the public procurement process.

Key activities:

- Analyse the characterization of the current state of Blasco Ibáñez Avenue (planned in Val_01) to understand the existing traffic conditions and challenges.
- Define the goals and objectives of traffic light prioritization (for example: reducing delays, improving public transport efficiency, among others).

Step 2: Study of the section

Section 2 of Avenida Blasco Ibáñez (between Av. Aragón – C. Doctor Manuel Candela and C. Ramón Llull) has merging lanes from the streets that cross the avenue and numerous intersections with reduced distance between them. In addition, there are sections where the available road width is also quite reduced. For this reason, the segregation of the bus line will be materialized through road markings and separating elements, without altering the current distribution of lanes (Val_01), and traffic light priority elements for public transport (traffic light prioritization beacons).

The intervention on this section will include the relocation of bus stops, the adaptation of vertical and horizontal signage and the replacement of any services that may be affected, street furniture or tree pruning, as appropriate, as introduced in the Val_01 measure sheet.

Step 3: Validation of the optimal solution

Validation process with EMT (PTO) of the preliminary location and typology of **traffic light priority elements for public transport (traffic light prioritization beacons)** solution to be adopted.

Establishing clear criteria to ensure that the solution is effective and meets the objectives when validating traffic light priority elements for public transport is essential. For that reason the following criteria should be considered during the validation of the optimal solution with PTO (EMT):

- **EMT:** effectiveness in reducing travel times: measure the reduction in travel times for public transport vehicles compared to baseline conditions.
- **Valencia City Hall:** system reliability and functionality: ensure that the prioritization system operates reliably and consistently under various conditions.
- **EMT - Valencia City Hall:** integration with existing infrastructure: verify that the prioritization system integrates smoothly with existing traffic management and public transport infrastructure.

Step 4: Subcontracting process for the supply and installation of traffic light priority elements for public transport (traffic light prioritization beacons)

This process requires, on the one hand, defining the technical and administrative specifications and, on the other, the processing of the contract for the supply and placement of traffic light priority elements for public transport (traffic light prioritization beacons) -Step initiated and in process-.

The subcontracting process for the supply and placement of traffic light priority elements for public transport (traffic light prioritization beacons) intended to improve the efficiency and safety of public bus transport services on Avda. Blasco Ibáñez for reducing travel times through the implementation of dedicated bus lanes.

Technical conditions:

- **Traffic light priority elements** for public transport (traffic light prioritization beacons): priority traffic elements will guide decision-making, resource allocation and progress assessment.

Milestones of the public procurement process:

- **Preparation of the public procurement process:** this subphase includes determining the object, establishing the estimated budget and preparing the contract documentation (conditions, requirements and budget justification).
- **Request for offers, awarding of the public contract and contract formalization** *(part of WP6).*
- **Execution of the contract** *(part of WP6):* this subphase includes infrastructure completion, system testing and system integration.
- Once the **traffic light priority elements for public transport** have been installed, Valencia City Hall and EMT will carry out a post-implementation review (pilot testing).
- **Reception of the work carried out and validation of results** *(part of WP6).*

The installation of **traffic light priority elements for public transport (traffic light prioritization beacons)** and the consecutive validation and acceptance of the results of the pilot tests is expected to start in the fourth quarter of 2024.

5.1.1.1.3. Challenges & Mitigations

The criteria of **Step 3** provide a situation point for validating traffic light prioritization elements ensuring that the system effectively enhances public transport while balancing the needs of all road users. The subcontracting process **(Step 4)** will ensure that the chosen traffic light prioritization solution validated is effective, reliable, and ready for broader implementation. All in all, within the process of implementing and validating **traffic light priority elements for public transport (traffic light prioritization beacons),** the following challenges and mitigations can be highlighted.

Challenges:

- **Traffic congestion:** implementing traffic signal priority (TSP) for BRT buses involves adjusting traffic lights to give BRT buses priority, reducing delays and improving overall traffic flow; this implementation may cause an exceed on roadway capacity.

Mitigations:

- **Install sensors (traffic light prioritization beacons)** that detect approaching BRT buses and adjust traffic signals accordingly to minimize the impact on general traffic while ensuring BRT efficiency.

5.1.1.1.4. Next steps towards implementation

The next steps necessary to proceed with the implementation of the measure (already taking place under WP6) are briefly described below.

Study of offers and award of contracts

- Evaluation of technical proposals (tender process).
- Awarding of the public contract and contract formalization.
- Execution of the contract.
- Reception of the work carried out and validation of results.

Installation of traffic light priority elements for public transport (traffic light prioritization beacons)

- Execution of technical tasks: technical analysis and proposal of technical work.
- Validation and acceptance of the technical supply and facilities.

5.1.2. Demo site: Rome

5.1.2.1. Measure ROM_04: To design the new high frequency and high-capacity PT infrastructure

5.1.2.1.1. Description of the measure and main outcomes expected

As outlined in the SUMP approved in Rome in 2022, the improvement and enlargement of the Mass Rapid Transit (MRT) supply is a key element to rebalance the modal share in favour of the PT.

To this end, the SUMP expects by 2030 the implementation on 11 new tramway lines. Four of them are already financed (in sone cases with RFF funds, with a deadline in 2026) and are “in the pipeline”: TVA, Togliatti, TTV and Tiburtina, along with the implementation of new adequate depots. For two out of these four lines, the measure ROM_04 will deliver an **executive design of the lines and depots,** and a **requirements’ definition for the tendering process** (TVA line 1st branch and Togliatti line). For the two others, the measure will deliver **procurement activities** and the **launch of implementation** (TTV and Tiburtina). The remaining seven tramway lines have different schedules: they need to undergo a **process to be eligible for funding** by the Italian Ministry of Transport and Infrastructures (MIT). This process will be reported upon in this measure.

In addition, the MRT increase also expects the Metro C line extension (opening of 2 new stops in the central area, connection with B line in Colosseo) and the procurement of new carriages and vehicles to increase the PT capacity in Rome. Within the measure ROM_04, **40 new trams and 14 new metro trains will be procured**.

Currently, the urban tram network in the city of Rome consists of six lines, with an infrastructure of approximately 32 km and the rolling stock currently consists of 164 carriages. At present only two depots and workshops exist, located in Via Prenestina and Porta Maggiore facilities.

The main objective of the measure is empowering the sustainable and high-capacity transportation, with rationalization of several bus lines, reduction of pollutants and improvement of service standards to the public.

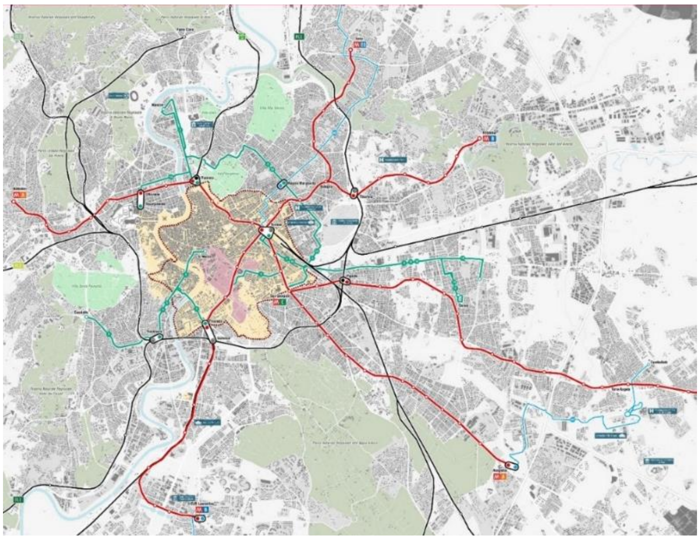

Figure 6 Current tram network - extension 32 km

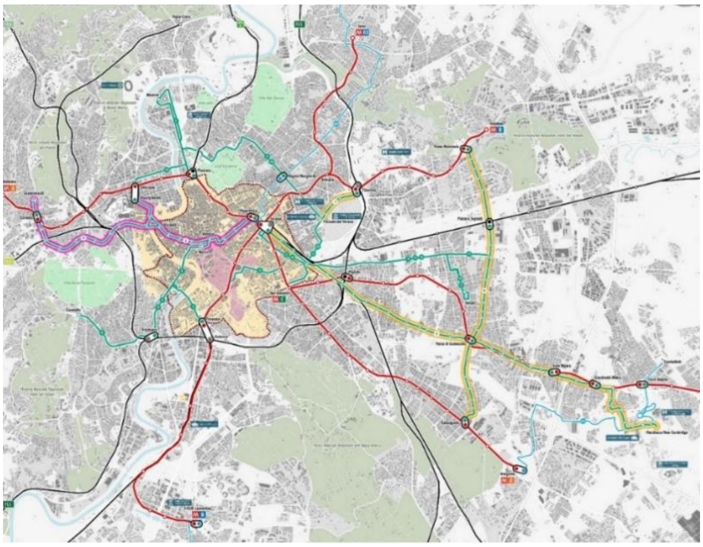

Figure 7 Tram network extension in the SUMP mid-term scenario: 63.7 km (4 lines)

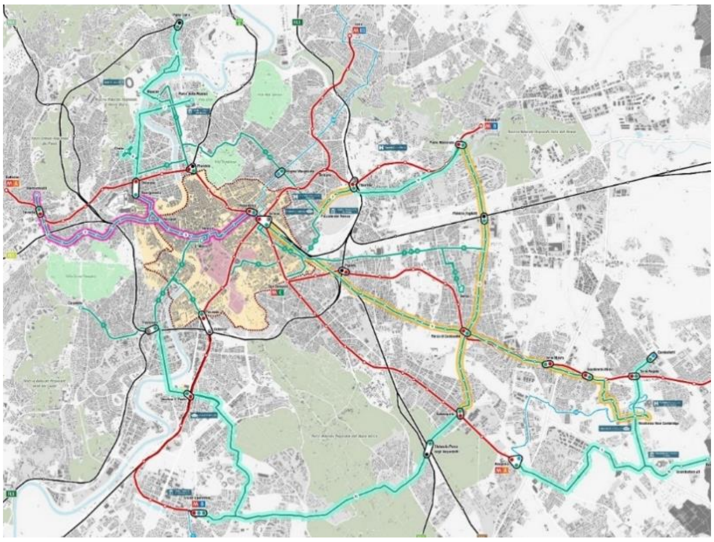

Figure 8 Tram network extension in the Long-term scenario 101.2 km, (+ 7 lines and a new depot)

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5.1.2.1.2. Preparation of the measure

TRAMWAY LINES

Termini-Vaticano-Aurelio tramway (TVA) - The TVA new infrastructure will connect the renewed multi-modal hub of Termini with the western part of the city. The final terminus will be at Cornelia metro A station, while its branch at Piazza Risorgimento (Vatican) will connect with the city's main tourist and religious centers. The line design includes some sections without overhead contact line. Therefore, the new carriages will have to be equipped with on-board storage systems. It will have a length of 8.3 km, 20 stops.

In 2023 the technical and economic feasibility project, prepared by RSM, and the economic framework of the TVA line were approved. Following the participatory process held in early 2024, the final approval and the signature of the contract were issued in May 2024. Meanwhile, the documents for the publication of tenders related to the management of works and the safety coordination services were prepared. Tenders were published on May 14, 2024. Pending the finalisation of the contractual acts, the Director of Works ordered the RUP to urgently start the survey and investigation activities preparatory to the start of the design.

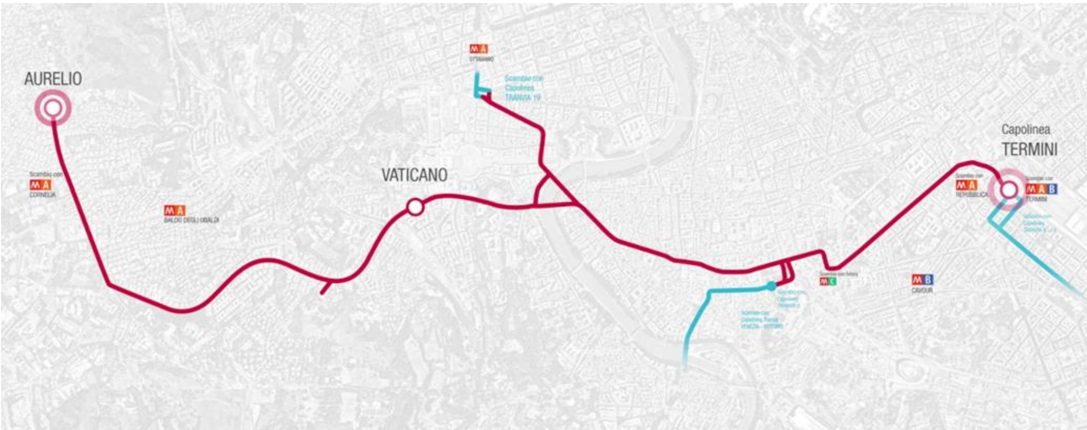


Figure 9 Map of TVA tram line

TOGLIATTI tramway - The tramway infrastructure is “transverse” and located in the eastern peripheral area of the city. It will cross the three metro lines, and the urban railway. The project also includes infrastructural road works. The new line will also cross the GRAB, a new cycling path under construction. The entire route is about 8 km long with 19 intermediate stops. The line includes some sections without overhead contact line. Therefore, the new carriages will also have to be equipped with on-board storage systems, which will be hosted and maintained in the Atac depot in Via Prenestina.

The final and executive design of the Togliatti line was finalized by RSM in 2023 and received by the Mobility Department. It was sent to Invitalia (the national contracting authority) to issue the tender. The tender notice for the integrated contract was published in September 2023, and awarded in late 2023.

Figure 10 Map of Togliatti tram line

<u>Termini Tor Vergata tramway (TTV) –</u> The line will connect the Termini Hub with the eastern periphery of the city. The line expects the integration, modernization (including gauge) and extension of an existing line. Because the new route of the line involves a short stretch the Appia Antica regional park, an Environmental Impact Assessment (EIA) was necessary. This assessment covers the "interference" in the regional park, as well as the compliance of the project with opinions expressed by the relevant bodies at the services conference.

In 2023, the preliminary phase for the construction of the new TTV tramway was completed with the Services Conference involving municipalities, Net, Italgas, Superintendence, and Atac.

At the end of November 2023, the projects were sent to the Lazio Region to start their own Environmental Impact Assessment and Services Conference. In February 2024, the procedure was initiated at the Lazio Region. It takes up to 180 days to accept or reject the application.

<u>Tiburtina-Verano tramway -</u> In June 2024, the final design and the economic framework of the Tiburtina Station-Verano tramway elaborated by RSM and the Rome Mobility Department were approved by the Lazio Region. This step came just after the approval of the final Project by the Lazio Region.

<u>Design and approval of 7 new tramway lines for future funding by MIT –</u> RSM was entrusted by the Mobility Department of Rome to carry out all the activities for the preparation of the *technical-economic feasibility* project of 7 new tram lines (according to the SUMP). Therefore, RSM carried out a tender procedure in five lots for the assignment of the design services related to technical and economic feasibility.

The activities were organized in two phases, an initial one involving the drafting of the feasibility document of the project alternatives (DOCFAP), and a second one following the Contracting Authority's approval of the DOCFAP, about the drafting of the technical and economic feasibility projects (PFTE-Phase 2). To carry out the activities, several meetings were organized to define the paths, possible route alternatives and design solutions. Possible roadway configurations were examined, including all mobility components (public transport, private transport, cycle paths, pedestrian mobility, etc.). Traffic patterns in the areas affected by the interventions were examined and transport assessments were carried out. Once the DOCFAP was approved, the technical and economic feasibility projects (PFTE) were drafted. The PFTE includes: topographical surveys of the areas affected by the intervention, phytosanitary surveys (trees), technical reports (urban framework, hydrological, hydraulic, geological, seismic, archaeological), transport studies, preliminary environmental studies, design drawings (chorographies, plans, sections, profiles, armament, , etc.), power supply system (report, sizing, substations), signalling system, construction site, census and interference resolution (sub-services), preliminary site plan, preparation of technical/economic documentation, and the documentation required for MIT funding. In addition, on the basis of the PFTE design documents, communication materials were developed for the dissemination phases.

The above PFTE were then shared with the Mobility Department to obtain approvals in the Conference of Preliminary Services. (*The purpose of the Conferences of Preliminary Services is to indicate to the applicant, prior to the submission of a final project, the conditions for obtaining the necessary opinions, understandings, concertations, authorisations, concessions or other acts of consent).* After obtaining the feedback from of all relevant offices, the PFTE were accordingly revised for the final version to be approved by the *Capitol Council*.

METRO STATIONS

2 new Metro C stations – The Rome Mobility Department together with the "Roma Metropolitane" company supervise on-going works in the Amba Aradam and the Colosseo Fori Imperiali stations.

METRO AND TRAM VEHICLES

New metro trains – In 2023, the framework agreement between Roma Capitale Mobility Department and Hitachi Rail was signed. The first application contract calls for the supply of 14 trains, of which 12 are destined for Metro B and 2 for Metro A. The delivery will start in December 2024 and will be completed within 12 months. A further Jubilee 2025-related financing for the purchase of a further 6 trains in the amount of 60 mln € is under way.

New Tramcars – The requirement for 121 new bidirectional trams (partly substituting the older ones) has been identified by the Mobility Department and Atac (the main PTO in Rome). The framework agreement was concluded with the supplier in 2023. During the UPPER project it is expected to have 12 tramcars delivered and commissioned.

Figure 11 Mock-up of the new tram

5.1.2.1.3. Challenges & Mitigations

TVA tramway

- Interference with the Jubilee and with other on-going works

The construction of the TVA line has been divided into 3 lots. After discussions and evaluations, since 2025 is the year of the Jubilee, the public administration decided to start the first lot of work (funded by RRF) from the external part of the line (Aurelio) rather than from Termini as initially planned, so as not to interfere with other ongoing construction sites. This first lot is the subject of the UPPER project.

- Integration into the historic landscape

In 2023, the Roma Capitale Mobility Department commissioned the Faculty of Architecture of La Sapienza University of Rome to study and research new design solutions for the enhancement of the central and historic Piazza della Repubblica - Ponte Vittorio.

- Interference with existing systems

All potential interferences were considered in the executive design phase:
- Water and sewage systems
- High, medium and low voltage lines
- Visual impact with monuments
- Possible relocation of bus stops
- Tree planting
- Urban planning compliance

TTV tramway

- Environmental issues: electromagnetic fields and micro-tremor investigation

Environmental investigation plan: definition of references to be contacted to speed up its approval time by involving the relevant agencies in the first instance

- Archaeological issues: intersection with monuments and a protected historical park.

Involvement of the Soprintendenza (National heritage protection body) / EIA procedure, archaeological investigation plan: mode of activation and conduct.

- Technical issues: adaptation and integration with the Termini station square with the other infrastructures.

Design coordination on the proposals on Piazza dei Cinquecento (Termini station hub) and neighbouring areas in the different time scenarios with the engineering of the insertion of the tramway seat of the Termini-Tor Vergata LRT line.

7 new tramways design

The activity was delayed due to difficulties in acquiring underground utilities information, receiving needed feedback from the city boroughs, archaeological authorities, citizens and other stakeholders. For this reason, it was necessary to grant an extension to the activities in order to finish all required activities.

5.1.2.1.4. Next steps towards implementation

TVA tramway – Final and executive design, services conference, project verification, validation and approvals (Commissioner, Roma Capitale, Lazio Region, MIT) will be concluded by September 2024, and works will start in autumn 2024.

TOGLIATTI tramway – Final and executive design, services conference, project verification, validation and approvals (Commissioner, Roma Capitale, Lazio Region, MIT) by September 2024. Start of Works October 2024 - duration: 600 days.

TTV tramway – Conclusion of the EIA evaluation by Regione Lazio to proceed with the final design of the line.

Tiburtina-Verano tramway – The next step will be the call for tenders for the integrated project including the construction of infrastructure providing a rapid surface connection of Tiburtina Station and Metro B and a rapid surface connection with important streetcar routes in the semi-central districts of the city (Viale Regina Margherita, Prenestina-Porta Maggiore, and Aventino-San Giovanni-Porta Maggiore).

7 new tramways design – At present, all the Conferences of Services have been held and we are waiting for the approval of the feasibility projects by the Capitol Council to prepare all documentation needed for the consequent funding request at MIT.

2 new Metro C stations – Inauguration in early 2025.

5.1.3. Demo site: Lisbon

5.1.3.1. Measure LIS_02: Promote, extend services and prioritise PT

5.1.3.1.1. Description of the measure and main outcomes expected

This measure aims to address the factors affecting the performance of CARRIS' bus and tram services, with particular emphasis on commercial speed. The measure consists of two complementary activities:

- Testing of camera-based BUS lane enforcement to address infractions. The misuse of BUS lanes by unauthorized vehicles, as well as the improper parking blocking BUS lanes and bus stops, are very frequent occurrences that greatly affect the quality of bus and tram services. This activity aims to test the introduction of automatic enforcement technologies, while instigating national authorities to adopt regulations that would allow PTOs to operate such systems and apply fines to offenders.

- Analysis of existing bottlenecks and enhancement opportunities, to allow the identification of critical points of conflict in the city of Lisbon and the evaluation of improvement measures. This activity aims to produce a report/analysis that prioritizes critical areas of conflict and assesses the best strategies to mitigate their negative impacts in PT service offer and operations

5.1.3.1.2. Preparation of the measure

Over the course of measure preparation, CARRIS has prepared, launched and finalized the tender for the procurement for the camera-based automatic infraction detection mechanisms, to conduct the BUS lane enforcement pilot. Two providers sent their proposals, and one was selected to proceed with the testing. Presently waiting for the finalization of the contract signing process, in order to initiate the installation of the camera-based systems onboard the vehicles.

In parallel, multiple discussions were fostered with the National Road Safety Authority to promote the development of new regulations that will allow for the employment of these automated infraction detection systems in road enforcement, enabling the police and other credited agents to issue fines based on the collected evidence. As a secondary goal, CARRIS also advocated for PTOs to be recognized as authorized enforcement agents, able to apply fines in instances where BUS lane infringement or improper parking directly impacts PT operations.

Regarding the analysis of the existing points of conflict in the city of Lisbon, a data collection was conducted for a set of indicators relating to: the operational performance of bus and tram services; the reported incidents and accidents. The collected data refers to the whole CARRIS network and years of 2022 and 2023. The report analysing the main factors affecting commercial speed and the identification of critical conflict points in the city is under preparation.

5.1.3.1.3. Challenges & Mitigations

During the measure's preparation, two major challenges were identified that prompted the reformulation of its scope and goals.

The first encountered obstacle relates the lack of pre-existing legislation enabling the use of camera-based enforcement systems to collect valid evidence of infractions, which could then be used to issue fines. This circumstance is not unique to Lisbon, having been reported by other cities within the UPPER Consortium, such as Valencia for example.

As a contingency, the measure's scope was reformulated into a "proof-of-concept" pilot (rather than the enforcement pilot initially intended), whereby CARRIS would install and operate the automatic infraction detection camera-based system (testing the technology, evaluating its performance and collecting the generated outputs) without issuing fines. In this framework, the pilot tests will act as a Case Study to promote the creation of new legislation allowing for these technologies to be allowed in road traffic enforcement. This approach was discussed with the National Road Safety Authority, who approved and welcomed the initiative, stating that this would also enable them to more easily define the requirements for these systems.

The second obstacle encountered is due to budgetary constraints. The initial measure design proposed the installation of 10 to 20 equipments onboard the vehicles that would be allocated to services in one or two major corridors in the city. However, the received proposals were significantly higher than anticipated, allowing the purchase of only 1 or 2 equipments.

In this context, the monitoring of the selected corridors is no longer practical. Instead, the pilot was reframed into a technological exploration pilot, whereby the focus will be on thoroughly assessing the provided system, its features, and its success in detecting infractions. The smaller scope of the pilot shall be compensated by an in-depth analysis on the operational and road safety data collected by CARRIS, in order to quantify the magnitude of these infractions' impact on the PT services and to identify critical points in the city where they are more common or severe.

5.1.3.1.4. Next steps towards implementation

Next steps include the installation of the camera-based system onboard of the vehicles to initiate the pilot tests. Once these are launched, in parallel to the data generated by the automatic detection system, a set of relevant operational performance indicators will be collected for the whole CARRIS network. This will enable the development of two side-by-side reports: one recounting the outputs of the technological pilot, and one highlighting the impacts of infractions on the quality (i.e. performance) and safety of the CARRIS' bus and tram service operations.

These reports will be shared with the National Road Safety Authority, highlighting the degree of impact of these incidents on PT services and road safety, and providing a proof-of-concept on automatic infraction detection technologies, to prompt the development of specific legislation to certify these technologies and allow for their employment (by PT operators, law enforcement and other relevant entities) to produce fines.

5.1.4. Demo site: Budapest

5.1.4.1. Measure BUD_06: To improve the existing PT prioritizing tools in Budapest

5.1.4.1.1. Description of the measure and main outcomes expected

In the recent years, numerous new interventions have been introduced around Budapest, with a focus on public transport prioritization. These new interventions have included the establishment of dedicated bus lanes, new traffic light programmes, and other similar transport measures that resulted in success by reducing journey times and attracting more public transport users. These successful interventions raised the attention of BKK to continue working on similar processes that could ensure the competitiveness of public transport.

The BUD_06 measure focuses on the **creation of a methodology for the evaluation of existing preference instruments**. With the help of the methodology, the effectiveness of the existing PT prioritizing tools and locations will be measured, which will help in the effective selection preferred tool for new designs.

BKK is currently working on the Public Transport Network Strategy of Budapest, which is a sub-strategy of Budapest SUMP. PT Network strategy also defines the need for finding new ways and locations to prioritize PT flow in the city and to develop methodologies to assess the effectiveness of prioritization tools.

The main outcomes of this measure will be a **methodology** to assess the effectiveness of prioritization tools already implemented, a **priority list** of the possible PT prioritization measures (for different type of locations and given conditions) and a **documented guideline** to testing new location (on which sections of actual PT lines would it be justified to implement PT prioritization).

5.1.4.1.2. Preparation of the measure

<u>Case description</u>

BKK is committed to the continuous provision of competitive public transport services, but the average speed of public transport is not everywhere competitive with private motorized transport. BKK uses different PT prioritising tools to help and control traffic flow in order to be competitive in travel time, but the effectiveness of these tools has not yet been uniformly measured. In case an intervention is about to be introduced in a new location, there is no documented guideline available to help select the appropriate tool.

BKK continuously monitors the journey times of public transport in Budapest, monitoring their length and unexpected changes. A methodology that has been used for several years is available for this type of spare time test. However, a comprehensive journey time investigation has not been carried out in the recent period. BKK has so far examined the impact of the already implemented PT prioritization tools only on a case-by-case basis. However, in order to ensure a competitive service, a comprehensive investigation has become due, for which a methodology must first be prepared.

The tools BKK applies for prioritizing PT flow, with the purpose of reducing journey times and improving predictability of PT services, are the following:

- Passive tools
  - Dedicated bus lanes in crowded road sections (median or curbside bus lanes)
  - Bus/tram-only road with exceptions
  - Common transit lanes (e.g. trams and buses)
  - Bus corridor
  - Negative bay for bus stops
  - Separation of PT flow from other road traffic by dedicated traffic lights
- Active tools
  - Traffic signal controlled PT priority
  - Bus gate – enables buses to switch lanes in dedicated locations

Technical specifications

For the analysis, BKK used the mileage data recorded in the RealCity program[1]. Only the mileage data of the last three months is available as a tender for the program, on a stop-by-stop basis for all Budapest connections. After the data was collected, the analysis was broken down into hourly segments so that both peak and off-peak trends could be seen. The available data did not allow to examine short and point-specific priority methods, so it was necessary to select bus lanes of the appropriate length from the listed priority means. Within these, sections that are led in the middle, led on the edge and shared with the tram were selected, which are of suitable length and areas with the highest number of passengers. In the first round, these locations will be examined.

[1] The RealCity program stores the data of all trips made (travel time, speed, time spent at stops) in the last three months.

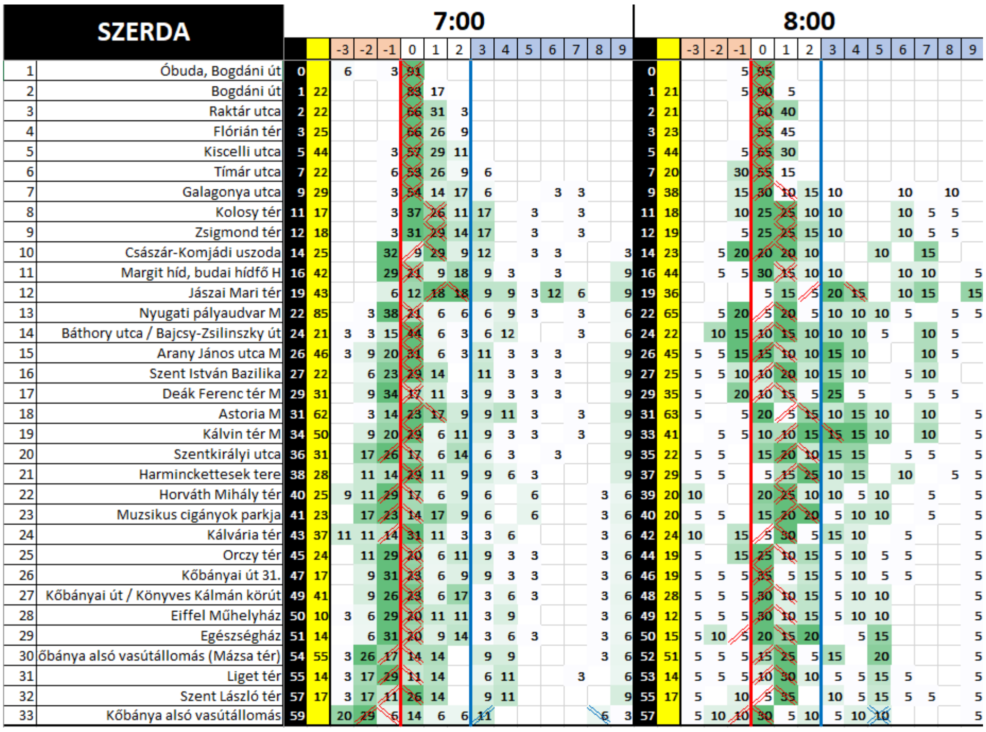


Figure 12 Bus line No. 9 between Deák Ferenc square and Kálvin square stops

After the selection of the locations and the collection of the data, the journey time and running time examination was carried out. In order to make the data more transparent, the analysis was not only done in MS Excel, but also using Power BI software for analyses and data visualizations.

On the Figure 13 below, the black line shows the planned travel time, the lines above it show when the buses are late and the lines below show the early buses.

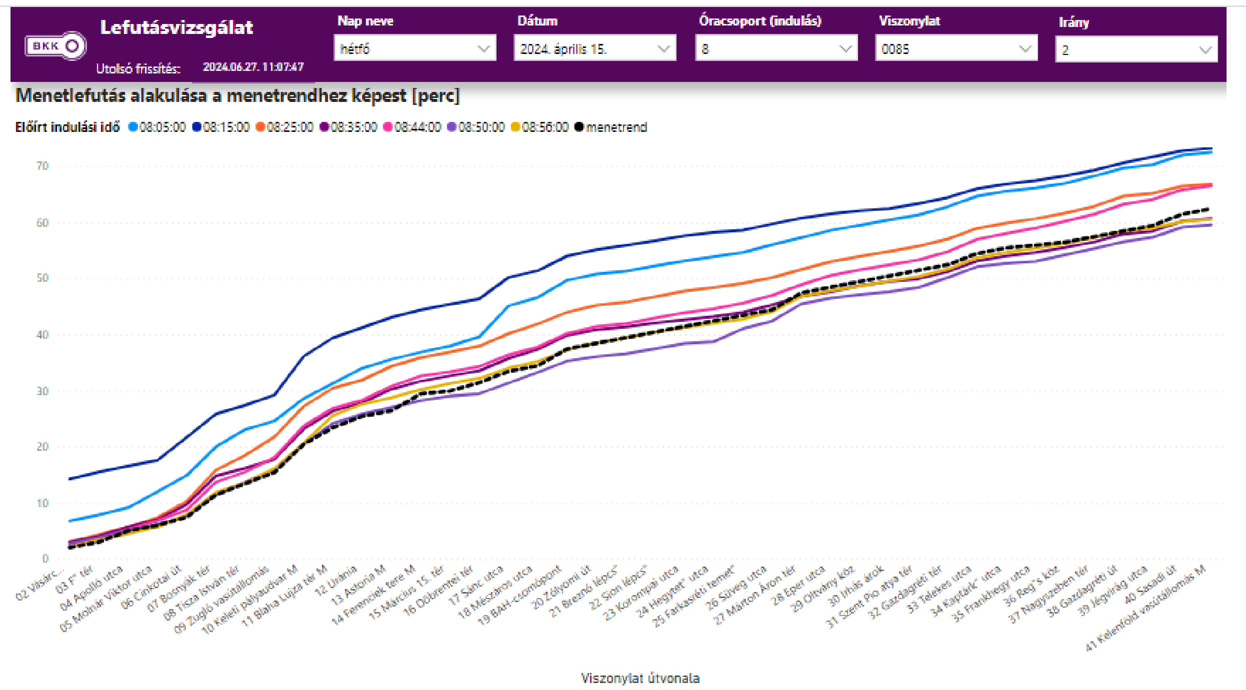
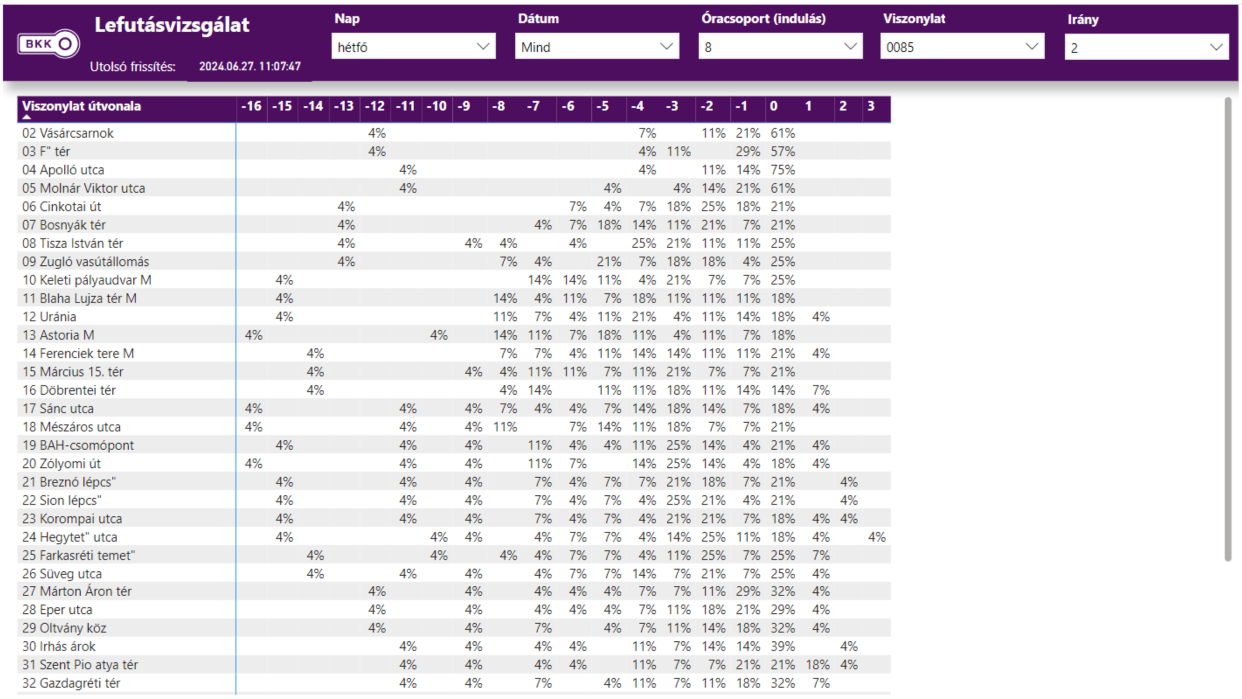


Figure 13 Bus line No. 8E between Vásárcsarnok and Kelenföld railways station

On the Figure 14 below, a standard deviation table shows what percentage of the bus rides arrives with the specified minutes late or early. Based on this, analyses will be prepared in the next period, in which it will be seen whether the delays at stop intervals can be reduced as a result of prioritisation.



Viszonylat útvonala	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3
02 Vásárcsarnok					4%								7%		11%	21%	61%			
03 F" tér					4%								4%	11%		29%	57%			
04 Apolló utca						4%							4%		11%	14%	75%			
05 Molnár Viktor utca						4%						4%		4%	14%	21%	61%			
06 Cinkotai út				4%							7%	4%	7%	18%	25%	18%	21%			
07 Bosnyák tér				4%						4%	7%	18%	14%	11%	21%	7%	21%			
08 Tisza István tér				4%				4%	4%		4%		25%	21%	11%	11%	25%			
09 Zugló vasútállomás				4%					7%	4%		21%	7%	18%	18%	4%	25%			
10 Keleti pályaudvar M		4%								14%	14%	11%	4%	21%	7%	7%	25%			
11 Blaha Lujza tér M		4%							14%	4%	11%	7%	18%	11%	11%	11%	18%			
12 Uránia		4%							11%	7%	4%	11%	21%	4%	11%	14%	18%	4%		
13 Astoria M	4%						4%		14%	11%	7%	18%	11%	4%	11%	7%	18%			
14 Ferenciek tere M			4%						7%	7%	4%	11%	14%	14%	11%	11%	21%	4%		
15 Március 15. tér			4%					4%	4%	11%	11%	7%	11%	21%	7%	7%	21%			
16 Döbrentei tér			4%						4%	14%		11%	11%	18%	11%	14%	14%	7%		
17 Sánc utca	4%					4%		4%	7%	4%	4%	7%	14%	18%	14%	7%	18%	4%		
18 Mészáros utca	4%					4%		4%	11%		7%	14%	11%	18%	7%	7%	21%			
19 BAH-csomópont		4%				4%		4%		11%	4%	4%	11%	25%	14%	4%	21%	4%		
20 Zólyomi út	4%					4%		4%		11%	7%		14%	25%	14%	4%	18%	4%		
21 Breznó lépcs"		4%				4%		4%		7%	4%	7%	7%	21%	18%	7%	21%		4%	
22 Sion lépcs"		4%				4%		4%		7%	4%	7%	4%	25%	21%	4%	21%		4%	
23 Korompai utca		4%				4%		4%		7%	4%	7%	4%	21%	21%	7%	18%	4%	4%	
24 Hegytet" utca		4%					4%	4%		4%	7%	7%	4%	14%	25%	11%	18%	4%		4%
25 Farkasréti temet"			4%				4%		4%	4%	7%	7%	4%	11%	25%	7%	25%	7%		
26 Süveg utca			4%			4%		4%		4%	7%	7%	14%	7%	21%	7%	25%	4%		
27 Márton Áron tér					4%			4%		4%	4%	4%	7%	7%	11%	29%	32%	4%		
28 Eper utca					4%			4%		4%	4%	4%	7%	11%	18%	21%	29%	4%		
29 Oltvány köz					4%			4%		7%		4%	7%	11%	14%	18%	32%	4%		
30 Irhás árok						4%		4%		4%	4%		11%	7%	14%	14%	39%		4%	
31 Szent Pio atya tér						4%		4%		4%	4%		11%	7%	7%	21%	21%	18%	4%	
32 Gazdagréti tér						4%		4%		7%		4%	11%	7%	11%	18%	32%	7%		

Figure 14 Bus line No. 8E between Vásárcsarnok and Kelenföld railways station

On the Figure 15 below, the colour codes on the map indicate whether the bus' actual travel time is late or early compared to the planned travel time.

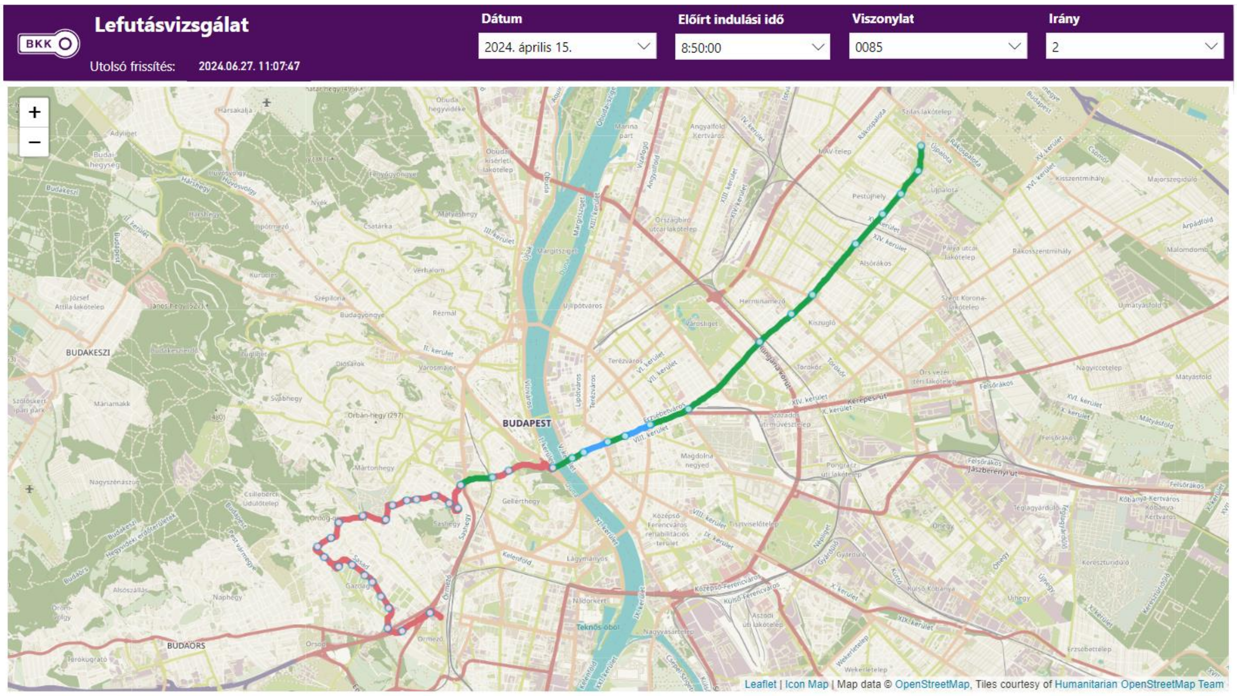


Figure 15 Bus line No. 8E between Vásárcsarnok and Kelenföld railways station

UPPER

5.1.4.1.3. Challenges & Mitigations

The real travel time data is only available for stop intervals, not for smaller sections, so the impact of shorter sections and spot interventions cannot be measured, only longer units.
BKK is not able to measure the impact of all of the preferential measures on a uniform database, for example: Green Passenger traffic lights program is operated by an external partner, and BKK does not have access to the data.

The planned journey times will be reached within a day, because they are corrected with predictable congestion during peak hours, so it will be predictable for passengers. However, this already distorts the comparison. The predictability of the travel time is an important goal, therefore, on one day, the services traveling on busier routes have several planned travel times. The journey times are determined according to the traffic of the given period, usually based on the real data of the previous three months. This means that a bus traveling on a busy road section at 6 a.m., when there is little traffic, has a planned travel time of 30 minutes, while the same bus takes 35 minutes at 8 a.m., for example.
For the time being, there are no funds available to implement the development proposals that come out during the investigation.

5.1.4.1.4. Next steps towards implementation

The next steps planned in the measure BUD_06 are the following:

- Further development of the Power BI visualization & development of the map display
- Creation of analyses showing whether delays can be reduced at stop intervals as a result of prioritization using the standard deviation table
- Analysis of the selected additional locations
- Proposal for new preference options based on the existing data

5.1.5. Demo site: Leuven

5.1.5.1. Measure LEU_07: Increase the quality of the PT services through traffic management and dedicated lanes for PT

5.1.5.1.1. Description of the measure and main outcomes expected

The city of Leuven, the regional public transport operator and the regional authorities are currently working on redesigning the public bus system to create high quality public transport in several dimensions. Within this context, Leuven aims to redesign the different transport axes throughout the city to facilitate the creation of separate bus lanes and prioritise traffic signals for the main PT axes. This measure will contribute to the planning, monitoring and evaluation of this redesign process. This measure will deliver an **analysis/tools for selecting locations** and refining the implementation method for bus corridors, an **analysis of further potential locations** with attention to potential gains and costs, the **identification of 3 locations** where priority for PT will be implemented through bus lanes and/or intelligent traffic lights, and the **preparation of the last phase of the new and improved bus network** starting in January 2025.

5.1.5.1.2. Preparation of the measure

The bus network in Leuven is changing completely and will be introduced on January 6th, 2025. With the Basic Accessibility ('Basisbereikbaarheid') Decree, the Flemish government made its renewed mobility vision concrete in 2019. With this, Flanders is committed to more efficient, sustainable and flexible public transport.

In 2020, a concrete plan was developed for Leuven. The basic principles for Leuven's new city network are:

- high-quality access to the 5 most important attraction poles
- fewer buses through the center while sufficiently smooth accessibility is guaranteed by having regional lines run via the Leuven ring road as much as possible and city lines via the center to avoid transfers
- city lines that run longer and more frequently, so that travelers don't have to wait as long
- an increased Saturday service on city lines during shopping hours

In August 2022, the Flemish Minister of Mobility decided however to introduce the Basic Accessibility Decree in phases. Only in January 2024, phase 2 started up, with a number of changes that also involved the Leuven network. On January 1st, 2025, phase 4 will start up in Leuven, with the introduction of a whole new bus network. Since the original plan was established four years ago, optimizations compared to the original 2020 plan were necessary. For phase 4, De Lijn (Leuven PTO) proposed a number of changes from the already approved network in 2020. The preparation for the new bus network is now finalized: the alignment with De Lijn and the key stakeholders of the city for the changes has been completed, the final proposal of the new network is approved by the city council, and the necessary infrastructural adjustments are approved and being prepared.

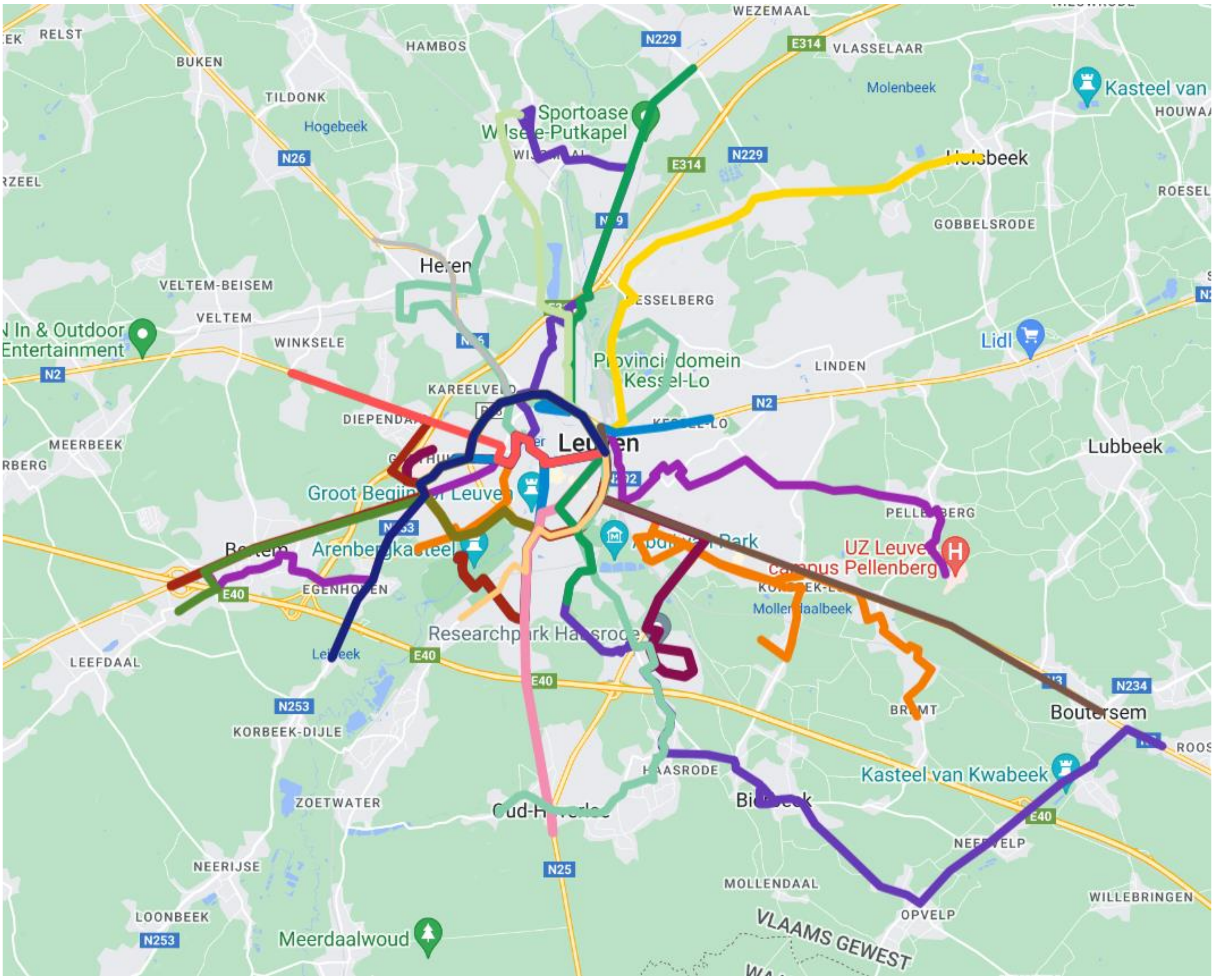


Figure 16 Overview of the new bus network from January 2025

kaart	straat/zone	Doorkomsten ochtendspits (7u30 - 8u30)		Doorkomsten dal (13u-14u)		Impact nieuw busplan		Impact nieuw busplan %	
		Huidig netwerk	Netwerk 2025	Huidig netwerk	Netwerk 2025	Spits	Dal	Spits	Dal
1	Van Wayenberglaan	46	29	33	24	**-17**	**-9**	-37%	-27%
2	Gasthuisberg	59	63	46	56	**4**	**10**	7%	22%
3	Tervuursestraat	9	10	2	8	**1**	**6**	11%	300%
4	Brusselsestraat boven	19	11	8	8	**-8**	**0**	-42%	0%
5	Sint-Jacobsplein	74	50	43	33	**-24**	**-10**	-32%	-23%
6	Kapucijnenvoer	13	13	8	8	**0**	**0**	0%	0%
7	Donkerstraat	7	8	4	8	**1**	**4**	14%	100%
8	Bruul	94	71	55	49	**-23**	**-6**	-24%	-11%
9	Mechelsestraat	10	9	8	4	**-1**	**-4**	-10%	-50%
10	SLAC	104	80	63	53	**-24**	**-10**	-23%	-16%
11	Wilsele Dorp	5	9	4	4	**4**	**0**	80%	0%
12	Begaultlaan	0	5	0	2	**5**	**2**	-	-
13	Engels Plein	12	12	12	12	**0**	**0**	0%	0%
14	Aarschotsesteenweg	17	13	8	4	**-4**	**-4**	-24%	-50%
15	Minkceler/Rijschoolstraat	0	0	0	0	**0**	**0**	-	-
16	Eenmeilaan	6	9	2	8	**3**	**6**	50%	300%
17	Gemeentestraat	17	9	16	8	**-8**	**-8**	-47%	-50%
18	Diestsesteenweg	25	25	12	10	**0**	**-2**	0%	-17%
19	Station	219	230	123	143	**11**	**20**	5%	16%
20	Bondgenotenlaan	123	98	79	67	**-25**	**-12**	-20%	-15%
21	Maria-Theresiastraat	18	23	10	12	**5**	**2**	28%	20%
22	Grote Markt/Naamsestraat	21	13	17	12	**-8**	**-5**	-38%	-29%
23	Ring (Provinciehuis)	50	77	31	48	**27**	**17**	54%	55%
24	Casablanca	8	9	8	8	**1**	**0**	13%	0%

Figure 17 Overview of the difference in the number of passages in the main streets of Leuven between the current bus network and the new network

Figure 18 Example of planned infrastructure works for the optimization of stops for the new bus network

For the redesign of the transport axes, an analysis report for the local baseline measurements for delay and modal split has been drafted, data has been collected and the option to use U-Need for the analysis has been explored.

5.1.5.1.3. Challenges & Mitigations

An analysis by the UPPER-tool U-NEED to further determine the ideal locations is still scheduled and is taking longer than expected, causing a delay.

5.1.5.1.4. Next steps towards implementation

An analysis for the selection of locations and refinement of the implementation method for bus corridors is being carried out by the end of August 2024, including an analysis with the UPPER-tool U-NEED in the fall. After that the locations where priority for PT should be prioritized can be identified.

5.1.6. Demo site: Thessaloniki

5.1.6.1. Measure TES_03: To improve transit services through dynamic multimodal management of PT corridor

5.1.6.1.1. Description of the measure and main outcomes expected

The measure TES_03 aims to develop and evaluate alternative plans with respect to the reallocation of public space along a major signalized urban arterial corridor (i.e. Egnatia Street) in the city of Thessaloniki. To this end, **a microscopic traffic simulation model is developed to examine the impacts of the alternative plans on vehicular and pedestrian traffic**. This measure is expected to increase the level of service (LoS) for public transport (PT) and pedestrians, to improve accessibility to/from metro stations, facilitate multimodal trip making, shift travel demand towards sustainable transport modes, and enhance the commercial character of the city center. Additionally, this measure will be combined with measure "TES_06: Social optimum-based traffic management to reduce PT travel times and increase user satisfaction" to assess the introduction of transit signal priority (TSP) in each public space reallocation plan.

5.1.6.1.2. Preparation of the measure

Egnatia St. is the only two-way major signalized urban arterial corridor that spans across the city of Thessaloniki and can serve eastbound/westbound through traffic apart from inter-city trips. During the past two decades, traffic flow performance had been significantly deteriorated along Egnatia St. due to the presence of the construction sites of the new metro line. Recently, most of the construction sites have been removed in line with the expected completion of the metro line, and normal traffic operations along Egnatia St. have been restored. Moreover, the city of Thessaloniki recently conducted a Sustainable Urban Mobility Plan (SUMP) that proposes specific interventions pertaining to the operation of PT and the allocation of public space on Egnatia St. Based on the recommendations of the SUMP, the measure TES_03 proposes and evaluates three alternative scenarios that encompass infrastructure changes and redesign of PT lines along Egnatia St., taking into consideration the expected opening of the metro line. Table 2 below depicts the current status (baseline scenario) and the proposed changes per alternative scenario on Egnatia St.. The proposed space reallocation plans, the introduction of the metro line, and the redesign of the PT bus lines are expected to convert this street into a modern multimodal signalized corridor capable of adequately accommodating increased travel demand levels in the future.

Scenario No.	Scenario Name	General Purpose Lanes	Exclusive Bus Lanes	Sidewalks	Metro Line	Cycling Lanes	Bus Trips (AM Peak)
0	Baseline	2 lanes per direction	1 lane per direction	Yes	No	No	127
1	Scenario 1	2 lanes per direction	1 lane per direction	Yes	Yes	No	89
2	Scenario 2	1 lane per direction	1 lane per direction	Yes	Yes	1 middle lane per direction	89
3	Scenario 3	1 lane per direction	1 lane per direction	Yes	Yes	1 side lane per direction	89

Table 2 Infrastructure status and PT operation plan per examined scenario

The proposed alternative scenarios refer to future traffic conditions that do not currently prevail on Egnatia St.. For example, the introduction of the new metro line in Thessaloniki's transport system by the end of 2024 is expected to have profound implications on travel demand per transport mode. In the context of this simulation analysis, the mode choices per alternative scenario are inherited from the projections of SUMP and a General Transport Study that has been recently conducted for the future expansion of Thessaloniki's metro system. Findings from both studies have been rigorously assessed to select legitimate modal splits per alternative scenario (Table 3). Bicycle traffic has not been simulated for the first two scenarios, since very few bicycles run on Egnatia St. in real world conditions due to the absence of dedicated infrastructure. However, the existence of an exclusive bike lane per direction in future Scenarios

2 and 3 is expected to attract more bike trips. Additionally, the latter transport studies did not include information about the shares of light goods vehicles (LGV) and heavy goods vehicles in future scenarios. Thus, the numbers of the baseline scenario have been also adopted for the future scenarios. Finally, it can be observed that the introduction of the metro line, the redesign of the PT bus lines, and the allocation of existing space on the road to exclusive bike lanes is expected to shift travel demand from private means to public transport, walking and cycling.

Transport Mode	Mode Abbreviation	Baseline Scenario	Scenario 1	Scenario 2	Scenario 3
Private Car	**LV**	55.6%	46.22%	41.68%	41.68%
Taxi	**TAXI**	1.7%	1.51%	1.51%	1.51%
Light Goods Vehicle	**LGV**	2.4%	2.40%	2.40%	2.40%
Heavy Goods Vehicle	**HGV**	0.7%	0.71%	0.71%	0.71%
Public Transport	**PT**	18.5%	22.42%	24.09%	24.09%
Walking	**PED**	21.1%	24.10%	24.10%	24.10%
Bicycle	**BIC**	-	-	1.61%	1.61%

Table 3 Mode choice per examined scenario

Each scenario has been simulated with the use of the microscopic traffic simulator SUMO (Alvarez Lopez et al., 2018). A description of the development process of each simulation model is presented in dedicated sections below. A comparative analysis of the simulation results has been conducted to evaluate the impacts of the new public space reallocation and PT operation plans. In specific, several KPIs pertaining to network-wide and vehicle performance have been estimated, such as average network speed, average delay per vehicle type, number of stops per vehicle, and others.

Baseline Scenario: Existing transport infrastructure and traffic conditions

The baseline simulation model encompasses the existing topology of Egnatia St. as well as the currently available transport modes that operate along the latter signalized arterial corridor. In its existing configuration Egnatia St. has two general purpose (GP) lanes and one exclusive bus lane per direction. The network topology was imported in SUMO via OpenStreetMap and was modified to reflect the actual road layout with high precision. There are 12 bus stops on the eastbound direction, and 11 on the westbound one. The locations of the bus stops were imported in SUMO via a GIS file that is publicly available from the Organisation of Urban Transportation of Thessaloniki (OASTH), and configured (dimensions and person capacity) via SUMO's network editor (netedit). Traffic control elements (traffic signs and signals) and traffic monitoring devices (magnetometers) were also input and configured in netedit. Specifically, traffic signal plans were provided by Yunex Greece (technology provider that has installed and maintains the traffic controllers on Egnatia St.) in OCIT-C format. A script was developed to automatically translate the traffic signal plans in SUMO compatible file format. A manual cross-validation approach was adopted to ensure that the translation had produced correct SUMO input files for traffic signal control in the simulation model. The locations of the 66 traffic detectors that are installed along Egnatia St. and operated by the Region of Central Macedonia (RCM) were provided by RCM in GIS format. They were inserted and configured as induction loop detectors (E1) in SUMO. Figure 19 depicts the network topology of the baseline simulation model with snapshots of the two major signalized intersections of the corridor.

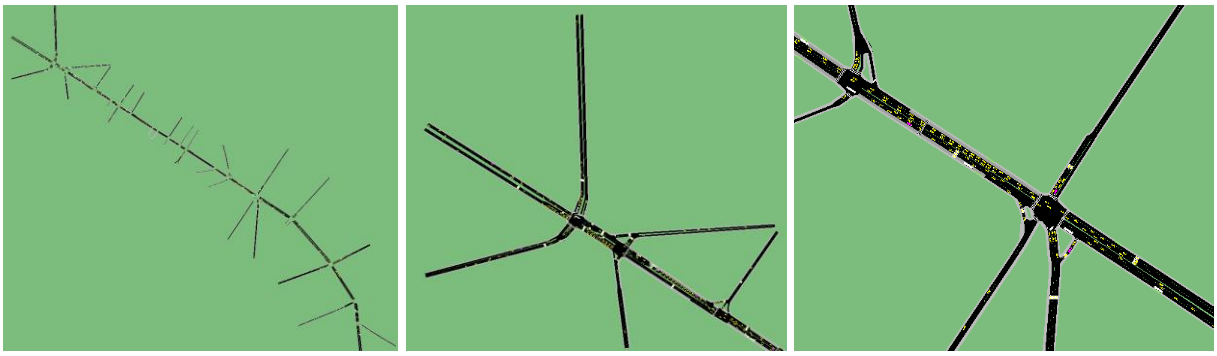


Figure 19 Network topology in the baseline traffic simulation model

Demand loading has been based on two different datasets containing traffic flow counts observed on Egnatia St.. On the one hand, traffic flow counts have been collected via the detection equipment of the Traffic Management Center (TMC) of RCM that is installed on 8 out of 12 signalized junctions along Egnatia St., while on the other hand traffic flow counts, splits rates, and traffic composition (percentage of private cars, light goods vehicles, heavy goods vehicles, and taxi) were collected via an on-site traffic count study conducted by CERTH that encompassed all junctions on Egnatia St.. Both datasets were used to estimate incoming traffic flows and corresponding split rates for all junctions on Egnatia St. during the morning rush hour (08:00-09:00AM). Figure 20 depicts the latter information for two major signalized junctions on Egnatia St.. Incoming traffic flows and split rates per junction were input to SUMO's "routeSampler.py" script to generate a realistic traffic pattern that fulfills the counting data.

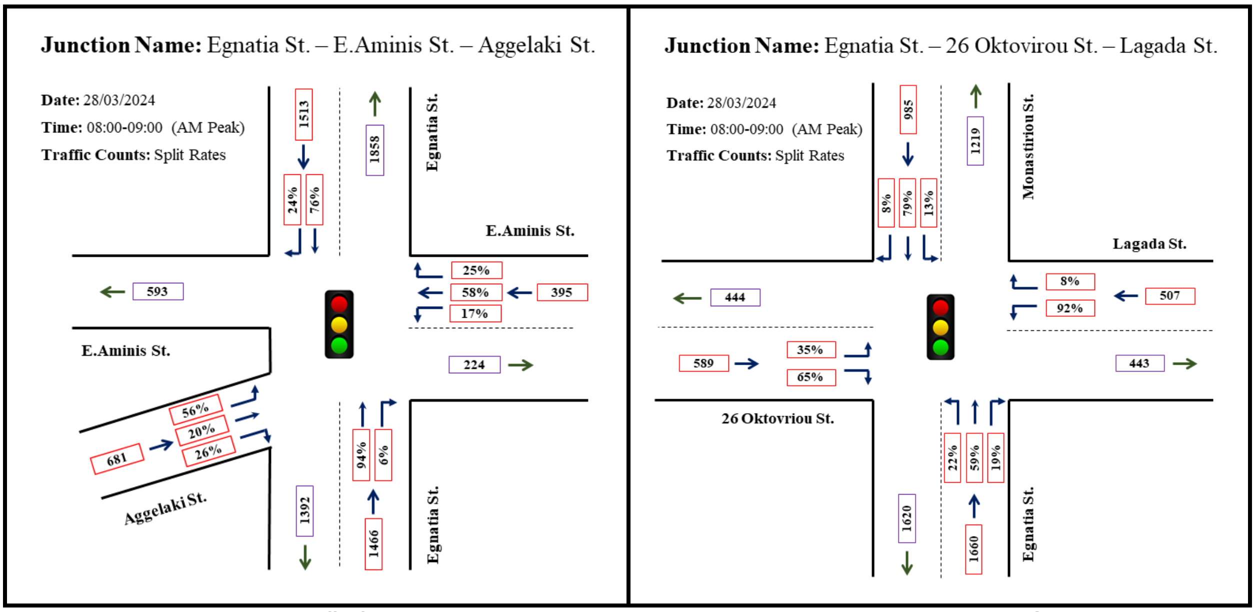


Figure 20 Traffic flow counts and split rates at two major signalized junctions on Egnatia St.

Pedestrian counts were also collected via a dedicated onsite study conducted by CERTH. These counts were used to estimate pedestrian movements (in the form of Origin-Destination Matrices) at six junctions along Egnatia St. where metro stops have been constructed. The ""routeSampler.py" script was used to generate a realistic pedestrian traffic patterns across the whole corridor that fulfilled the counting data. Figure 21 depicts the counting areas at two major signalized junctions on Egnatia St., while Table 4 shows the number of walking trips per feasible pedestrian movement at Egnatia St. – E.Aminis St. – Aggelaki St. junction.

Figure 21 Locations of pedestrian flow measurements at two major signalized junctions on Egnatia St.

Junction Name: Egnatia St. – E.Aminis St. – Aggelaki St.										
O / D	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Total**
1	0	60	44	4	12	4	0	8	4	136
2	40	0	12	4	0	4	8	12	20	100
3	32	0	0	4	4	32	32	16	4	124
4	12	0	0	0	0	4	60	0	4	80
5	28	4	4	4	0	4	8	0	0	52
6	0	4	12	4	0	0	20	4	76	120
7	16	8	36	12	0	44	0	0	72	188
8	64	16	20	0	0	16	4	0	56	176
9	44	8	24	16	4	60	176	28	0	360

Table 4 OD Matrix of walking trips at Egnatia St. – E.Aminis St. – Aggelaki St. junction

Information about existing bus lines, schedules, and ridership per line during the morning rush hour along Egnatia St. was provided by the Transport Authority of Thessaloniki (TheTA) and integrated into the simulation model. Table 5 shows the number of bus trips executed along each bus line during the morning rush hour and the average number of passengers per bus trip.

Baseline Scenario			
No.	**Bus Line**	**Trips / Hour**	**Average Number of Passengers**
1	01X	6	27
2	02K	7	57
3	7	5	13
4	10	9	49
5	11-11B	7	37
6	14	9	53
7	17	9	14
8	20	4	11
9	21	3	11
10	22	1	27
11	25	4	7
12	26	4	9
13	27	8	17
14	28	3	52
15	29	5	3
16	31	4	39
17	32-32A	3	20
18	34	4	12
19	35	3	9
20	37	4	28
21	38	2	27
22	39	3	42
23	45A-45B	3	12
24	57	6	69
25	83-83B-83M	11	26

Table 5 Number of trips and average ridership per bus line operating along Egnatia St. during morning rush hour

Error checking was made to verify the accuracy of the coded input data. Specifically reviews of the coded network, coded demand, and default parameters were conducted to ensure that the calibration process did not result in parameters that were distorted to compensate for overlooked coding errors. Subsequently, a trail-and-error approach was adopted to calibrate model parameters for the development of a valid base model. Emphasis was placed on the calibration of model parameters related to car following, lane changing and vehicle insertion. Table 6 depicts the values of calibrated model parameters that achieved a substantial reconciliation of simulated traffic flows and travel times. Values within the parenthesis indicate the mean and standard deviation of the normal distribution that was used to generate values for vehicle parameters, while values within brackets indicated the minimum and maximum values that vehicle parameters could obtain from the distribution. Simulated and real-world traffic flows were compared on 34 intersection legs, while the respective travel times (estimated from floating car data) were compared along 6 routes on Egnatia St. (Figure 22). The comparative results shown on Figure 23 indicate that simulated traffic replicates with high accuracy the actual traffic conditions and that the baseline simulation model is valid.

Parameter Name	Private Car	Taxi	Light Goods Vehicle	Heavy Goods Vehicle	Bus
carFollowModel	Krauss	Krauss	Krauss	Krauss	Krauss
sigma	(0.5,0.1); [0.0,1.0]	(0.5,0.1); [0.0,1.0]	(0.5,0.1); [0.0,1.0]	(0.5,0.1); [0.0,1.0]	(0.5,0.1); [0.0,1.0]
tau	(1.0,0.1); [0.8,1.5]	(1.0,0.1); [0.8,1.5]	(1.1,0.1); [0.8,1.5]	(1.3,0.1); [1.1,1.8]	(1.3,0.1); [1.1,1.8]
decel	(4.5,0.3); [3.5,5.0]	(4.5,0.3); [4.0,5.0]	(4.5,0.2); [3.5,5.0]	(4.0,0.1); [3.8,4.2]	4
accel	(2.6,0.2); [2.0,3.0]	(2.7,0.2); [2.3,3.2]	(2.5,0.2); [2.0,3.5]	(1.5,0.2); [1.1,1.7]	1.2
speedFactor	(1.1,0.1); [0.8,1.2]	(1.1,0.1); [0.9,1.2]	(1.1,0.1); [0.9,1.1]	(1.0,0.1); [0.9,1.1]	(1.0,0.1); [0.9,1.1]
emergencyDecel	9	9	9	9	7
color	yellow	blue	magenta	gray	white
vClass	passenger	passenger	delivery	truck	bus
departLane	best	best	best	best	best
departPos	base	base	base	base	base

departSpeed	max	max	max	max	max
arrivalLane	random	random	random	random	random
arrivalPos	max	max	max	max	max
arrivalSpeed	current	current	current	current	current
length	(5.0,0.2); [4.0,5.6]	(5.0,0.2); [4.0,5.6]	(6.5,0.2); [6.0,7.0]	(8.0,0.2); [7.0,9.0]	12
width	1.8	1.8	(2.0,0.1); [1.9,2.2]	(2.4,0.1); [2.3,2.5]	2.5
lcAssertive	(1.1,0.1); [1.0,1.2]	(1.1,0.2); [1.0,1.2]	(1.0,0.2); [0.9,1.1]	(1.0,0.2); [0.9,1.1]	(1.0,0.2); [0.9,1.1]

Table 6 Parametrization of core SUMO models per simulated vehicle type

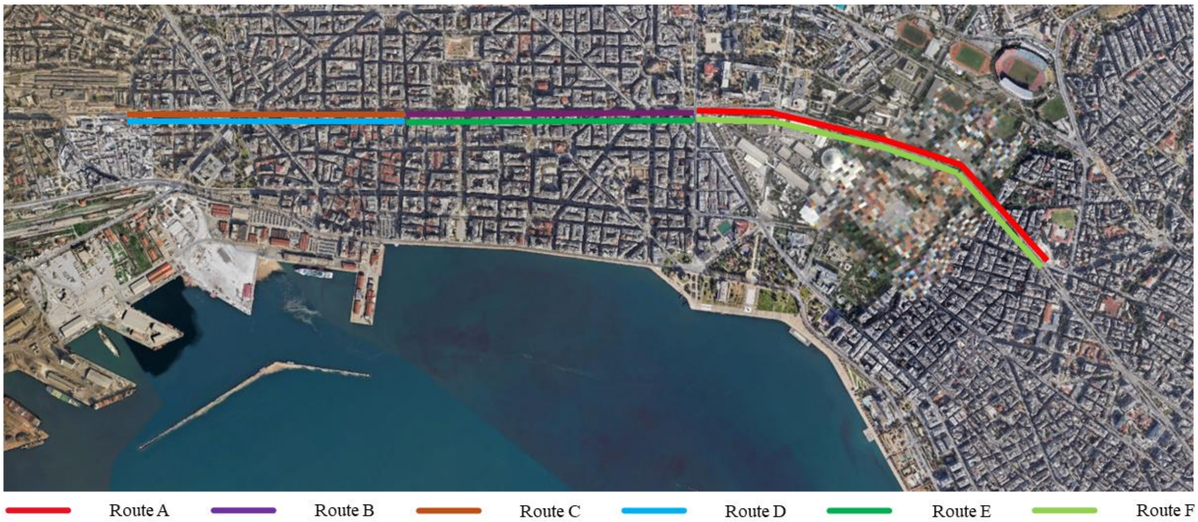


Figure 22 Definition of routes per direction along Egnatia St. for calibration purposes

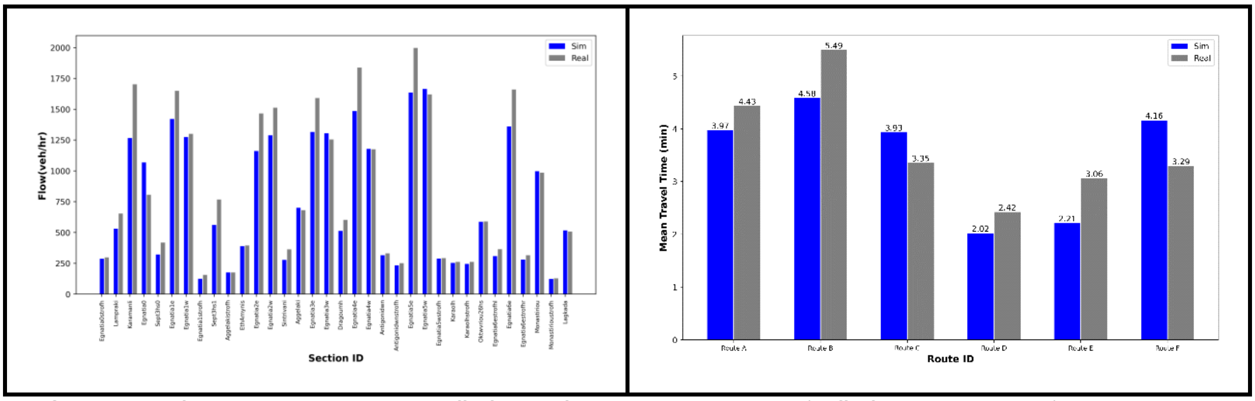


Figure 23 Comparison of simulated and real-world traffic flow performance measurements (traffic flow and travel time) pertaining to the baseline simulation model

<u>Scenario 1: Metro line and redesign of PT bus lines</u>

The newly constructed metro line below Egnatia St. that will become operational by the end of 2024 has been integrated into the baseline simulation model. Additionally, changes were made to the schedules of the bus lines that were input to the baseline model, according to one of the redesign plans of public transport that TheTA is considering implementing in the city of Thessaloniki concurrently with the beginning of the metro line operation. Specifically, the redesign plan integrated in the simulation model of Scenario 1 foresees the reduction of bus trips on the existing bus lines along Egnatia St. by 30%. Average ridership per bus line has been assumed to remain constant. Table 3 depicts the model split simulated in Scenario 1. Vehicular and pedestrian traffic patterns have been updated considering the new number of trips conducted with each transport mode. All other elements of this simulation model have remained the same as in the baseline model. Impact assessment will be based on the same simulation results and key performance indicators (KPIs) as the baseline model.

Scenario 2: Metro Line, redesign of PT bus lines, and exclusive right-side bike lane

The simulation model of Scenario 2 is based on that of Scenario 1 but also encompasses the reallocation of road space to different transport modes. In Scenario 2, the road layout is comprised of 1 GP lane, 1 exclusive bus lane, 1 exclusive bike lane next to the sidewalks, and wider pavements for pedestrians per direction. Table 3 depicts the modal split simulated in Scenario 1. Vehicular and pedestrian traffic patterns will be updated considering the new number of trips conducted with each transport mode. Traffic signal plans will be adapted to accommodate bicycle traffic. All other elements of this simulation model will remain the same as in the simulation model of Scenario 1. Additional KPIs related to bicycle traffic will be defined and estimated for impact assessment purposes.

Scenario 3: Metro Line, redesign of PT bus lines, and exclusive bike lane in the middle

The simulation model of Scenario 3 is similar to that of Scenario 2 but for the location of the exclusive bikes lanes which are placed in the middle of the street instead of the right-most part of it (next to the sidewalks). All other elements of this simulation model will remain the same as in the model of Scenario 2.

Preliminary Analysis of Simulation Results

A preliminary analysis of the Baseline and Scenario 1 simulation results has been conducted to determine the impacts of the introduction of the new metro line and the redesign of the public transport operation plans. Impact assessment has been based on traffic related KPIs estimated per vehicle type. Figure 24 depicts the boxplots of average vehicle speed per vehicle type for the two simulation scenarios. It can be observed that demand shift towards public transport and reduction of bus trips across Egnatia St. substantially increases average vehicle speed for all simulated vehicle types (approximately 25%). Moreover, a significant reduction of the number of stops per vehicle is observed for all vehicle types in Scenario 1 (Figure 25). Overall, the provision of enhanced public transport service along Egnatia St. is expected to generate significant travel time savings.

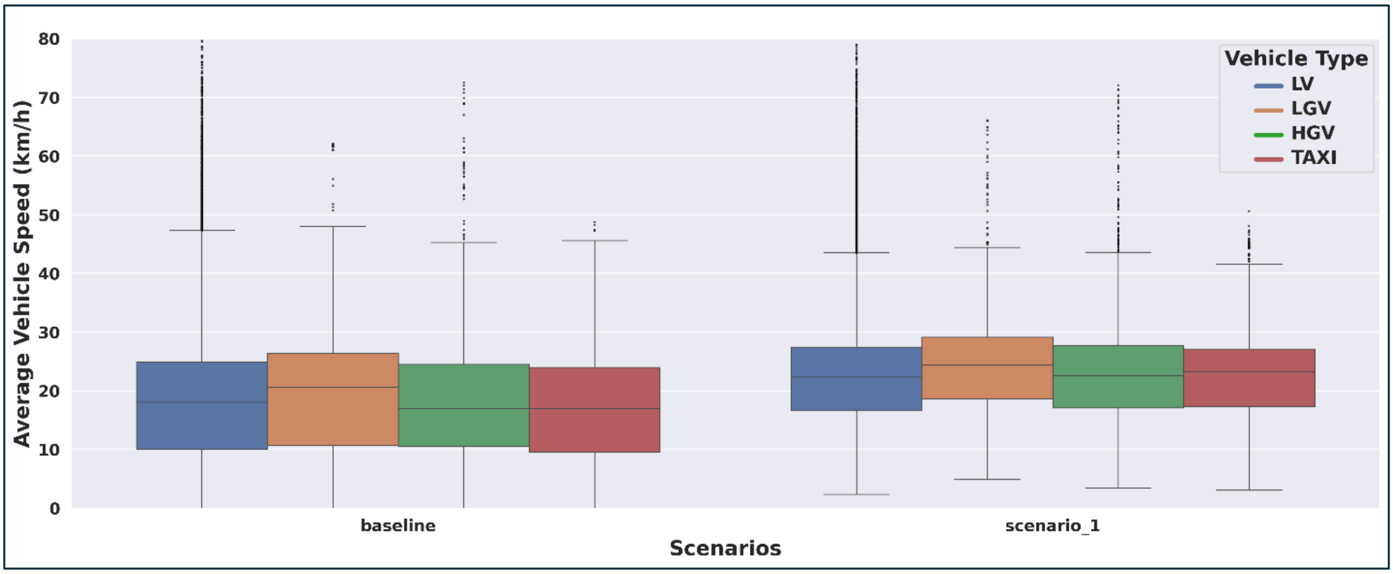


Figure 24 Distribution of average vehicle speeds per vehicle type for the Baseline Scenario and Scenario 1

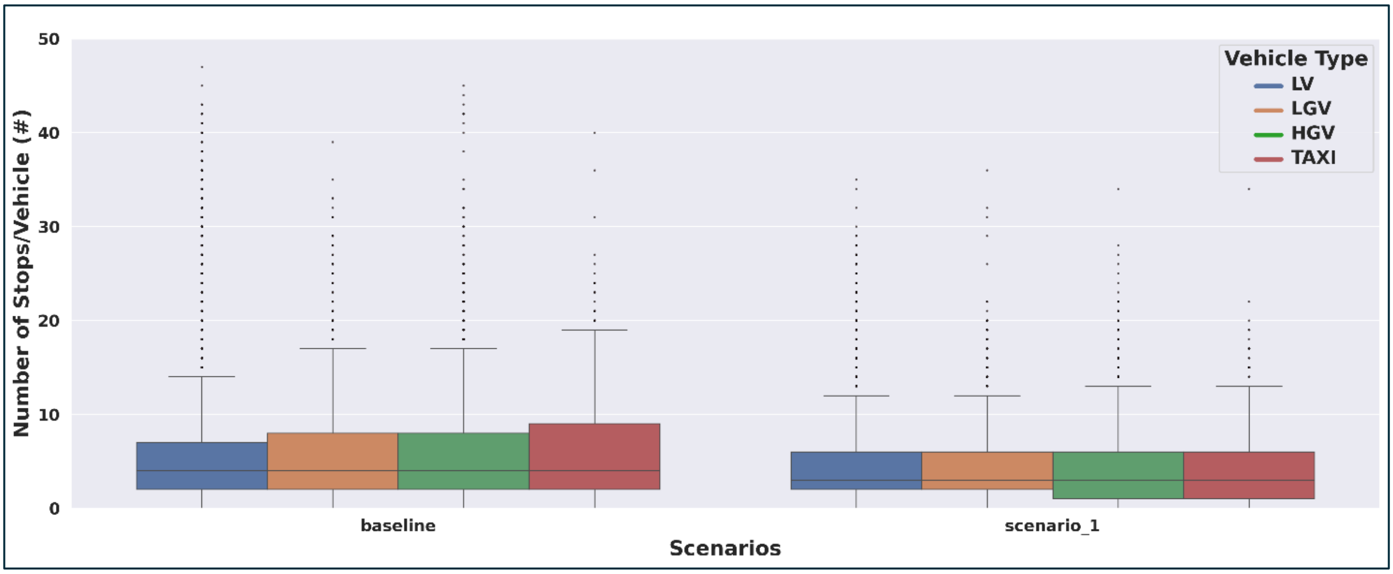


Figure 25 Distribution of average vehicle speeds per vehicle type for the Baseline Scenario and Scenario 1

5.1.6.1.3. Challenges & Mitigations

The error-checking and calibration tasks related to simulation model development are time-consuming and tedious. Thus, significant resources were allocated to review coding errors and calibrate model parameters to build a baseline simulation model that reflects real-world traffic conditions with high accuracy. Additionally, it is expected that significant resources will be required for the adaptation of traffic signal plans to cater for bicycle traffic in Scenarios 2 and 3. This process cannot be automated and will have to be manually conducted based on expert's knowledge about traffic signal timing.

5.1.6.1.4. Next steps towards implementation

Within the next period simulation models pertaining to Scenarios 2 and 3 will be developed. Moreover, a more in-depth and comprehensive assessment of simulation results obtained from the Baseline and Scenario 1 simulation models will be conducted that will also account for KPIs related to vehicular emissions and pedestrian traffic.

5.1.6.2. Measure TES_06: Social optimum-based traffic management to reduce PT travel times and increase user satisfaction

5.1.6.2.1. Description of the measure and main outcomes expected

The measure TES_06 aims to advance transit signal priority (TSP) along a major signalized urban arterial corridor in the city of Thessaloniki via the adoption of a multi-agent reinforcement learning (MARL) framework. To this end, a microscopic traffic simulation model is developed to examine the performance of the MARL framework compared to a conventional traffic signal control scenario where traffic lights are regulated based on pretimed signal control plans. The service is expected to reduce public transport (PT) delay during rush hours and improve user satisfaction, without adversely impacting environmental indexes and efficiency of the overall vehicular traffic flow.

5.1.6.2.2. Preparation of the measure

TSP refers to the provision of preferential treatment to buses or trams over other vehicle types when they approach traffic signals. TSP systems use real-time information from transit vehicles to communicate with the traffic signal controller and optimize signal timing so as to receive priority at downstream signalized intersections. MARL can be applied to this problem due to its ability to decentralize and adapt to changing traffic flows at multiple signalized intersections without prior domain information. MARL agents learn optimal policies by mapping states to actions, making them suitable for complex environments like traffic systems where modeling state transitions is challenging. To evaluate the MARL framework for TSP, an existing simulation environment (SUMO-RL) is extended to model urban traffic with varying levels of non-stationarity (this includes different traffic patterns) and train/test multiple agents to assess their performance under these conditions. SUMO-RL (Alegre et al., 2021) provides a simple interface to instantiate Reinforcement Learning (RL) environments with SUMO (Alvarez Lopez et al., 2018) for Traffic Signal Control. It supports MARL and can be customized with respect to new state and reward definitions. Figure 26 depicts the architecture of the adopted MARL framework.

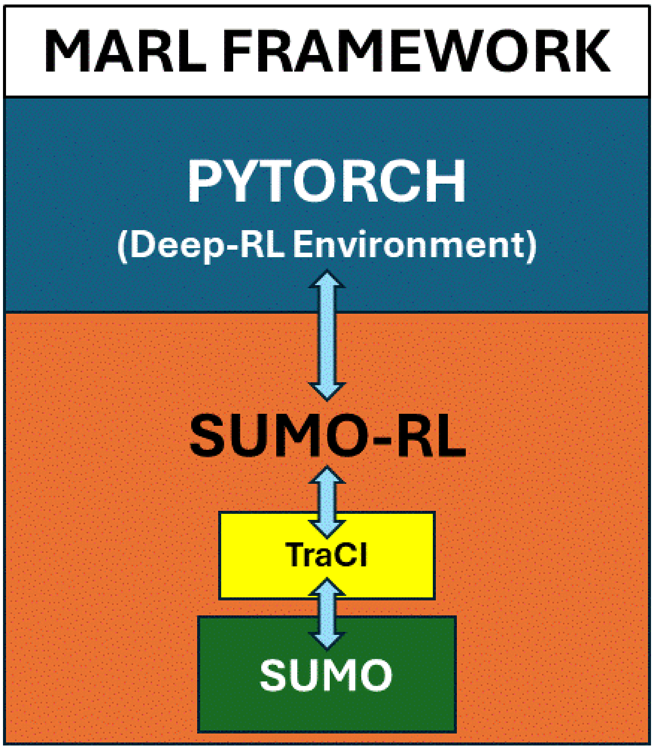


Figure 26 The architecture of the MARL Framework

Reinforcement Learning

Reinforcement learning involves an agent learning to behave optimally by interacting with an environment, receiving rewards based on its actions. The goal is to learn an optimal control policy π that maps states to actions to maximize cumulative rewards. RL problems can be modeled as Markov Decision Processes (MDPs), characterized by a set of states S, a set of actions A, and a reward function $T(s, a, s')$. An experience tuple $\langle s, a, s', r\rangle$ indicates the agent's state s, action a, resulting state s', and reward r. The cumulative reward under policy π is defined by the action-value function $Q^{\pi}(s, a)$ as:

$Q^{\pi}(s,a) = E[\sum_{t=0}^{\infty} \gamma^t r_{t+s} \mid s_t = s, a_t = a, \pi]$	(1)

where $\gamma \in [0,1]$ is the discount factor for future rewards. The optimal control policy π^* can be obtained if the optimal Q-values $Q^*(s, a)$ are known:

$\pi^*(s) = \arg\max_a Q^*(s,a) \quad \forall s \in S, a \in A$	(2)

RL methods are categorized into model-free and model-based. Model-free methods, such as Q-learning, do not require knowledge of the transition and reward functions and learn the action-value function based on interactions with the environment. The RL algorithm used in this paper is Q-learning (QL), a model-free off-policy algorithm that estimates the Q-values in the form of a Q-table. After an experience $\langle s, a, s', r\rangle$, the corresponding $Q(s,a)$ value is updated through:

$Q(s,a) \coloneqq Q(s,a) + \alpha\left(r + \gamma \max_{a'} Q(s',a') - Q(s,a)\right)$	(3)

where $\alpha \in [0,1]$ is the learning rate. In order to balance exploitation and exploration when agents select actions, we use the ε-greedy mechanism. This way, agents randomly explore with probability ε and choose the action with the best expected reward so far with probability $1 - \varepsilon$.

Non-stationarity in RL environments, particularly in traffic control, occurs when the environment's dynamics change over time, affecting the agent's learning process. This necessitates continuous adaptation and can result in performance degradation due to the agents' need to relearn optimal policies frequently. Addressing non-stationarity involves techniques to maintain the agents' performance despite changes in the environment's dynamics. Specifically, we have explicitly modelled a set of contexts and their associated local policies to deal with non-stationary environments. Thus, by augmenting state definitions we reduce partial observability and minimize the effect of non-stationarity on the learning process and on convergence.

Urban Traffic Model under Time-Varying Dynamics

We introduce a framework for modelling urban traffic under time-varying dynamics. In particular, we first introduce a baseline urban traffic model based on MDPs. This is done by formalizing the relevant elements of the MDP: its state space, action set, and reward function. Furthermore, we describe the multiagent training scheme used ("Multiagent Independent Q-learning") by each traffic signal agent in order to optimize its policy under non-stationary settings.

State Space

The definition of state space strongly influences the agents' behaviour and performance. Each traffic signal agent controls one intersection, and at each time step t it observes a vector s_t that partially represents the true state of the controlled intersection. A state, in our problem, could be defined as a vector $s \in \mathbb{R}^{(2+2|P|)}$, as in Eq. (4), where P is the set of all green traffic phases, $\rho \in P$ denotes the current green phase, $\delta \in [0, maxGreenTime]$ is the elapsed time of the current phase, $persondelay_i \in [0,\infty]$ is defined as the total delay experienced by drivers/passengers on the incoming movements of phase i, and $emissions_i \in [0,\infty]$ is defined as the total CO_2 emissions produced by all vehicles on the incoming movements of phase i.

$s = [\rho, \delta, \mathrm{persondelay}_1, \mathrm{emissions}_1, \ldots, \mathrm{persondelay}_{\lvert P\rvert}, \mathrm{emissions}_{\lvert P\rvert}]$	(4)

The above definition results in continuous states. Q-learning, however, traditionally works with discrete state spaces. Therefore, states need to be discretized after being computed. Both $persondelay$ and $emissions$ attributes are discretized in ten levels/bins equally distributed. We point out that a low level of discretization is also a form of partial observability, as it may cause distinct states to be perceived as the same state. Furthermore, we assume that one simulation time step corresponds to five seconds of real-life traffic dynamics. This helps encode the fact that traffic signals typically do not change actions every second; this modelling decision implies that actions (in particular, changes to the current phase of a traffic light) are taken in intervals of five seconds.

Action Set

In an MDP, at each time step t each agent chooses an action $a_t \in A$. The number of actions, in our setting, is equal to the number of phases, where a phase allows green signal to a specific traffic direction; thus, |A| = |P|. We consider two actions: an agent can either keep green time to the current phase or allow green time to another phase; we call these actions keep and change, respectively. There are two restrictions in the action selection: an agent can take the action change only if δ ≥ 10 s (minGreenTime) and the action keep only if δ < 50 s (maxGreenTime). Additionally, change actions impose a yellow phase with a fixed duration of 4 s. These restrictions are in place to model the fact that in real life, a traffic controller needs to commit to a decision for a minimum amount of time to allow stopped cars to accelerate and move to their intended destinations.

Reward Function

The rewards assigned to traffic signal agents in our model are defined as the change in the linear combination of cumulative $persondelays$ and $emissions$ between successive actions. After the execution of an action a_t, the agent receives a reward $r_t \in \mathbb{R}$ as given by Eq. (5):

$r(t) = (W_t + E_t) - (W_{t+1} + E_{t+1})$	(5)

where W_t, E_t and W_{t+1}, E_{t+1} represent the cumulative $persondelays$ and $emissions$ at the intersection before and after executing the action a_t, following Eq. (6):

$\text{Total cost} = \sum_{v \in V_t} (w_{v,t} + e_{v,t})$	(6)

where V_t is the set of vehicles on roads arriving at an intersection at time step t, $w_{v,t}$ is the total person-delays experienced by the drivers/passengers of vehicle v since it entered one of the roads arriving at the intersection until time step t, and $e_{v,t}$ is the total emissions produced by vehicles v since they entered one of the roads arriving at the intersection until time step t. A vehicle is considered to be waiting if its speed is below 0.1 m/s. Note that, according to this definition, the larger the decrease in cumulative cost, the larger the reward. Consequently, by maximizing rewards, agents reduce the total person-delays and emissions at the intersections, thereby improving the local traffic flow.

Multiagent independent Q-learning

We tackle the non-stationarity in our scenario by using Q-learning in a multiagent independent training scheme (Tan, 1993), where each traffic signal is a QL agent with its own Q-table, local observations, actions and rewards. This approach allows each agent to learn an individual policy, applicable given the local observations that it makes; policies may vary between agents as each one updates its Q-table using only its own experience tuples. Besides allowing for different behaviours between agents, this approach also avoids the curse of dimensionality that a centralized training scheme would introduce.

Experimental Setup and Metrics

Experiments involve training RL agents in the SUMO simulation environment and evaluating their performance in terms of average person delays and emissions. A dedicated simulation platform was developed to facilitate the training of the RL agents (Figure 27) and expedite the execution of the simulations with and without TSP (Figure 28). The simulation platform enables users to define values for the training parameters of the RL agents and select optimization objectives for running the simulations. It is important to note that in our experiments transit vehicles do not receive priority under any circumstances, but rather when person-delays are higher on the intersection legs that the transit vehicles are travelling on. Thus, TSP is subject to ridership per transit vehicle and the rest of vehicular traffic is not impeded when transit vehicles are empty or carry very few passengers. Performance metrics include average delay time per vehicle type, average number of stops per vehicle type, throughput, average network speed, total network emissions and others. These metrics help in understanding how well the agents achieve preferential treatment for transit vehicles without adversely impacting overall traffic efficiency and air quality.

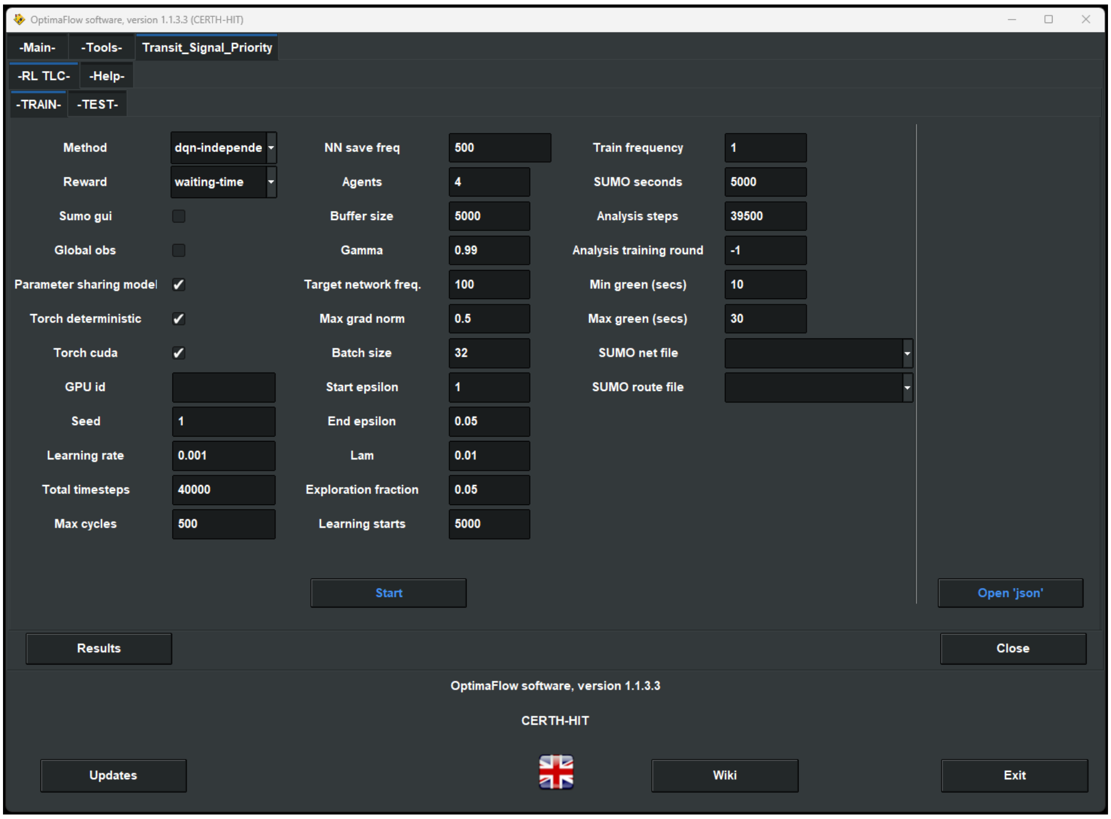


Figure 27 Custom software platform developed for instantiating SUMO-RL and training the MARL agents

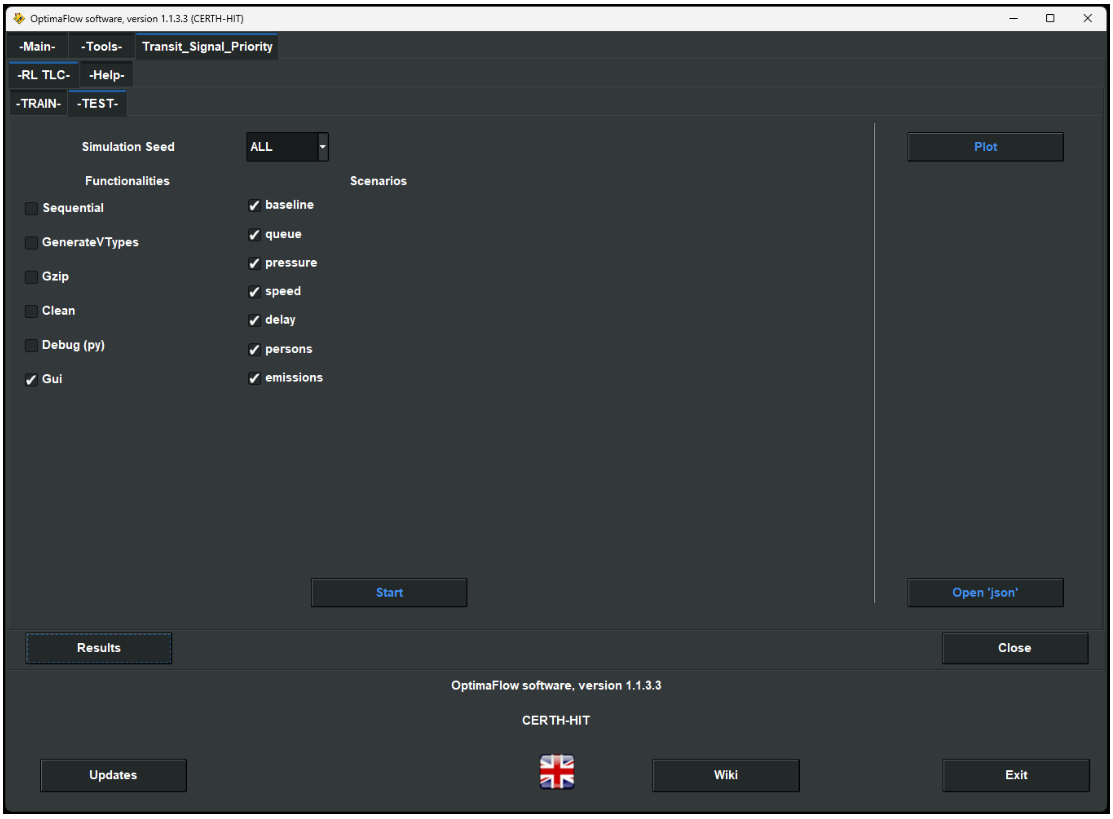


Figure 28 Custom software platform for executing the MARL-based TSP algorithm in SUMO simulations

5.1.6.2.3. Challenges & Mitigations

The SUMO-RL environment had been initially developed for applying AI-based traffic signal control in hypothetical networks with symmetrical junction geometries. Extending its capabilities to accommodate real-world networks with increased diversity in junction geometries and complex traffic patterns has been a significant challenge. Moreover, SUMO-RL had been also tailored to increase junction LoS via dynamic adaptation of traffic signal timings rather than providing TSP. The training and testing of the SUMO-RL algorithms with new reward functions that cater for TSP needs has been a challenging endeavour as well.

5.1.6.2.4. Next steps towards implementation

Within the next period SUMO-RL will be extended to address road networks with asymmetrical junction geometries. Subsequently TSP model training will be conducted with the use of the baseline simulation model that has been developed in the context of measure “TES_03: To improve transit services through dynamic multimodal management of PT corridor”. Finally, new KPIs will be developed to assess the performance of public transport with and without TSP.

5.1.7. Demo site: Oslo

5.1.7.1. Measure OSL_07: To incentivise the use of PT and shared/active modes of transport

5.1.7.1.1. Description of the measure and main outcomes expected

This measure aims to use a smart traffic system that creates safe and accessible crossings for vulnerable road users, without disrupting the traffic flow. This measure aims to give decision makers data-driven approaches, visualizing results using dashboards, and making decisions based on continuous measurements.

V2X Actinode/Actibump system can for example generate continuous static vehicle counting, vehicle classification, vehicle weighing and environmental measurements. It can also communicate with other electronic roadside equipment. V2X smart speed bump (Actibump Edeva - Smart City Solutions) can be tested in Oslo when speeding, among other road users, is the problem for public transport.

V2X Actibump helps to provide a connected, smart, and sustainable traffic, so great benefits will occur for pedestrians and bicycles, traffic planning, public transport and, of course, traffic safety. The equipment will be monitored, and traffic related data will be presented in the software platform. V2X is connected to a software. It is a software as a service (Saas) that handles both data collection and storage as well as remote monitoring of the hardware.

5.1.7.1.2. Preparation of the measure

At the end of 2023, stakeholders were consulted about the problems for PT in Oslo. Then, a solution using a number plate camera to detect vehicles that are not allowed or are turning left against the rules on central street in Oslo (Dronning Eufemies Gate -DEG) was proposed.

Number plate cameras connected to the Norwegian vehicle database can inform about many details concerning the vehicles driving on DEG. They inform if, for instance, it is mostly taxis that turn left against the rules and if it is mostly during rush hours that private cars drive in the bus lane against the rules. Using the automated number plate recognition (ANPR), it is possible to quantify how big the problem really is. To collect relevant data, ANPR cameras were put up on the entrances of zones where traffic is prohibited on DEG, and where turning left is prohibited. Data was collected for Q1-Q2 2024.

Possible measures for improved compliance are for example:

- Variable sign
- Communicate with companies whose vehicles are driving incorrectly
- Active speed bumps
- Automated fines (requires legal changes)
- V2X – possible future solution

The result showed that the suggested problem was not confirmed, and the suggested measures are unnecessary at DEG. A workshop with stakeholders was organised to present the data collected and the analysis' result. To facilitate decision-making on the next steps, a web interface is used to present the data both in real-time and over the lifespan of the system. This data provides a better ground to decide what kind of V2X measures have implication on accessibility for public transport in Oslo. Towards the end of 2024, new corridors will be tested in Oslo.

Figure 29 Actinode camera on top of traffic light for data collecting at DEG

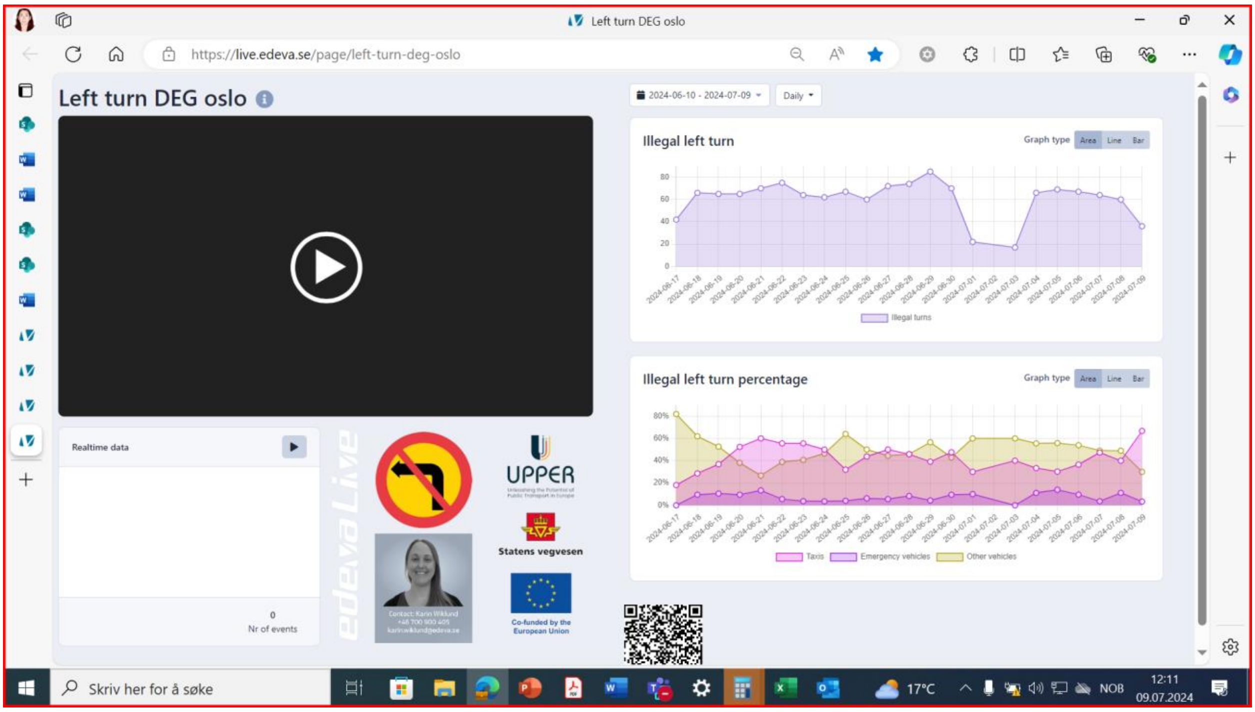


Figure 30 Dashboard for compliance for forbidden left turn in DEG https://live.edeva.se/page/left-turn-deg-oslo

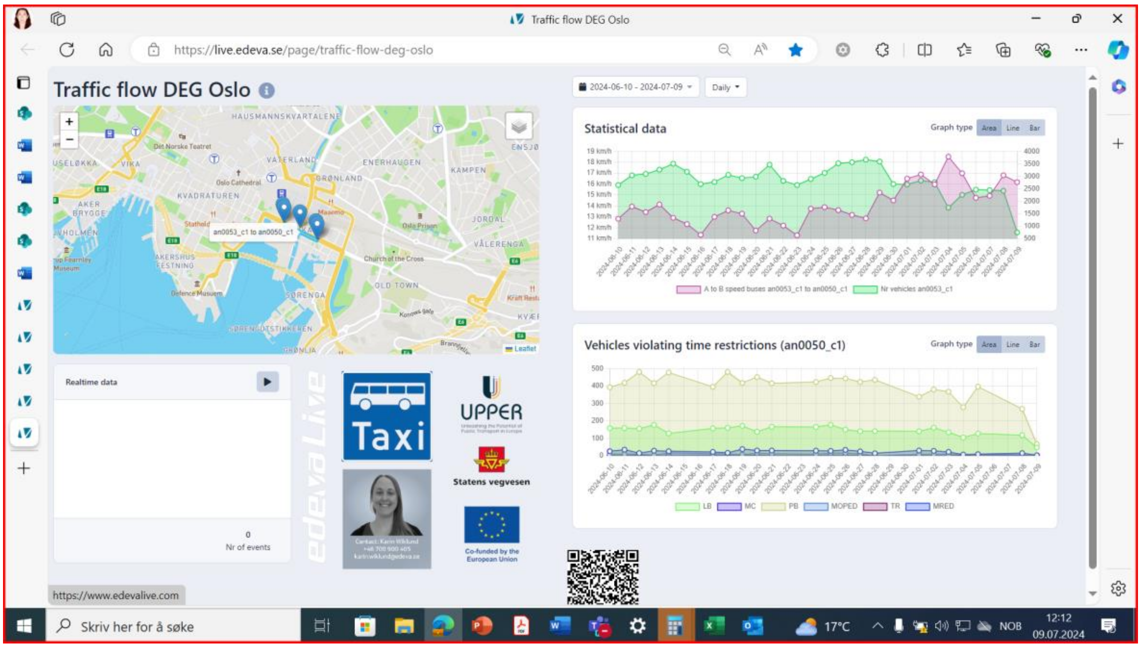


Figure 31 Dashboard for compliance for forbidden traffic during rush time on bus lane https://live.edeva.se/page/traffic-flow-deg-oslo

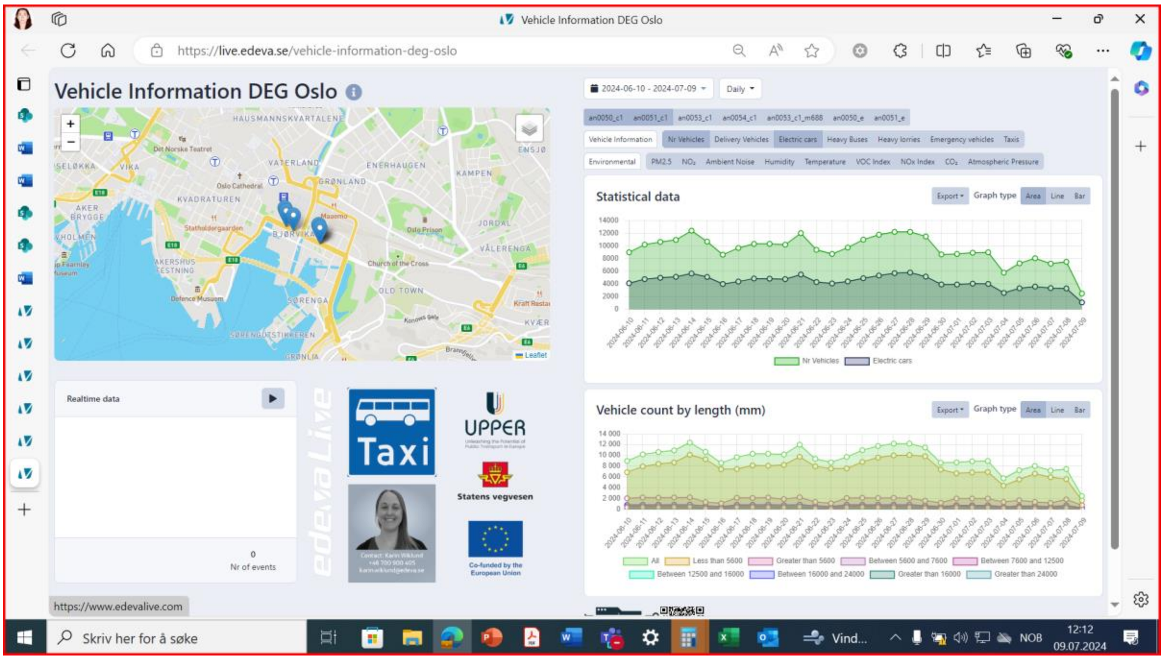


Figure 32 Additional data, such as vehicle classification can be collected and presented in dashboard https://live.edeva.se/vehicle-information-deg-oslo

5.1.7.1.3. Challenges & Mitigations

The objective of the measure OSL_07 is to nudge for more public transport use at Dronning Eufemias gate (DEG), that is a road in central Oslo where car traffic is prohibited on part of the road. Unfortunately, the compliance with these rules is low, which hampers the accessibility for buses. There is also an issue with people turning left on places where it is forbidden.

Collecting data on DEG vehicle by vehicle (V) to actinode (X) provides unique information that can be used in communication from Actinode to vehicle. But when verifying the problem on DEG, the obvious solution was not the information from Actinode to Vehicle. Therefore, it was decided not to go on with measures at DEG, and to rather move on to another location at Rv4 in Oslo to collect data and verify possible V2X measures there.

5.1.7.1.4. Next steps towards implementation

The next step for this measure is to collect data on Rv 4 vehicle by vehicle (V) to Actinode (X), in order to for verify the problem in Rv4, and implement possible V2X measures to improve PT.

5.2. Low emission zones and other traffic regulations

5.2.1. Demo site: Rome

The **PGTU**, the general traffic Masterplan issued in 2015, by the Municipality of Rome, splits the territory into 6 concentric areas, that basically have homogeneous mobility and demographic characteristics and they set up as having common planning targets. The driving concept in fact is "the inner the stricter", that is, the more the area is central, the more the traffic must be reduced.

The rationale behind has been initially driven by the willingness to preserve the historical heritage, and to improve livability and the air quality, pushing people out of their cars.

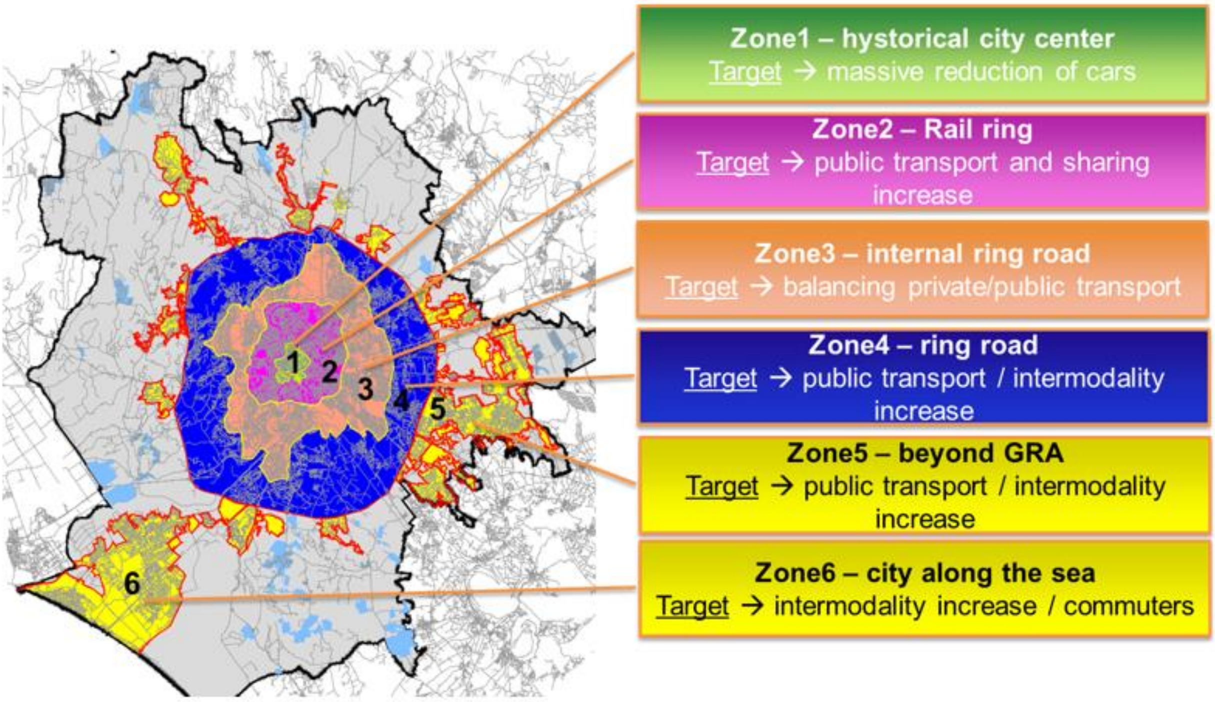


Figure 33 Rome's 6 PGTU zones

The **SUMP** in Rome, elaborated, designed and approved in the period 2017-2022, includes the above strategy in its framework. The SUMP at the same time aims at radically rebalancing the modal share in favour of Public Transport, through a multi-faceted strategy in which the policies regulating mobility demand management play a key role.

Therefore, the access restriction policies implemented (and those under elaboration), supported by ITS infrastructures, affect and will affect the zones from 3 inwards, where traffic and demographic density are higher and have the most relevant impact on the urban environment.

This must be achieved through a combination of measures that, on one hand, implement **new infrastructures and services,** and on the other hand, **restrict and regulate the private traffic**.

To complement the above framework, Rome has to comply with the Regional Air Quality Plan (**PRQA**) that, amongst others, provides measures and actions to mitigate the impact of traffic on air quality, so as to overcome the condemnation by European Court of Justice for non-compliance with the Ambient Air Quality Directive 2008/50 for exceeding the NO_2 in some Italian areas, including Rome.

In this context, the focus within the UPPER project is on the first three zones of the above map: the central **LTZ** (ZONE 1) already well regulated and not directly addressed in UPPER, the **VAM** (Part of ZONE 2) addressed in measure ROM_01, and the **Green Area** (ZONE 3 extended) addressed in measure ROM_02.

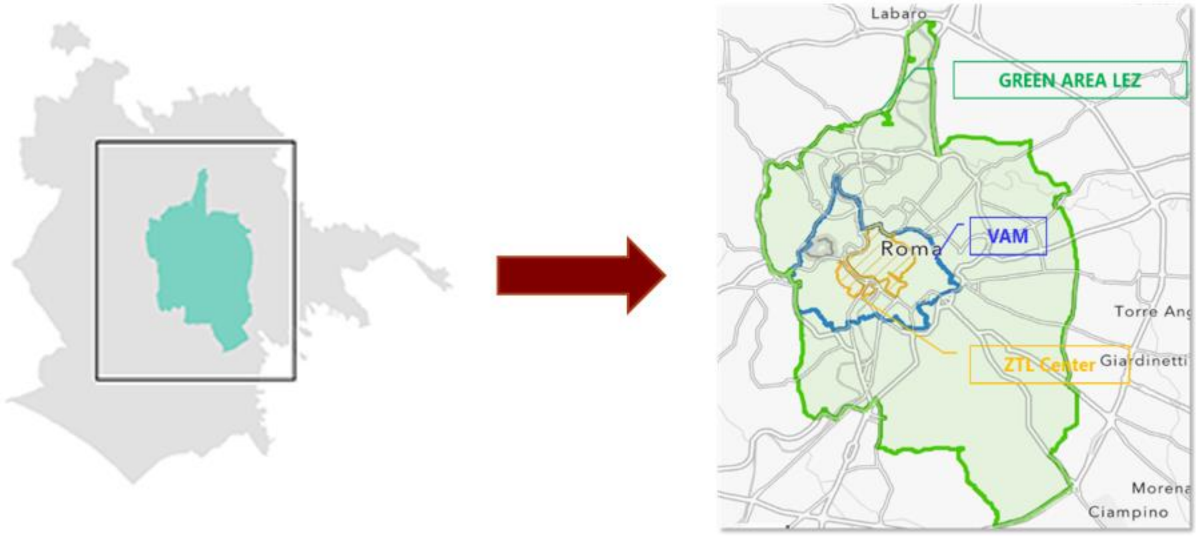


Figure 34 Rome first three environmental areas

Both **ROM_01 and ROM_02 measures** build on the consolidated Rome experience in the implementation of LTZ, which dates back to the '90s. Since then, prototypes, pilots, processes, and services were piloted and finally implemented on a large scale, making Rome a flagship for the Italian cities and an outstanding example in Europe.

The policy concerning the traffic restrictions was initially issued with formal acts and sampling controls with urban police in the 90's. However, the strong innovative aspect concerned the underlying **technology:** since 2000, electronic access gates placed along the perimeter of the LTZ allow the remote control of traffic entering the Central LTZ, using Automatic Number Plate Recognition (ANPR). This enables the issue of fines in case of violation, thanks to the integration between the Traffic Monitoring Center (TMC) of Rome and the Urban Police control room.

The three zones (central LTZ, VAM, Green Area) are concentric and will work in synergy with each other. Therefore, the entry/exit points of the innermost zones could in future also be used as entry/exit points for the outermost zones. The data and information that will be collected will contribute to **assessing the SUMP performances**, according to the guidance of the Ministry of Transport (MS appointed).

5.2.1.1. Measure ROM_01: To reduce private vehicles by implementing a "pollution charge" scheme in the core part of Rome Zone 2

5.2.1.1.1. Description of the measure and main outcomes expected

Within the measure **ROM_01** the objective of Roma Capitale is to significantly reduce vehicular traffic in the central areas to "push" people to leave their cars at least in the surrounding parking areas and reaching their destination with

LPT services. In order to achieve this objective, the current model of the Limited Traffic Zone (ZONE 1) should be complemented with a Congestion Charge scheme, applied in the so-called VAM area, covering 23 km^2**.** The measure will deliver 53 electronic new access points and new regulations for access.

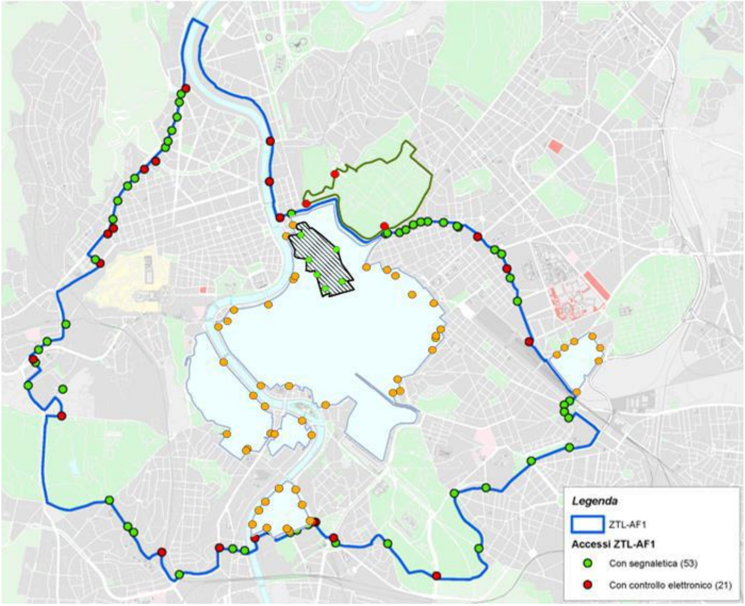


Figure 35 The VAM area – the future congestion charging zone

5.2.1.1.2. Preparation of the measure

Presently, in the VAM area, a restriction is in force to ban pollutant vehicles **longer than 7.5 mt**. This basically affects the tourist's coaches and vehicles for goods distribution. At present restrictions are time-based, apply for all vehicles with total length over 7,5 meter, and are controlled at all 74 e-gates/poles (red & green dots on Figure 36). There is the opportunity to buy daily or other temporary access permits for tourist coaches (or special freight delivery vehicles).

In 2023 the implementation of the remaining 53 electronic gates around the VAM area (green dots on Figure 36) was concluded, in view of the enforcement of the policies to limit access to pollutant vehicles to this area.

The rationale behind the implementation of measure ROM_01 is driven by the idea of banning gradually the most pollutant vehicles, using differentiated fares, the lower the emission standards the more you pay (electric vehicles at present would enter for free). The ultimate scheme will then deliver a complementation of congestion and pollution charging.

During the first project period, specific analyses to implement the Congestion Charge scheme in Rome have been carried out, taking into consideration the complexity and need for flexibility, calibration and integration with the other schemes (LTZ and LEZ-Green Area) and the existing equipment (hardware and software).

A specific study/preliminary analysis has been carried out, including a benchmark with the congestion charge schemes in Milan, Stockholm and London, to outline the components for the scheme in Rome.

The study has considered the following aspects:

- Operating model/drivers
    - Analysis of all the vehicle categories sorted by emission standards, usage (to transport people or goods), for private or collective transport, service fleets, special categories (e.g. vulnerable people), so as to incentivise the use of LEVs.
    - Fares – Implement a charging scheme that varies according to vehicle type, and traffic density, mitigating peak congestion and emissions.

- Fines – to ensure proper compliance with charges contributing to the reduction of congestion.
- Operating hours – to calibrate the traffic flows.
- Purchase of permits and activation of the “tickets” - setting-up of the central system, for secure and efficient fee collection and to enable a user friendly approach for the users.
- Potential extension of the area.

- Analysis of all the possible legal tools for the management of the Congestion charging scheme

5.2.1.1.3. Challenges & Mitigations

This measure is supposed to have a strong impact on the acceptance and on the change of the mobility habits. Therefore, the mitigation aspects consists of leveraging on the PULL measures that are the subject of the UPPER project. The VAM zone will benefit from more parking around the area and multi-modal hubs and mini-hubs to encourage multi-modality (ROM_03, ROM_08), more PT infrastructures (ROM_04), more PT vehicles available (ROM_05), integrated digital services within the MaaS (ROM_06), the empowered data analysis and collection of the Rome Mobility management Centre (ROM_07), increased sharing supply (ROM_08), and ultimately the incentives schemes (ROM_09).

5.2.1.1.4. Next steps towards implementation

The next steps expect the definition of the optimal operating model for Roma (ongoing activity), the finalisation of the preliminary impact analysis, the definition of the “legal tool” including the outline of the management flows, the completion/issuing of the relevant formal acts, consultation with the citizens, definition of the communication strategy. The tender for the procurement of the remaining electronic poles to complete the perimeter of the LEZ will be published (July 2024) and awarded.

5.2.1.2. Measure ROM_02: Promoting modal shift towards PT with implementation of a LEZ in Rome Zone 3

5.2.1.2.1. Description of the measure and main outcomes expected

The Measure ROM_02 concerns the “Green Area”, which is an area of 156 square meters, with a perimeter of 72 km. It basically corresponds to the ZONE 3, to make this a proper Low Emission Zone. This measure must be placed among the initiatives to push people outside their (polluting) cars, and change their mobility habits in favour of PT. The measure combines policies and ITS to implement restrictions according to a Roadmap indicated by the City Administration, based on the provisions of the Lazio Region PRQA (Regional Air Quality masterplan) to cope with the condemnation for the infraction for non-compliance with the Ambient Air Quality Directive 2008/50 for exceeding the NO_2 emissions limit. The measure includes the implementation of a total of 154 electronic access gates over the “Green Area” perimeter.
The measure expects to deliver:

- 154 electronic access gates
- Revised “Specifications Document” that defines the roadmap, the new regulations for access (permits for residents and freight delivery), the incentives, etc.
- New signalling
- Large-scale implementation of the measure

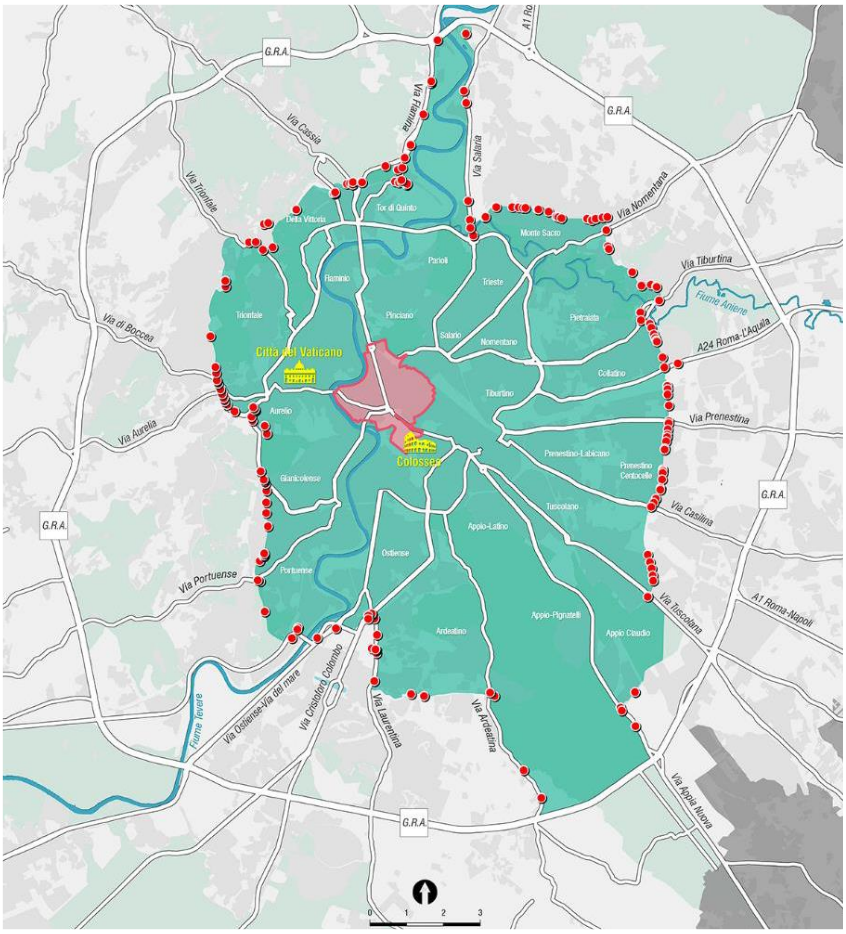


Figure 36 The Green Area and its 154 access points

5.2.1.2.2. Preparation of the measure

In May 2022, the European Court of Justice condemned Italy for non-compliance with the Ambient Air Quality Directive 2008/50, placing a mitigation responsibility for the harmful effects of traffic on the Lazio regional authority that has issued a strategic regional air quality plan (PRQA revised in 2022), which sets targets, objectives and deadlines also for the mobility sector.

Normally, since its establishment in 2015, the Green Area is a zone where traffic restrictions are activated in exceptional cases of pollution emergency. Since November 2022, it has been formally regulated with the Deliberation n° 371/2022, which sets boundaries and outlines a roadmap for traffic restrictions. According to the roadmap, pre-Euro 5 Diesel cars are provisionally expected to be banned from 2025 onwards. The "Green Area" is a Low Emission Zone with the purpose of reducing ambient pollution resulting from urban traffic according to the PRQA, in particular focusing on NO2 and PM emissions harmful for health.

The activities include three different levels:

- The **policy** one – which outlines and issues the restrictions to private traffic. The initial roadmap is subject to revision following a proposal by the city of Rome to the Lazio region, expected for the 1st November 2024.
- The **technical** one – analysis of traffic data, the vehicle fleet composition, modal propensity analyses, hypothesis on incentives, traffic simulations, in the pre and post scenario to assess the different scenarios to achieve the expected polluting reductions. Drafting of a document to demonstrate the effects of different scenarios "Assessment of the interventions to lower ambient emissions and to restore air quality in the territory of Rome". The activity has involved RSM, the City Mobility Department, the City Environmental Department.

- The **infrastructural** one (Hardware and Software) – completion of the electronic access control system including 154 electronic poles, and the Central control system. These infrastructural investments are covered by different sources (PON Metro ReactEU and Jubilee 2025). The system must be capable of sorting the type of motorization of the vehicles passing through the electronic access poles, the connection with the database of the national motorisation must be ensured; in addition, the system will be flexible enough to adapt to different "rules" and policies.

In mid-2024, a specific call for tender was launched by RSM with the specifications designed in cooperation with the Mobility department, and the following has been completed:

- 80 electronic poles have been installed, with the relevant signalling
- the centre control platform was defined
- evaluation of the capacity plan, for the on premise installation in RSM centre of the hardware and software licences required for the correct computational and repository capacity necessary for the central system

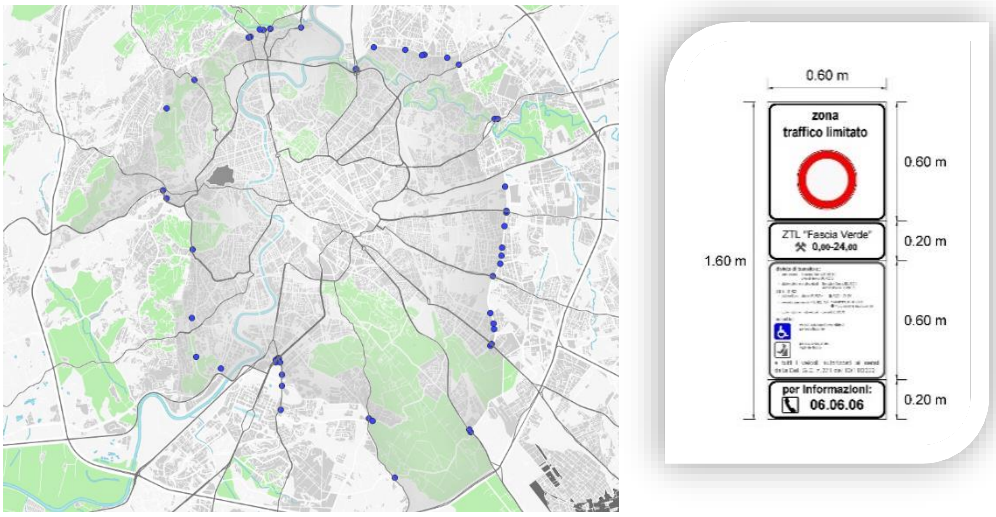


Figure 37 Installations finalized 2024 and signalling placed around the Green Area

5.2.1.2.3. Challenges & Mitigations

Social impact and acceptance: the measure ROME_02 is supposed to have a major social impact, therefore forms of incentives and compensation are being studied and the roadmap is being fine-tuned, to have a final decision to be implemented by November 1st 2024. The initial enforcement expected with the Deliberation n° 371/2022 caused a strong reaction from the citizens.

Mitigation strategies and flexibility rules were studied and presented in the measure ROM_09, including the possibility to have a bonus in terms of flexibility for the first period for the banned categories of vehicles, depending on the Euro emission category.

5.2.1.2.4. Next steps towards implementation

Following the analyses performed by RSM and the document "*Assessment of the interventions to lower ambient emissions and to restore air quality in the territory of Rome*" submitted by the city of Rome (Mobility Department) to the Lazio Region, the enforcement rules will be confirmed and formally issued to enter into force on November 1st 2024.

After that, monitoring the effect of the measure on the air quality and on the mobility habits will be possible. Thanks to the implemented electronic poles, a first monitoring campaign had already been carried out in winter 2023/24 and had provided the data modelling of the phenomena, a better scenario analysis as well as the forecasting for next winter period.

5.2.2. Demo site: Ile de France

5.2.2.1. Measure IDF_03: Impact evaluation and future design of low emission zones and restricted traffic zones

5.2.2.1.1. Description of the measure and main outcomes expected

In France, large metropolitan areas with more than 150,000 inhabitants whose air quality is not satisfactory for health must set up low emission zones (LEZ). The measure IDF_03 aims to use the digital twin set up in IDF_02 as well as the data collected to assess the impact of the LEZ implementation in the VGP and neighbouring territories, and conduct a study on scenarios of implementing future new policies (LEZ, ZEZ, financial aid, ...). In analysing the results, particular attention will be paid to determining how public transport can be strengthened to guarantee accessibility to the new low-emission zones.

5.2.2.1.2. Preparation of the measure

- Assessment of the impact Metropole du Grand Paris (MGP) LEZ on VGP territory

Before evaluating new traffic restriction policies, VGP wanted to estimate the impact of Metropole du Grand Paris (MGP)'s current LEZ on its territory. This initial estimate would give VGP an idea of the consequences of such a measure in reducing emissions on the scale of its territory.

The MGP (black border on the map of Figure 38) set up a LEZ in Paris and adjacent suburbs (hashed part on the map) in 2019[2]. The VGP territory is located outside the LEZ and adjacent to it (red border on the map). The current MGP LEZ prohibits the circulation of private vehicles with *Crit'Air*[3] stickers 4 and 5 corresponding to Diesel Euro norm 2 and 3, respectively. At the beginning of 2025, the restriction will focus on *Crit'Air 3* vehicles corresponding to Diesel Euro norm 4 and Petrol Euro norm 2 and 3.

Figure 38 Map of LEZ, MGP and VGP borders

[2] https://www.zonefaiblesemissionsmetropolitaine.fr/

[3] The Crit'Air stickers assignment is based on the type of fuel and the Euro standard.

Although the consequences of the LEZ on improving air quality remain undeniable, it will dramatically disrupt the mobility behaviours of populations. These behaviours can take several forms depending on the household situation (e.g. number of persons, income, occupation).

The central adaptations can be:

- change for a vehicle with an appropriate technology
- a modal shift towards public transport and other alternatives such as bicycles or walking
- changing routes to circumvent the perimeters of the LEZ

Therefore, these behaviours must be considered before assessing the LEZ impact.

- Methodology

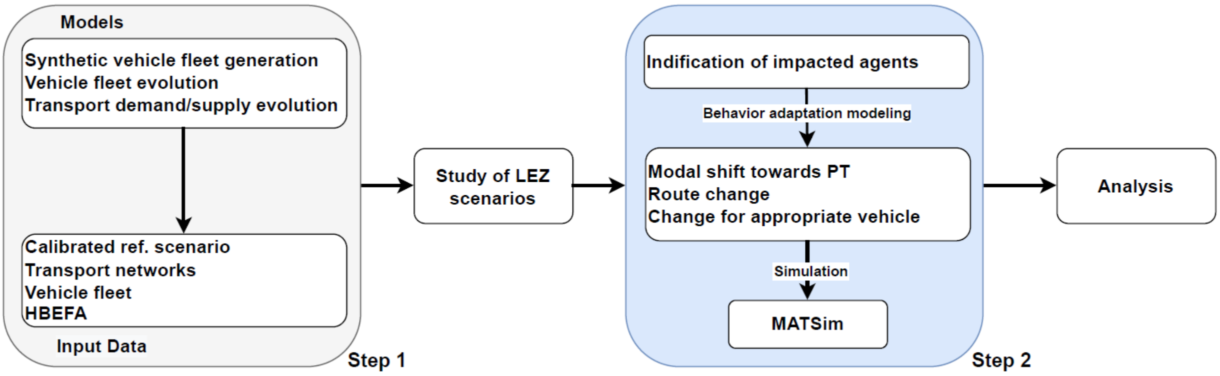


Figure 39 The main steps of the simulation framework for assessing LEZ scenarios

Figure 39 provides an overview of the simulation framework. The simulation's input (supply and demand parts) is generated in the first step. Travel demand groups the activities and trips performed by agents. It includes elements such as activity types and their locations, activity start and end times, and transportation modes. The supply comprises several components of the multimodal transport network (road links, intersections, transit schedules, and vehicles).

These inputs allow to realize calibrated reference scenarios (without considering the application of the LEZ). Then, in the 2nd step, the agents impacted by the LEZ are identified from the reference scenarios by analysing their travel routes. If an agent's itinerary is included within the perimeter of the LEZ, in that case, this agent is impacted by the LEZ if they use an inappropriate vehicle. Thus, depending on their situation, this agent will either (i) switch to another alternative, such as public transport, (ii) change their itinerary by crossing the LEZ, or (iii) change their vehicle with an appropriate technology. Once this adaptation is performed, the agents' travel is simulated again to evaluate emissions and other indicators.

- Identification of agents shifted toward PT

Trips likely to be performed by PT should not exceed a certain ratio corresponding to the duration in PT divided by that by car. This ratio was defined to 2.4 to meet 30% of impacted agents (see Figure 40). Then, to avoid excessively long and unrealistic public transport travel times, a filter is applied to select trips of which duration does not exceed a threshold. This threshold was defined at the 95th percentile which corresponds to 1h30min.

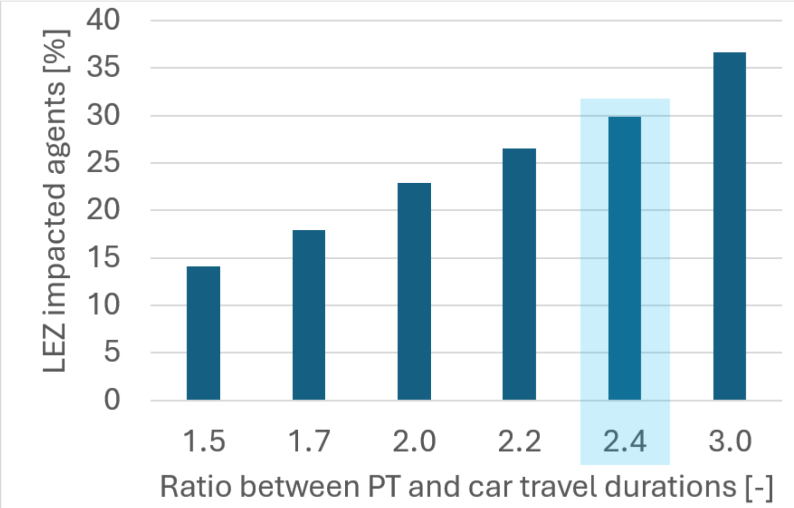


Figure 40 Share of LEZ impacted agents according to the ratio between PT and car travel durations

- Identification of agents changing their routes

To get an idea of the agents likely to bypass the LEZ, it is essential to list the different types of travel carried out within the perimeter of the LEZ. Figure 41 gives an overview of the three possibilities for traveling within the LEZ: full inside corresponding to trips with origin and destination within the LEZ; partially inside for trips with either origin or destination within the LEZ; and finally, crossing for trips with both origin and destination outside the LEZ.

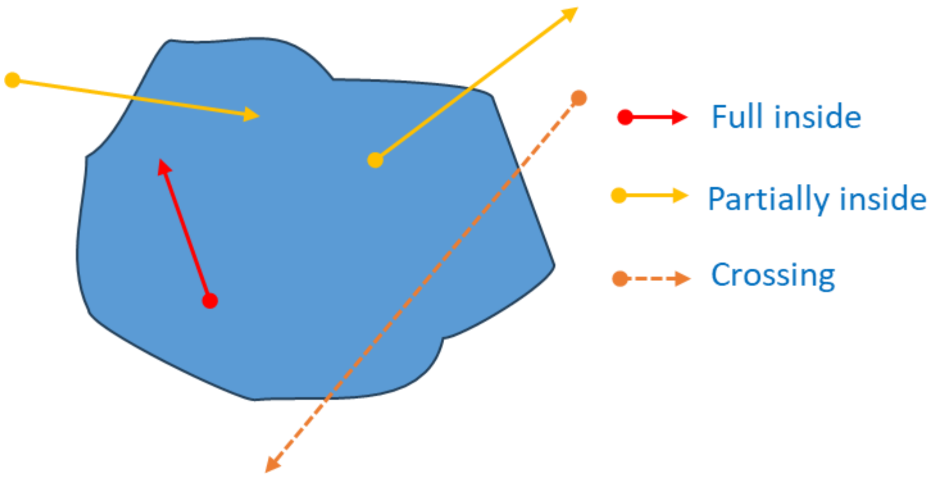
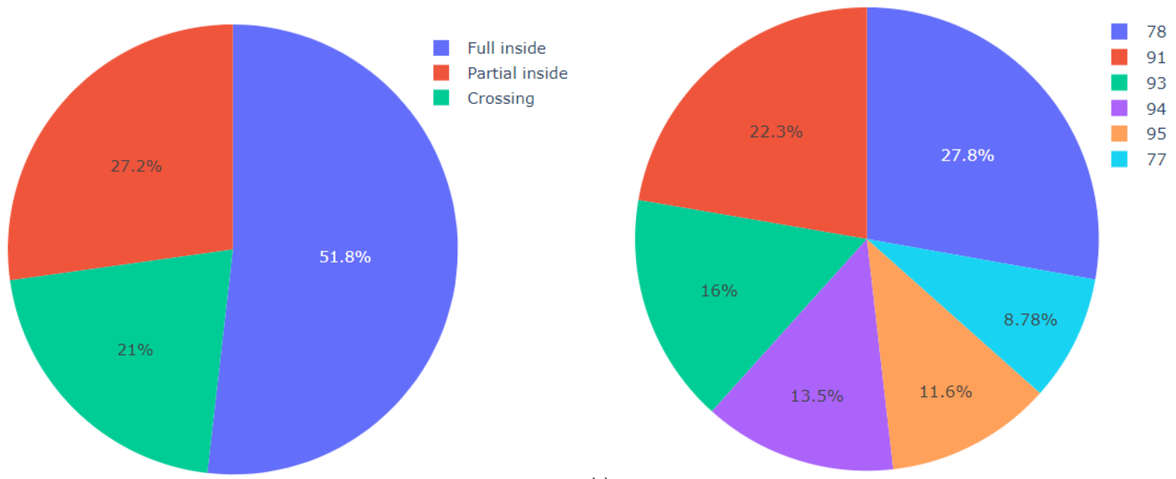


Figure 41 The three possibilities for traveling within the LEZ

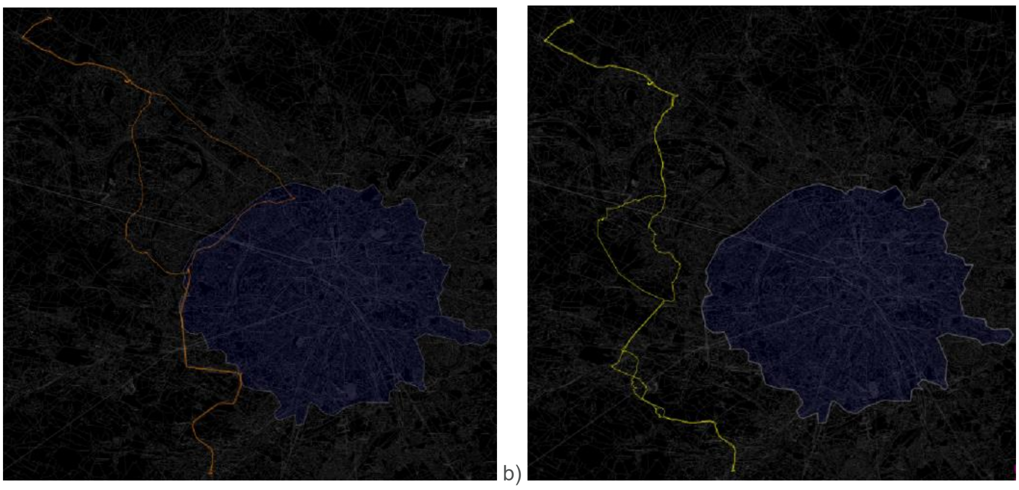
Thus, only agents performing crossing trips will likely adapt their itinerary to avoid the LEZ. These trips represent 21% of trips made in the LEZ (Figure 42.a). In addition, nearly 30% of these agents reside in Department 78, where the VGP territory is located (Figure 42.b).



a) b)

Figure 42 Distributions of trips (by car) performing within the LEZ and of crossing agents according to department of residence

The road network was adapted so that non-compliant vehicles could not circulate in the LEZ, allowing agents in the digital twin (MATSim) to bypass it. Therefore, we created a new transport mode in MATSim to allow this choice of travel. Figure 43 presents an overview of the change of routes for a given agent. Figure 43.a corresponds to the situation without the application of the LEZ, while Figure 43.b considers its implementation.



a) b)

Figure 43 Example of route change of a given crossing agent

- Vehicle replacement

The principle of prohibited vehicles' replacement consists in ensuring that there are enough compliant vehicles in each department (based on the vehicle fleet data) to make a new reassignment. The reassignment of non-compliant vehicles is done while respecting the distribution of LEZ compliant vehicles. Figure 44 gives an overview of this repartition in 2022 where Diesel Euro norm 2 and 3 were prohibited.

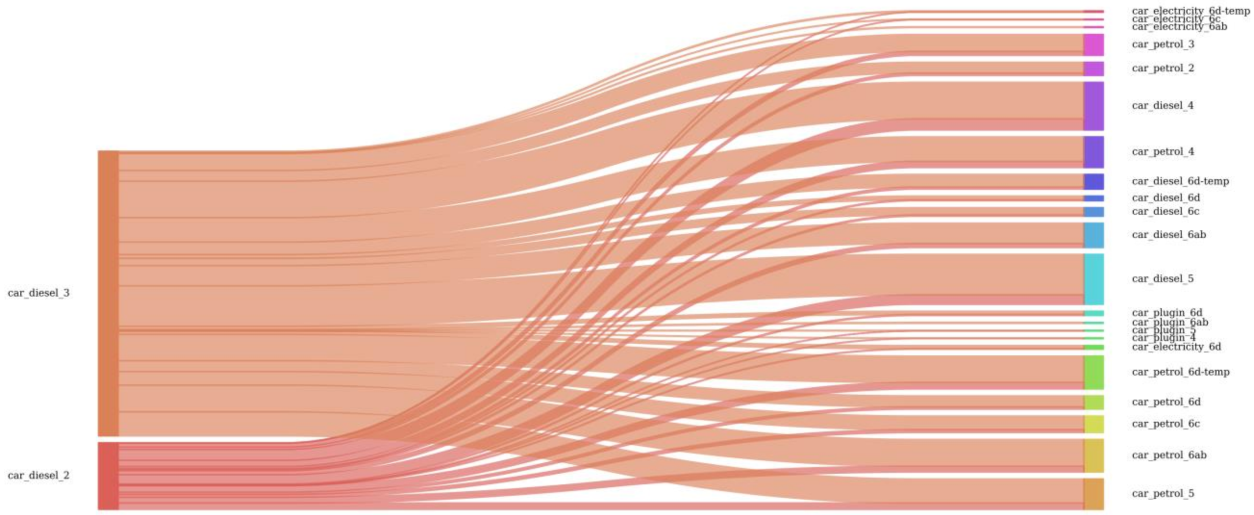


Figure 44 Reassignment of non-compliant vehicles

- First results

Prospective scenarios enabled the simulation of the emission reductions related to people’s behaviour change as a consequence of the LEZ. In 2025, the MGP LEZ will generate a sharp reduction in particles emissions, with **80% in the LEZ perimeter and over 43% in the perimeter of the entire region**. Although LEZ restrictions are not specific to VGP territory, it does have potentially rebound effects for trips between VGP and the LEZ area. Application of the Paris LEZ will result in a **60% reduction in particles emissions within the VGP territory**.

5.2.2.1.3. Challenges & Mitigations

One of the main difficulties encountered during the preparation is the consideration of individuals’ travel behaviour changes when impacted by the LEZ in (MATSim). The bypass was deemed possible by modifying the road network and creating a new mode of transport for prohibited vehicles. The potential of the modal shift towards public transport is mainly based on the minimization of travel time and the possibility of making all commuter trips by public transport.

5.2.2.1.4. Next steps towards implementation

After assessing the impact of the MGP LEZ on the VGP territory, the next step will be to define with VGP the different prospective scenarios that it wishes to explore in its policy of implementing the LEZ. VGP's first request concerns banning unclassified vehicles and Crit Air 5, i.e., old diesel.

5.2.3. Demo site: Leuven

5.2.3.1. Measure LEU_02: To study the needs for parking and public transport in different areas of the city

5.2.3.1.1. Description of the measure and main outcomes expected

The city of Leuven has one main peripheral parking which is gradually growing in use, including a dedicated free bus service, connecting the peripheral Park & Ride spaces (P&Rs) with the city centre, on the weekends. Leuven wants to analyse how the use of P&Rs can be further increased. This measure consists in analysing the current use of P&Rs and hubs in combination with PT. The aim is to identify social patterns, obstacles, and opportunities in these locations. In addition, this measure will use simulation tools to study the impact that the increased use of these parking sites would have in modal shift. This analysis forms the basis for the parking policy plan which will be adopted in the current SUMP. Based on the study, new small scale parking lots will be implemented. Improvements to the existing offer can also be implemented. This measure will deliver: an **analysis to support the parking policy plan**, an **analysis of new potential locations for P&Rs**, an **analysis of needs and opportunities to improve the use of peripheral parking lots**, the **implementation of a small-scale peripheral parking lot**, **focused measures aimed at improving the service level at the existing P&Rs,** and an **evaluation of implemented actions.**

5.2.3.1.2. Preparation of the measure

Firstly an analysis of the current use of P&Rs in combination with public transport was conducted and an analysis report was drafted. A new hierarchical typology of parking was proposed and the ideal locations for potential new P&Rs were determined through consultations with different internal and external stakeholders.

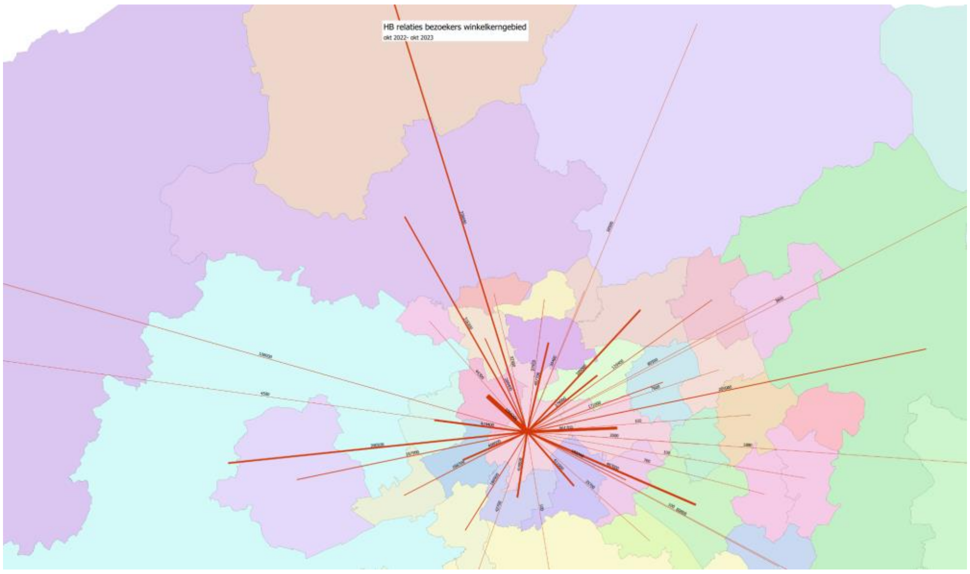


Figure 45 Origin-destination analysis of visitors of the city center

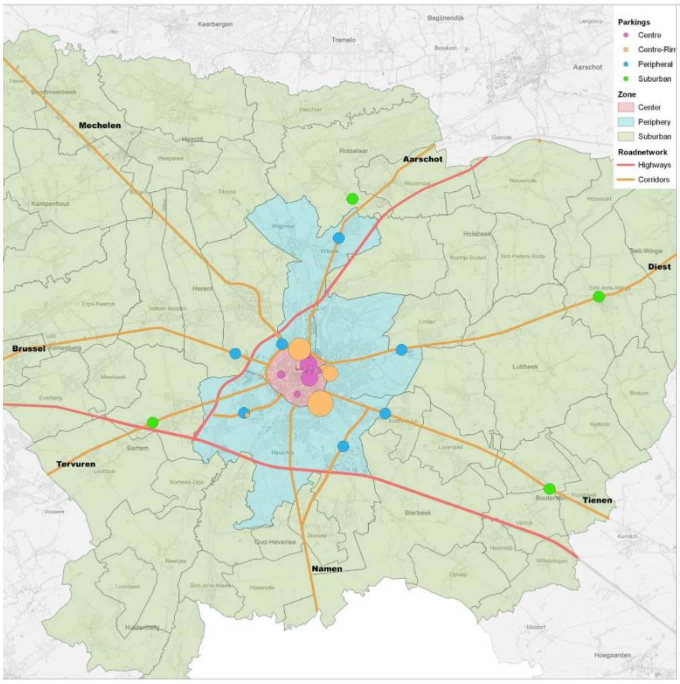
Parking hierarchy Leuven

Future parking levels for visitors

To minimise car trips to and from Leuven, visitors are best to park in the following type of car parks in the following order of priority.

		Existing parkings	Desired parkings
1) Suburban car parks	• at a good distance from city centre (> 10 km), outside the congestion-sensitive area • with easy connection to the main road network • transfer possibilities to HOV or bicycle highway • ample car parking facilities (including charging stations) • Park&Ride combination tickets with attractive rates	Some limited, existing parking infrastructure	• N19: Rotselaar • N3: Boutersem • N2: Sint-Joris-Winge • N3: Bertem (E40)
2) Peripheral car parks (Park & Ride/Bikes)	• Outside city centre and off the main ring road • with easy connection to the main road network • Good connection with PT city network and cycling routes • High quality bicycle parking • Shared bicycles • Park&Ride combination tickets with attractive rates	Some limited, existing parking infrastructure	• N2 - Diestsesteenweg: Commscope, • N3 - Tiensesteenweg: Korbeek-Lo (Carrefour) (?) • Station Haasrode researchpark (?) • N264 – Parking Wetenschapspark • N26: Kareelveld (carpoolparking E314) • N2 – Brusselsesteenweg: Diependaal (afrit E314) (?)
3) City centre parkings - rim	• Existing parkings with high (underused) capacity, but given the proximity to the city centre, these parkings generate traffic in residential areas and on the congested ring road.	Bodart Vaartkom P1 station Parkpoort Teken (GHB) De Bond	Bodart (?) Vaartkom P1 station Parkpoort Teken (?) De Bond
City centre parkings - centre	• Phase out parkings not on main routes ("lussen")	Parking Ladeuze Minckelers Center Diestsestraat Kinepolis Leuven Centrum Sint-Jacob Heilig Hart Tweewaters Vismarkt	Parking Ladeuze Minckelers Diestsestraat Leuven Centrum Sint-Jacob Tweewaters Benedenstad Heilig Hart De Bond
4) Street parking	• Mainly for residents and specific target groups • Visitors: short term parking only • 45 min free on shop&go spots • Max 2 hours elsewhere • Pricing should push to other types of car parking • 4.900 parking spots in 2024		

Figure 46 List of existing and desired car parks according to the future parking hierarchy



Corridor	Potential locations
Diest	New suburban parking Sint-Joris-Winge New peripheral parking Commscope / Jan Vranckx-Platte-Lo
Tienen	New suburban parking Boutersem New peripheral parking De Mol
Namen	New peripheral parking Haasrode
Tervuren	New suburban parking Bertem / E40 New peripheral parking Wetenschapspark
Brussel	New peripheral parking Diependaal
Mechelen	New peripheral parking Kareelveld
Aarschot	New suburban parking station Rotselaar New peripheral parking Wilsele-Putkapel

Figure 47 Main corridors to the city centre and the potential P&R locations

Further analysis is being carried out to examine which locations have the greatest potential for reduction of car traffic in the vicinity of the city, and to select the optimal location of the parkings. The research questions that are being examined are:

- What is the potential demand of suburban and peripheral parkings along the respective corridors?
- How does the demand vary given:
  - The frequency/amplitude of bus- train services
  - The pricing of each parking level
  - Completely phasing out of on-street parking in the city centre

- Which levels and corridors should be prioritized, i.e. have the greatest potential reduction of car traffic in the vicinity of Leuven?
- What are the optimal locations of the parkings?

Successful case studies were also examined and good practices for parking policy plans from other regions were explored. Something to look at further is the example of the city of Antwerp, where for the first time in Flanders a combi ticket is offered via the bus operator's app for a 24h parking session in a P&R, with a return trip to the city centre for 5 euro. The Antwerp P&Rs example also shows that a frequent public transport connection is important, but that users' perception of the reliability of that public transport connection is actually a big challenge in Flanders. Furthermore, the city of Ghent has a good example of a website with an indication of the current parking occupancy and information per parking lot about possible onward transport.

In addition to the collection and analysis of good practices, the city of Leuven is currently conducting street surveys to further analyse needs and opportunities to improve the service level and use of existing peripheral parkings for visitors to the city. Details of the survey content can be found in the table below.

Survey	**Questions**
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 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? 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?

Table 7 Survey questions on P&R use in Leuven

5.2.3.1.3. Challenges & Mitigations

The intention was to further look at the research questions by modelling, but finding the right model for this research proved difficult: it requires a license and information/scripts on how the models are formatted and that information is not always available. A regional transport model is also needed, so that a wider region than Leuven alone can be considered for the suburban car parks. The model also has to include data on public transport and cycling, but many models focus on commuting, while for peripheral car parks the focus is more on leisure and visitors. An analysis by the UPPER-tool U-Need to further determine the ideal locations is still scheduled but is taking longer than expected, causing a delay.

5.2.3.1.4. Next steps towards implementation

A further analysis of the new potential locations of the P&R's is being carried out, including an analysis with the UPPER-tool U-NEED in the fall 2024. A list of ideas for the parking policy plan has already been compiled and will be further completed in preparation of the drafting of the framework for the parking policy plan by the end of December. After the future locations of P&R's are selected, a parking policy plan can be drafted and approved by the end of July 2025. By the end of 2025, an implementation plan for at least one P&R will be developed.

5.2.4. Demo site: Thessaloniki

5.2.4.1. Measure TES_04: To influence modal shift through congestion sensitive Parking pricing

5.2.4.1.1. Description of the measure and main outcomes expected

The measure TES_04 investigates the possible effects of modifying the cost of city's controlled parking system on modal shifts, and consequently on traffic and environment. Also, under TES_04, users' willingness to pay (WtP) for parking in the city centre is being investigated. To achieve this, a questionnaire survey was carried out, following the stated preference (SP) approach. The responses were analysed using discrete choice modelling techniques to estimate the modal share (between public transport and private car) in each of the pricing scenarios. The estimated modal shares were used to estimate the traffic impacts and CO_2 emissions of different parking pricing scenarios. As such, the outcome of TES_04 acts a comprehensive analysis that can significantly guide Thessaloniki's policy-makers, with regards to the operation of the controlled parking system.

5.2.4.1.2. Preparation of the measure

<u>Case study</u>

In 2017, aiming to manage parking and traffic in specific areas of the city, a controlled parking system was implemented in the city of Thessaloniki. The system includes four parking space categories:

- for residents: Anyone living at any address in the implementation areas is entitled to free parking at certain locations. To secure this right, residents apply for resident card to the municipal community to which they belong.
- for visitors: Anyone who does not own a resident card is entitled to a parking cost of 1.70 €/hour from 08:00am to 21:00pm during weekdays and from 09:00am until 16:00pm on Saturday. Apart from the aforementioned hours, parking is free, including Sundays and public holidays. Parking in these spaces is allowed for a maximum of 4 hours.
- loading/unloading: These areas are used to supply stores and are subject to the regulatory decisions of the Municipality of Thessaloniki.

- persons with disabilities: free parking near the entrance of the house is provided for those who have a disability or are the trustee of a disabled person.

One of the areas that the controlled parking system operates is the city centre, where 1,610 parking spaces for visitors and 3,435 parking spaces for residents are available. The controlled parking system had 300,000 unique users in 2022 and served roughly 1,500,000 parking transactions. The average parking duration for visitors in the city centre is two hours. The city is currently engaged in discussions regarding the potential implications of transitioning from a fixed hourly parking cost to a dynamic pricing policy.

Data collection

For the purpose of this measure, an online stated preference experiment was designed. The web questionnaire was disseminated through local websites to ensure broad participation. A total of 208 responses were collected in December 2023. The distribution of the sample per area of residence is presented in Figure 48. The distribution of responses covers many parts of the city, but the majority of participants lives in the eastern part of Thessaloniki.

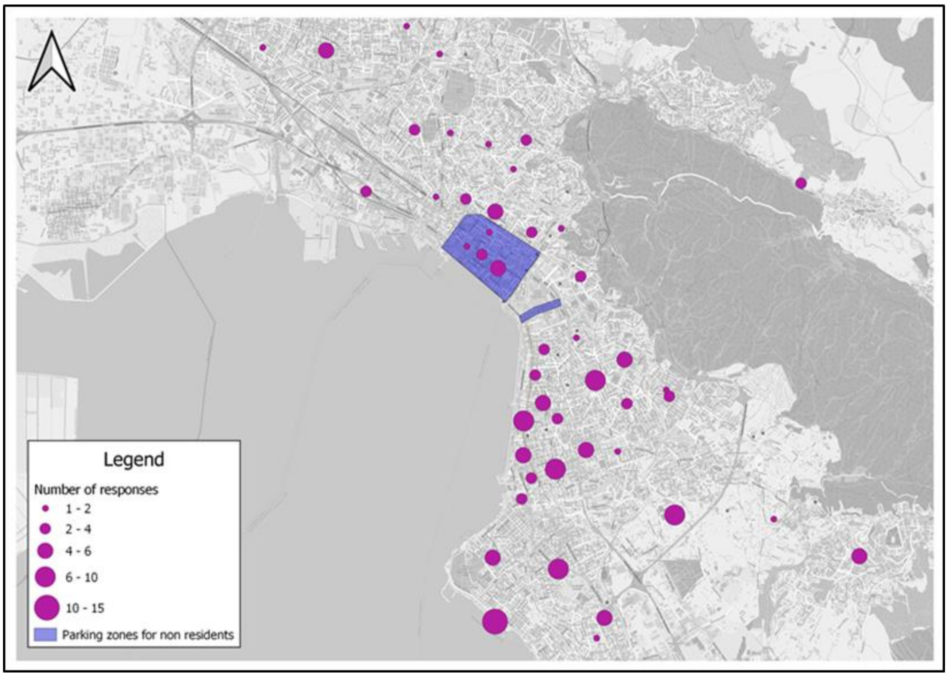


Figure 48 Spatial distribution of responses

The questionnaire was divided into three sections in order to collect information from the participants:

- Respondents' existing mobility preferences

The aim of this section was to understand the travel frequency and usage of car and public transport for trips that have the city centre as destination, as well as the frequency of using the controlled parking system.

- Respondents' stated preferences

First, participants were asked to evaluate different hypothetical prices for the controlled parking system in Thessaloniki. The prices ranged from 0.5 €/hour to 3 €/hour, with a step of 0.25 €/hour, and the respondents had to select among "very cheap", "cheap", "normal", "expensive", "very expensive".

Following that, six stated preference scenarios were addressed to the respondents, where participants had to choose between traveling by car or by bus from their place of residence to the centre of Thessaloniki, taking into consideration different travel attributes (an example is presented in Figure 49). In more detail, the travel attributes that were included in the scenarios are: travel cost with private car and bus, travel time with private car and bus, parking cost for private car, time to find a parking space for private car.

The travel cost with private car, as well as the travel time with private car and bus, were fixed for each individual, considering his/her place of residence. This approach was chosen to increase realism in the scenarios (which is one of

the most challenging elements in the stated preference experiments according to Cherchi and Hensher, 2015), and to emphasize the parking-related attributes.
The travel cost with public transport attribute had two levels, €0.45 and €0.90, similarly to the existing discounted and regular tickets, while both the parking cost and the time to find a parking space had four levels. The parking cost levels ranged from 0 to €5.50 (2.75 €/hour), and the time to find a parking space ranged between 2 and 15 minutes. All these values are highly realistic considering the existing pricing of the controlled parking system and the traffic conditions in the city centre.
Moreover, to define a more precise context, participants were asked to assume that: a) the trip takes place on the afternoon of a typical weekday when shops are open, b) the time spent in the city centre is approximately 2 hours.

- Respondents' demographic and socioeconomic characteristics

In this section, participants were asked to state their gender, age, employment status, monthly household income and place of residence. The latter was used to estimate the travel cost and duration to the city centre, with private car and public transport.

	Car	Bus
	Travel cost: The cost of fuel required in the current situation to move from your home to the center. **Travel time**: The time it takes in the current situation to move from your home to the center by car. **Cost of parking in a visitor space in the controlled parking system**: 5,5 € (2,75 €/hour) **Time to find a parking space**: 2' 	**Travel cost**: The cost of a reduced city bus ticket in the current situation (€0,45). **Travel time**: The time it takes in the current situation to move from your home to the center by city bus. **Cost of parking in a visitor space in the controlled parking system**: Not applicable. **Time to find a parking space**: Not applicable. 
Select the means of transport you would choose	○	○

Figure 49 Example of stated preference choice tasks (a) private car, (b) bus

Data analysis methodology

The responses were initially subject to a descriptive analysis, involving the computation of absolute and relative frequencies. This approach aimed to offer a comprehensive overview of participants' characteristics, attitudes, and preferences. In this study, for the stated preference experiment, we use a mixed-logit model framework. Standard logit models assume that individuals in the population share the same preferences for the attributes of alternatives. Yet, in reality, preferences may vary significantly among individuals, and the standard logit model fails to capture this heterogeneity. On the other hand, in a mixed logit model (or random parameters logit model) the parameters are assumed to vary from one individual to another. Therefore, mixed-logit models are capable of handling population's heterogeneity (inter-individual heterogeneity) and capturing the variability in preferences across different decision-makers (Hensher and Greene, 2003).

As in a typical random utility model, each individual is assumed to choose the alternative that provides the highest utility; the utility for an individual n, for an alternative i and a choice situation t is specified as:

$$U_{nit} = V_{nit} + \varepsilon_{nit} \quad (1)$$

where V_{nit} is the systematic part of utility and ε_{nit} is the stochastic disturbance which is independently and identically distributed according to Gumbel type I distribution across individuals, alternatives and choice situations. The systematic part of the utility, for the purposes of this study, is specified as following for the private car and the public transport options accordingly:

$$V_{car} = \delta_{car} - \beta_{DTT}DTT - \beta_{DTC}DTC + \beta_{cp}cost\_park + \sigma_{car} \quad (2)$$

UPPER

$V_{PT} = \beta_{DTT}DTT + \beta_{DTC}DTC + \beta_{cmu}car\_monthly\_usage + \beta_{PTmu}PT\_monthly\_usage + \beta_{pmu}park\_monthly\_usage + \sigma_{PT}$ (3)

where:

- δ expresses the alternative specific constant (ASC). Considering that the number of estimable ASC parameters is i-1 (i is the total number of alternatives), the ASC parameter associated with public transport was fixed to zero.
- β expresses the parameter estimates of each attribute. As previously mentioned, the model was estimated for considering inter-individual heterogeneity, meaning that for specific variables, random parameters were assumed. More specifically, random parameters were assumed for the three cost and travel time related parameters (βDTT, βDTC, βcp). For all these three parameters, a negative lognormal distribution was assumed, since negative values are expected for the cost and travel time related parameters. The initial mean values for each one of the three distributions was defined after initially developing a simple multinomial logistic regression model; the coefficients of the specific variables were used as initial mean values of the negative lognormal distributions. It is noted that except for the inter-individual taste variations, the estimation with intra-individual heterogeneity was examined. However, the estimation with both inter- and intra-individual heterogeneity found that this was not improving the fit of the model, but was significantly increasing the required computational time. Similar findings regarding the estimation with both inter- and intra-individual heterogeneity are also identified by Krueger et al. (2021).
- σ is a panel effect term which accounts for variation over the respondents. This term was assumed to follow a normal distribution.

The explanatory variables of the mixed-logit model are specified in Table 8. It is noted that travel time and cost were initially examined as alternative specific parameters, but after several trial and error tests, it was considered more suitable to proceed with generic parameters. Considering that DTT and DTC were computed as travel time/cost with public transport minus travel time/cost with car, both parameters were added with a negative sign in the utility of car and with a positive sign in the utility of the public transport alternative. The cost of parking is included only in the car alternative, since parking cost does not exist for the public transport alternative. Moreover, parameters related to individuals' existing mobility preferences were only included in the utility of the public transport alternative. Finally, the panel effect term was added in the utilities of both alternatives.

Variable	Description
DTT	Travel time with public transport minus travel time with car
DTC	Cost with public transport minus cost with car
cost_park	Cost for parking
car_monthly_usage	Use of private car at least once per month (0: No, 1: Yes)
PT_monthly_usage	Use of public transport at least once per month (0: No, 1: Yes)
park_monthly_usage	Use of controlled parking system at least once per month (0: No, 1: Yes)

Table 8 Description of model's explanatory variables

The probability that an individual n will choose an alternative i, for a given value of βn is:

$$P_{ni}|\beta n = \frac{e^{(Vni)}}{\sum_c e^{(Vnc)}} \quad (4)$$

and the unconditional probability is specified as following:

$$P_{ni} = \int_{\beta 1} \int_{\beta 2} \int_{\beta 3} (P_{ni}|\beta) f(\beta|\theta) d\beta_1 d\beta_2 d\beta_3 \quad (5)$$

For estimating the mixed-logit model, the Simulated Maximum Likelihood approach was used, with 1,500 Halton draws (Halton, 1960). The analysis was conducted in the Apollo package (Hess & Palma, 2019), which is implemented in the R programming language (R Core Team, 2017).

<u>Results – estimated modal shares for different parking pricing scenarios</u>

Figure 50 summarizes the responses about the perception of the respondents with regards to several hypothetical hourly prices, for on-street parking in the city centre. The results indicate that an hourly price of €1.50 is considered normal, prices between €1.75 and €2.00 are considered expensive, and prices equal or greater than €2 are considered very expensive. According to this distribution of responses, the existing parking price of 1.70 €/hour for the Thessaloniki's controlled parking system is considered expensive.

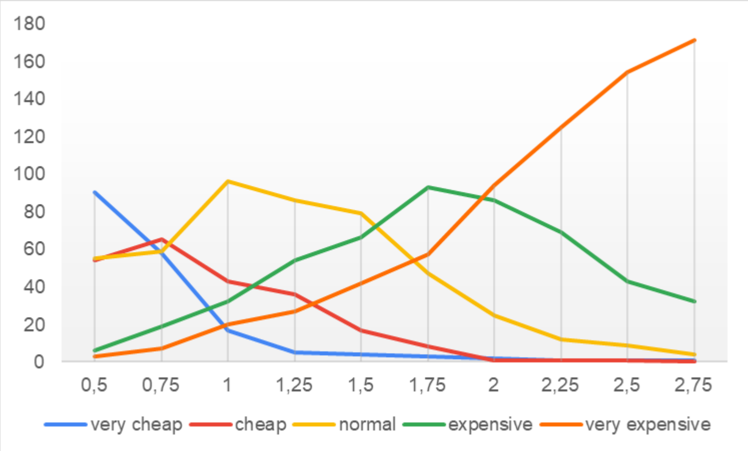


Figure 50 Perceptions regarding controlled parking pricing (absolute frequencies of responses)

The results of the mixed-logit model are presented in Table 9. The ASC value shows that there is an a-priori preference for the private car over the public transport alternative. This preference is somewhat expected considering respondents already rely more on private cars for their trips to the city centre. The impact of the respondents' existing mobility preferences on their choices in the stated preference context is also reflected in the estimates of the model parameters, which are related to the frequency of using a private car, public transport and the controlled parking system. As it was observed in the descriptive statistics, these three variables influence the choice of the respondents, and as the model's results show, there is a much higher likelihood to choose the public transport alternative if the individual already uses public transport at least once per month. On the contrary, those who are currently using private car at least once per month and the controlled parking system are inclined to choosing the private car alternative. Regarding the travel time and cost-related parameters both the signs and the magnitudes are reasonable. Also, based on the t-ratio values of the standard deviations of these three random parameters it can be identified that among individuals there is a great heterogeneity, especially with regards to the two cost-related parameters. The presented evaluation metrics of the model significantly outperform the metrics of the respective standard logit model that was initially developed, indicating that the consideration of the inter-individual heterogeneity is essential for more robust estimations.

	Estimate	**Std. error**	**Rob. t-ratio**
asc_car	2.1209	0.7999	2.360
asc_bus	0.0000	NA	NA
b_car_monthly_usage	-1.2481	0.7959	-1.544
b_PT_monthly_usage	3.1542	0.7239	4.198
b_park_monthly_usage	-1.6617	0.7072	-2.167
mu_log_b_cost_park	-0.3692	0.1258	-2.457
sigma_log_b_cost_park	0.7016	0.1082	7.910
mu_log_b_DTT	-3.4377	0.6005	-4.804
sigma_log_b_DTT	0.3435	0.3875	1.547
mu_log_b_DTC	-0.5926	0.3863	-1.664
sigma_log_b_DTC	1.1535	0.2185	6.559
sigma_panel	2.3851	0.3288	6.649
n_{indiv} = 208; n_{obs} = 1248			
LL(start) = -1192.87; LL(final) = -563.88			
AIC = 1149.76; BIC = 1206.18; Adj. R^2 = 34.82%			

Table 9 Model results – parameter estimate

To examine the impact of different on-street parking pricings on the shift to public transport, a synthetic dataset was generated and used for out-of-sample predictions. This dataset included the same variables that were used in the estimated mixed-logit model and each variable was generated based on the following rules:

- car_monthly_usage: for 77.5% of the cases the value is 1 (yes) and for the rest of the cases 0 (no)
- PT_monthly_usage: for 30.8% of the cases the value is 1 (yes) and for the rest of the cases 0 (no)
- park_monthly_usage: for 53.8% of the cases the value is 1 (yes) and for the rest of the cases 0 (no)
- DTT: continuous values with mean equal to 14 and standard deviation equal to 15
- DTC: continuous values with mean equal to -0.31 and standard deviation equal to 0.86
- cost_park: four different scenarios were examined (1.0, 1.7, 2.0, 2.5 €/h)

The abovementioned frequencies, mean values and standard deviations were defined based on the respective values of the original dataset. Since random sampling was followed during the data collection process, it can be reasonably assumed that these values are representative of Thessaloniki's population.

Using the above mentioned synthetic dataset, and based on the estimated mixed-logit model, the shares of private car and public transport were estimated for each one of the four pricing scenarios that were examined. The modal share estimations are presented in Table 10. The 1.7 €/hour price was used as a baseline, since it is the current pricing of the controlled parking system. The results show that for most of the examined cases, public transport modal share is almost half of the private car modal share (30-40% vs 60-70%). However, this difference is being bridged to a large extent in the case of long-term parking; especially for prices of 2 €/hour, public transport becomes equally attractive with private car.

Parking duration	Pricing	Private car share	PT share	PT difference (comparing to baseline)
Short-term (30 mins)	Baseline (0.85)	71%	29%	-
	Low (0.50)	73%	27%	-6.9%
	Mid (1.00)	70%	30%	+3.4%
	High (1.25)	69%	31%	+6.9%
Mid-term (1 hour)	Baseline (1.70)	66%	34%	-
	Low (1.00)	70%	30%	-11.8%
	Mid (2.00)	64%	36%	+5.9%
	High (2.50)	60%	40%	+17.6%
Long-term (2 hours)	Baseline (3.4)	55%	45%	-
	Low (2.00)	64%	36%	-20%
	Mid (4.00)	51%	49%	+8.9%
	High (5.00)	45%	55%	+22.2%

Table 10 Modal share per pricing scenario (relative values)

Going one step further with the analysis, an attempt to estimate absolute (and not relative) values of the modal share of the two modes is being made. To do so, modal share values from the Thessaloniki's strategic traffic model (i.e., the one used for city's SUMP) are being extracted, especially for trips with city centre as destination and with other purpose than going to work or education (since visitors parking spaces' targets in the controlled parking system are not these types of trips).

According to Thessaloniki's strategic traffic model, the absolute modal share of private car for this group of trips is 37% and the one of public transport is 31%. These absolute modal share values are proportional with the relative modal share values that were presented in Table 10 for the baseline scenario in the case of long-term parking. Thus, using the percentage differences for the public transport modal share that were presented in Table 10 for the long-term case, absolute modal shares for the two modes can be estimated for each pricing scenario, for trips that are destined to the city centre and have purpose other than going to work or education (Table 11).

Pricing scenario	Private car share	PT share
Baseline (1.70 €/hour)	37.0%	31.0%
Low (1.00 €/hour)	43.2%	24.8%
Mid (2.00 €/hour)	34.2%	33.8%

High (2.50 €/hour)	30.1%	37.9%

Table 11 Modal share per pricing scenario (absolute values)

Results – estimated traffic impacts for different parking pricing scenarios

The estimated modal shares for the different pricing scenarios were incorporated in Thessaloniki's strategic traffic model for identifying the traffic impacts of the modal shifts that arise from the change in the parking pricing. It is noted that the estimated modal shares were specifically used for the Home-Based Shopping Leisure trips (HBSL trips) of Thessaloniki's model, considering that the pricing of the controlled parking system mainly affects city centre visitors, and not city centre citizens or employees. Key results of the traffic simulation are presented in Tables 12 and 13.

Scenario	*All trip purposes*	*HBSL trips*	*HBSL trips with their end located within the city centre*	*VehicleKM in Municipality of Thessaloniki*	*VehicleHours in Municipality of Thessaloniki*
Baseline	618,028	174,416	38,462	322,247	11,024
Low (1.00)	622,170	180,448	44,498	333,426	11,488
Mid (2.00)	614,625	171,178	35,227	315,960	10,673
High (2.50)	611,189	166,955	31,004	308,034	10,251

Table 12 Key results of traffic simulation – Daily car trips

	All road types		**Arterial roads**		**Main collectors**		**Collectors**	
Scenario	*Average speed (km/h)*	*Average v/c*	*Average speed (km/h)*	*Average v/c*	*Average speed (km/h)*	*Average v/c*	*Average speed (km/h)*	*Average v/c*
Baseline	33	0.27	46	0.45	40	0.40	37	0.43
Low (1.00)	33	0.28	45	0.45	40	0.40	37	0.44
Mid (2.00)	33	0.27	46	0.44	40	0.39	37	0.43
High (2.50)	33	0.27	46	0.44	40	0.39	37	0.42

Table 13 Key results of traffic simulation – Average speeds and volume/capacity ratio

Results – estimated CO_2 emissions for different parking pricing scenarios

As observed in Table 12, between the different scenarios there is a difference in the vehicle kilometers that are made within the Municipality of Thessaloniki. Based on this, the CO_2 emissions for each scenario can be estimated. The CO_2 calculation process for the four different scenarios, as depicted in Table 16, includes:

- Calculating the litres consumed according to the COPERT formula
- Calculating CO2 based on the type of vehicles (petrol or diesel) using the proposed formula from the Ministry of Environment and Energy (YPEKA), which is based on the IPCC methodology

To calculate fuel consumption, initially, the average speed is calculated based on vehicle kilometres per vehicle hour on Thessaloniki's road network on an hourly basis. Subsequently, fuel consumption is calculated using the formula developed in the COPERT III road transport emission calculation software (Ntziachristos and Samaras, 2000). To align the calculations with the COPERT formula, it is assumed that the vehicles are less than or equal to 1400 cubic centimetres, and the vehicle class is EURO 1 and above. The formulas are based on the calculated average speed. For an average speed between 5 km/h to 12.3 km/h, the fuel consumption formula is:

$$\mathrm{FC}\ (\mathrm{g/km}) = 329.451\text{-}39.093*\mathrm{V}+1.531*(\mathrm{V2})$$

For an average speed between 12.3 km/h to 130 km/h, the fuel consumption formula is:

$$\mathrm{FC}\ (\mathrm{g/km}) = 98.336\text{-}1.604*\mathrm{V}+0.0106*(\mathrm{V2})$$

After calculating fuel consumption in grams per kilometre, the units are converted from g/km to lt/km. The purpose of this conversion is the final calculation of the total CO_2 emissions in tons produced by vehicles in Thessaloniki. The fuel density, measured in kg per litre, is used for this conversion. The final total values of litres resulting from the above calculations are presented in Table 14.

Scenario	Total lt

Baseline	26230.9058
Low (1.00)	27240.9042
Mid (2.00)	25592.76
High (2.50)	24765.9336

Table 14 Total Fuel Consumption in Liters for Different Parking Pricing Scenario

After calculating fuel consumption in litres, the CO_2 emitted by vehicles is calculated. The calculation formula varies depending on whether the vehicles are diesel or petrol. According to the ACEA report (2023) for the year 2021, the percentages of vehicles by fuel type in Greece are: petrol 90.1%, diesel 8.6%, hybrid electric 0.6%. Therefore, it can be assumed that the fuel consumption between diesel and petrol cars is the one presented in Table 15.

Scenario	Diesel car (lt)	Petrol car (lt)
Baseline	2360.781522	23607.81522
Low (1.00)	2451.681378	24516.81378
Mid (2.00)	2303.3484	23033.484
High (2.50)	2228.934024	22289.34024

Table 15 Distribution of Fuel Consumption Between Diesel and Petrol Cars for Different Parking Pricing Scenarios

The Ministry of Environment and Energy (YPEKA)[4], based on the IPCC CO_2 calculation methodologies, includes methodologies for calculating CO2. The calculation of CO2 emissions from the use of each fuel is based on the following equations:

Diesel Formula: $ECO2\_diesel = C\_diesel * NCV\_diesel * EF\_diesel * OX\_diesel * d\_diesel * 10^{-6}$

where

- ECO2_diesel is the CO2 emissions from diesel fuel use in tn
- C_diesel is the diesel consumption within the defined period in lt
- NCV_diesel is the Net Calorific Value of diesel: 4280 TJ/Ktn (source: National Inventory Report 2022 Greece**5**)
- EF_diesel is the CO2 emission factor: 7378 tn CO2/TJ (source: National Inventory Report 2022 Greece)
- OX_diesel is the diesel carbon oxidation factor: 1 (default value according to IPCC Guidelines for National Greenhouse Gas Inventories 2006)
- d_diesel is the average diesel density at 15°C: 0.8325 Kg/lt (calculated based on the minimum and maximum density defined for diesel in JMD 355/2000/2001)

Petrol Formula: $ECO2\_petrol = C\_petrol * NCV\_petrol * EF\_petrol * OX\_petrol * d\_petrol * 10^{-6}$

Where

- ECO2_petrol is the CO2 emissions from petrol fuel use in tn
- C_petrol is the petrol consumption within the defined period in lt
- NCV_petrol is the Net Calorific Value of petrol: 4279 TJ/Ktn (source: National Inventory Report 2022 Greece)
- EF_petrol is the CO2 emission factor: 7326 tn CO2/TJ (source: National Inventory Report 2022 Greece)
- OX_petrol is the petrol carbon oxidation factor: 1 (default value according to IPCC Guidelines for National Greenhouse Gas Inventories 2006)
- d_petrol is the average petrol density at 15°C: 0.7475 Kg/lt (calculated based on the minimum and maximum density defined for unleaded petrol in JMD 354/2000/2001)

According to the above formulas and having calculated the litres, the final CO_2 values are depicted in Table 16.

Scenario	tn CO2 (Diesel)	tn CO2 (Petrol)	Total tn CO2 daily

[4] https://ypen.gov.gr/wp-content/uploads/2023/05/%CE%9F%CE%B4%CE%B7%CE%B3%CF%8C%CF%82-%CE%B3%CE%B9%CE%B1-%CE%94%CE%B7%CE%A3%CE%9C%CE%95.pdf

5 https://ypen.gov.gr/wp-content/uploads/2022/04/2022_NIR_Greece.pdf

Baseline	6.206	55.319	61.525
Low (1.00)	6.445	57.449	63.894
Mid (2.00)	6.055	53.973	60.029
High (2.50)	5.859	52.230	58.089

Table 16 Daily CO2 Emissions in Tons for Diesel and Petrol Cars Across Different Parking Pricing Scenarios

5.2.4.1.3. Challenges & Mitigations

No challenges were identified during the development of TES_04.

5.2.4.1.4. Next steps towards implementation

The aim of this measure is to guide policy-making regarding Thessaloniki's controlled parking system, and more specifically to provide evidence about users' WtP, with a focus on the impacts of different parking pricings. Such a comprehensive analysis can be a really valuable input for decision-makers. However, for implementing these policies, various perspectives should be considered, and obstacles perceived by policy-makers should be understood. As such, next steps of this measure include the **implementation of participatory processes** that will involve relevant stakeholders, as well as **consultation with policy-makers**, to foster the implementation of the appropriate changes in city's controlled parking system.

5.2.5. Demo site: Lisbon

5.2.5.1. Measure LIS_01: Restrict car access in the city

5.2.5.1.1. Description of the measure and main outcomes expected

The measure LIS_01 proposes the implementation of traffic restriction pilot projects around municipal schools (4 schools) to promote safer and more active modes around schools. It will deliver the 4 pilot projects and a guide describing the process for future uptake. It also includes a public space transitory design activity, participatory actions with the school community, parish councils and citizens (mostly residents), and communication activities.

5.2.5.1.2. Preparation of the measure

For this measure, a first analysis of city schools was conducted in order to perceive which ones had an adequate profile to develop this project. 4 Schools were then selected.

Bi-lateral meetings (February 2024) with 4 Parishes were conducted to introduce this UPPER measure, branded through the Mexe-te pela Tua Cidade municipal program. This programme promotes safety and active modes in school surroundings with the closure of several streets to cars users (non-residents) during morning school entrance schedule, once a week, throughout an entire school year.

Figure 51 Teams meeting with one of the Parishes

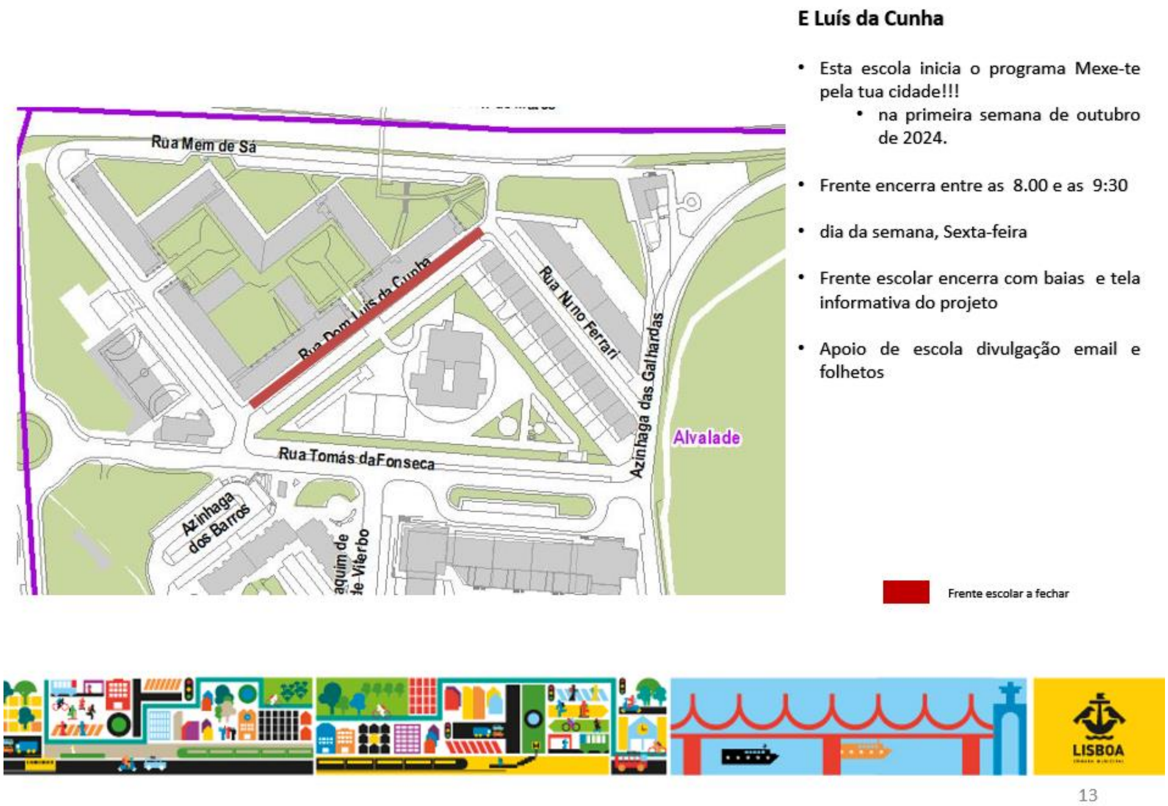


Figure 52 Plan presented at the meeting with one of the Parishes, with the traffic restrictions planned in School EB Dom Luís da Cunha

As a result of these meetings, 2 of these parishes declined participation. After a second round of city school's analysis, 2 other Parishes were selected, and bi-lateral meetings were conducted in March 2024. In total, stakeholders from 4 schools were involved, as well as their 4 parishes:

School	Parishes
EB Santo Amaro	Alcântara
EB Dom Luís da Cunha	Alvalade
EB Professor Manuel Sérgio	Ajuda
EB de Telheiras	Lumiar

Table 17 Schools and Parishes involved in LIS_01

CML then proceeded with an in-depth data collection and analysis of mobility behaviours surrounding the selected schools, that allowed the specification of the traffic restrictive points to be implemented.

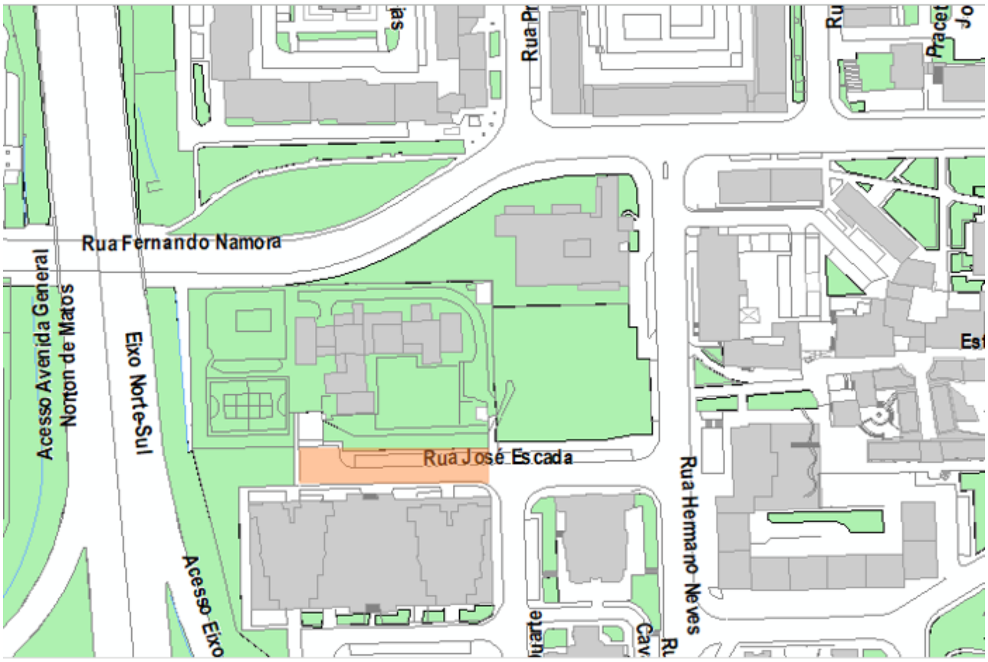


Figure 53 Plan portraying traffic restrictions planned in School EB de Telheiras

On the 4th of June, celebrating Children's Day and Bicycle Day, a pop-up test was implemented in EB Santo Amaro (Alcantara Parish), with great acceptance from all the stakeholders involved.

Figure 54 Traffic restriction implemented, in EB Santo Amaro, 4th of June 2024

Figure 55 Event Flyer, in EB Santo Amaro, 4th of June 2024

During summer 2024, CML is conducting meetings with the stakeholders in order to prepare all the work necessary to implement (human resources, promotion materials, equipment necessary) in the beginning of the next school year.

5.2.5.1.3. Challenges & Mitigations

Stakeholders' engagement is considered the biggest challenge so far, namely gaining the acceptance and the commitment of the parishes – new schools had to be selected, after 2 parishes declined involvement in this measure. This could be related to the upcoming year local authority's election, anticipating this issue could be recurrent for the upcoming year.

5.2.5.1.4. Next steps towards implementation

With the start of the 2024-2025 school year, in September-October 2024, the pilot restrictive car access measures will be put in place through pop-up activities throughout the year in the 4 schools mentioned above, during morning school entrance schedule, once a week.

6.Conclusion

The D3.5 UPPER Urban Vehicle Access Regulations Toolbox is a broad guidance document reporting on work conducted by multiple partners and sharing results to be exploited during and beyond the project by urban planners, local and regional authorities with prospects related to mobility measures improving transport sustainability with PT as a backbone.

The main conclusion is the wide diversity of available resources and key stakeholders to involve in decision making and implementation processes, due to their direct connection to the measures' outcomes, their responsibilities in enforcing or complying with them, or their expertise in activities linked to the intended outcomes. Specific conclusions can be drawn by topics and are subject of discussions among the UPPER partners, but each site has their own context and conditions to be considered in any local initiative.

The guidance provided in this deliverable aims at supporting decision makers and operators, and should be regarded as providing options and potential solutions in defined situations. It is also to be considered in the framework of the whole UPPER project and the deliverables involved, for an optimal exploitation of resources and lessons learnt.

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UPPER

Annex 1: Workshop 2 ‘Points of attention’

PT prioritisation in traffic management

Measure ID	Appraised by	“Point of attention” category	Evaluation result: Point of attention/ Comment	Solutions/ Best practices/ References
LIS_02	ECF	Target group/s that are mainly impacted by the measure	Explore possible synergies for traffic rules enforcement, e.g. check if the cameras can also be used to identify cars parked on cycle lanes.	
BUD_06	EPF	Tailored communication for increased acceptance and buy-in	Improving PT speed and reliability is good, but not enough. Other factors play a role too, e.g., fares, accessibility, seamless multimodal interchanges, ... Campaigns are necessary as well as training to get people to use PT.	
BUD_06	EPF	Active stakeholder engagement during measure development	Considering that some measures will have an impact on public space (e.g., less parking space which may be sensitive), it's useful to include engagement activities with citizens living in these areas, to increase support and understanding of the benefits.	Organise information and feedback sessions in impacted neighbourhoods
LIS_02	EPF	Seamless multimodality/intermodality	What about micromobility users? how do you intend to engage with car and PT users?	Micromoblity users should also be engaged and safety precautions should also be considered if PT speed will be increased. Infrastructure for pedestrians, cyclists etc is essential.
LIS_02	EPF	Tailored communication for increased acceptance and buy-in	For PT users, reliability is key and so is travel time/speed. If both can be improved, then this will definitely result in more passengers / higher satisfaction. Consider sufficient capacity as well as buses tend to be already full. Try to work on full routes instead of small sections, as otherwise the impact may be too small (e.g., 1-2' gained somewhere but then again stuck in traffic for the rest of the trip won't give travellers the impression that a lot has changed).	
OSL_07	EPF	Tailored communication for increased acceptance and buy-in	For PT users, reliability is key and so is travel time/speed. If both can be improved, then this will definitely result in more passengers / higher satisfaction. Try to work on full routes instead of small sections, as otherwise the impact may be too small (e.g., 1' gained somewhere but then again stuck in traffic for the rest of the trip won't give travellers the impression that a lot has changed). Clarify the link with OSL_03 (see EPF comment WP3 workshop).	
ROM_04	EPF	Active stakeholder engagement during measure development	Citizen engagement and communication are crucial during all stages of these developments (inconvenience for the population + need to change mobility culture focused on motorised transport).	Engaging citizens during all stages is crucial to avoid resistance; communication about infrastructure works timings & delays
TES_06	EPF	Tailored communication for increased acceptance and buy-in	Increasing PT efficiency alone is not enough to make PT attractive. There are other factors to take into account, for instance, availability, frequency, accessibility, safety etc	When engaging users ensure that different groups especially those vulnerable to exclusion are included; find out what else will make PT more attractive to them.
LEU_07	ETRA	Tailored communication for increased acceptance and buy-in	It is important to know the baseline of the delays, but also the potential benefits and impacts of creating a BRT system to better "sell" the measure. U-SIM.plan can be used to simulate the potential impact (and also can help to select the best locations). Are you planning to use that tool?	
LEU_07	ETRA	Social impact: Health and wellbeing Coexistence&Living peacefully Security&Safety	Which is the strategy selected to give priority to the bus (always priority, based on social optimum...)?. Has the impact of global traffic been taken into account when designing the prioritisation strategy?	
LEU_07	ETRA	Mobility as a right: Universal accessibility leaving no one behind.	Point of attention: 1. BRTs is usually designed to guarantee quick access and drop-off of the bus. Are you planning to adapt the BRT stops acordingly? Please, take into acount the special needs of some target users (disabilities, elderly, baby stroller...) when designing or adapting the stop. // 2. Are you planning to place the ticketing system of the BRT in the PT stop (rather than onboard the bus)? If so, take into acount the special needs of different target users (especially those more vulnerables).	
OSL_07	ETRA	Social impact: Health and wellbeing Coexistence&Living peacefully Security&Safety	The campaign should focus on on-board comfort on the one hand, on reducing journey time on the other hand, and finally on on-board safety by reducing bumps and sudden braking. Each of the above ‘benefits’ has a target user group.	
OSL_07	ETRA	Tailored communication for increased acceptance and buy-in	The average speed of public transport is probably going to increase. Has the impact of the measure on safety been assessed in any way?	

Measure ID	Appraised by	"Point of attention" category	Evaluation result: Point of attention/ Comment	Solutions/ Best practices/ References
TES_06	ETRA	Social impact: Health and wellbeing Coexistence&Living peacefully Security&Safety	Points of attention: 1. Will a dedicated bus lane (segregated or not) be created in these corridors? This is important for the effective implementation of traffic light priority // 2. It is likely to increase the average speed of public transport. It would be interesting to assess safety around these corridors, especially around stops // 3. Which is the strategy selected to give priority to the bus (always priority when a bus is identified, based on social optimum, based on traffic levels...)?. Has the impact of global traffic been taken into account when designing the prioritisation strategy?	
VAL_04	ETRA	Mobility as a right: Universal accessibility leaving no one behind.	BRTs is usually designed to guarantee quick access and drop-off of the bus. Take into acount the special needs of some target users (disabilities, elderly, baby stroller...) when designing the stop.	
VAL_04	ETRA	Social impact: Health and wellbeing Coexistence&Living peacefully Security&Safety	Point of attention: 1. Evaluate road safety & social interaction around the BRT stop // 2. Which is the strategy selected to give priority to the bus (always priority, based on social optimum...?). Has the impact of global traffic been taken into account when designing the prioritisation strategy?	
BUD_06	IBV	Mobility as a right: Universal accessibility leaving no one behind.	Will the prioritization actions planned in the measure take into account the needs of groups at risk of exclusion from PT (low income people, functional diversity, women and elderly)? How will you consider their needs and expectations?	
TES_03	IBV	Mobility as a right: Universal accessibility leaving no one behind.	How are people with functional diversity (including hearing, vision and cognition) are going to be integrated into the evaluation of the measure, considering that it is carried out based on 2D and 3D graphic models?	
BUD_06	ICLEI	Seamless multimodality/intermodality	Points to be considered when prioritising the PT measures: public acceptance, potential to foster multimodality/intermodality, potential to foster modal shift towards sustainable mobility goals and the MaaR concept	
LIS_02	ICLEI	Active stakeholder engagement during measure development	Engagement of key stakeholders is foreseen regarding the new regulatory framework, do you see potential obstacles, and how to overcome it? 'Awareness raising campaigns regarding the impacts of illegal parking and use of bus lanes' is planned, how do you see the potential acceptance/resistance of the measures?	
LEU_07	UITP	Seamless multimodality/intermodality	What is the basis behind selecting 3 locations for the BRT lines? Do you already have supporting infrastructure around certain routes e.g pedestrian/cycling lanes, shared bike stations/bike parking, will you provide integrated ticketing with parking and bus? will parking have real-time information to avoid congestion around parking facilities, utilising parking data to understand needs for bus operations,	
LEU_07	UITP	Active stakeholder engagement during measure development	As political support may be a threat, evidence-based decision making and stakeholder buy-in is key. Engaging different user groups from the beginning regarding location, parking locations and supportive infrastructure and services	
TES_02	UITP	Monitoring, evaluation and learning	Consider adapting services incrementally, montioring the impacts on ridership to find the right balance for users. Monitor the boundaries of the LEZ, to avoid creating addiitonal congestion.	Have you considered working with external consultant who can support with the traveller satisfaction and behaviour, and evaluating mitigation measures? E.G Trasnport for London did this due to capacity constraints
TES_02	UITP	Target group/s that are mainly impacted by the measure	Design mitigation measures to support those who may be impacted more than others. Make sure that with such measures, public transport is available, acceptable, accessible and affordable	
TES_02	UITP	Tailored communication for increased acceptance and buy-in	Expect push back from public who view these changes as disruptive and even costly to their daily lives. Clear 2-way communications, public awareness raising is necessary for buy-in. Show the vision, and emphasise what the benefits of public transport can do to the city. Educational campaign towards car users about prioritisation, to avoid misunderstanding and road accidents	UITP "benefits of public transport" communications materials can support
TES_02	UITP	Seamless multimodality/intermodality	Also consider the integration of modes such as walking and cycling routes around public transport, and digital service improvements such as wayfinding/real-time information and ticketing integraiton	

Measure ID	Appraised by	"Point of attention" category	Evaluation result: Point of attention/ Comment	Solutions/ Best practices/ References
VAL_04	UITP	Social impact: Health and wellbeing Coexistence&Living peacefully Security&Safety	According to the BRT concept and scorecard developed in the EU-funded project eBRT2030, the level of performance a BRT can achieve largely depends on the design of the busway alignment and the delay mitigation measures at traffic lights. **Keeping in mind that the most performant BRTs (BRT level 3 in eBRT2030 scorecard) should be of a quality corresponding to a modern light rail service (metro line 4 in Valencia), and it should also include restrictions regarding rerouting due to public events, works, etc as if BRT lines were running on a fixed infrastructure.** Physically separated bus lanes (e.g., by curb or median strip between the bus lanes and other parallel lanes) or bus-only corridors are the design parameters that allow higher average commercial speeds. Bus lanes with no physical segregation are significantly less performant and specially on the curb-side require high degrees of enforcement. Coordination and engagement is needed from local police to ensure bus-lane enforcement gets the right attention from police officers. Automatic enforcement measures are recommended. **Curb-side alignment is sub-optimal with respect to median alignment whenever possible. In both cases, limiting the turns across or using the bus lanes are a good practice to mitigate delays caused by the interactions with other road users.** Better performant BRTs are the ones with signal preemption, in which through active change in traffic lights patterns BRT buses have no delay when crossing intersections. Shortening bus route total cycle times allow either reducing the operating cost or increasing the service while keeping the same cost. When deciding the traffic light priority approach amongst the several possible programming solutions, it often needs to be reminded to put the **focus on individuals (people) rather than vehicles when calculating the capacity of intersections and the optimal phase programming.** Additionally, the BRT planned for Valencia is an infrastructure which will enhance the bus performance in a selected section of several bus routes, but not to one route entirely. While this is a great approach that allows buses in multiple routes to benefit from higher speeds than the rest of the network, other bus priority measures need to be taken in other sections of those lines to enable the benefits of the infrastructure to "shine". To be practical, if when a bus leaves the BRT infrastructure is trapped in traffic, the overall improvements per route in reliability, headway adherence, total travel time… will be limited. **As a suggested action, a detailed study on the lines running through the BRT corridor could allow identifying the pain points of the routes -if any- where there are quick-gains opportunities (usually stop distancing and passive bus priority to minimize delay at intersection).**	https://cms.uitp.org/wp/wp-content/uploads/2024/02/eBRT2030_OnroadtoconceptBRT_final.pdf
LIS_02	UITP	Monitoring, evaluation and learning	- What and how is the interaction foreseen between bus drivers and the detection devices? is it Manual? Automatic? - Clearing bus lanes from itruding vehicles increase average commercial speed but this does not mean that buses will necessarily run faster, just that will be less time halted by traffic. - This is a measure that generates a lot of attention amongst authorities and operators, the learning from Lisbon are of utmost interest for the sector	https://www.nyc.gov/html/dot/downloads/pdf/bus-lane-camera-report.pdf

UVARs and Parking

Measure ID	Appraised by	"Point of attention" category	Evaluation result: Point of attention/ Comment	Solutions/ Best practices/ References
IDF_03	ECF	Seamless multimodality/ intermodality	In the simulation, consider the impact of PT on replacing car use not in isolation, but in combination with (shared) cycling, walking, (shared) micromobility.	
LIS_01	ECF	Active stakeholder engagement during measure development	Maybe consider including a survey among parents at the pilot schools who drive their kids to school to find out more about their motivations, in order to be able to address them in a more targeted way.	
LEU_02	EPF	Seamless multimodality/intermodality	Communication campaigns are planned to inform about the P&R, which is good. However, main incentives for people to use the parkings will be convenience of a frequent & fast enough PT connection to the centre (Will this be guaranteed / feasible also for the planned smaller scale parkings? Are they connected by a regular PT line or will there be a shuttle service?) and price (e.g., integrate PT ticket in the parking price, perhaps to launch new P&Rs a shopping voucher could be offered, etc.). It's not clear from the measure description how such aspects are considered.	
TES_04	EPF	Active stakeholder engagement during measure development	Investigating willingness to pay makes sense. Make sure to provide attractive and convenient alternatives to car use. Otherwise, people might pay more which is good for city finances, but won't have a big impact on congestion & modal shift … (push & pull)	
ROM_01	EUROCITIES	Environmental impacts on CO_2 emissions, energy use, and air quality.	Point of attention: Consider planning ex-ante ex post studies on Environmental impacts on CO_2 emissions, energy use, and air quality	

Measure ID	Appraised by	"Point of attention" category	Evaluation result: Point of attention/ Comment	Solutions/ Best practices/ References
ROM_02	EUROCITIES	Social impact: Public and user health and wellbeing Coexistence&Living peacefully Security&Safety Reduce road deaths	Point of attention: Make sure to take advantage of gathered infos from previous LTZ implementations to highlight the positive-negative results	
ROM_01	IBV	Social impact: Public and user health and wellbeing Coexistence&Living peacefully Security&Safety Reduce road deaths	How will the impact that private car traffic has in the intervention area be communicated to citizens, to provoke a change in their mobility habits?	
ROM_02	IBV	Social impact: Public and user health and wellbeing Coexistence&Living peacefully Security&Safety Reduce road deaths	The improvement of the air quality in the intervention area is going to have a direct and posivive impact on citizens' health and well-being. How this fact will be communicated?	
LEU_02	ICLEI	Tailored communication for increased acceptance and buy-in	Measure steps seems well planned. As point of attention worth mentioning is communication and awareness raising about this measure for citizens to support the shift towards sustainable mobility.	
LIS_01	ICLEI	Social impact: Public and user health and wellbeing Coexistence&Living peacefully Security&Safety Reduce road deaths	Point of attention: consider that restricting the cars has to be combined with providing multimodality/intermodality, better accessibility by walking, cycling and safer conditions all along the journey	
TES_04	ICLEI	Target group/s that are mainly impacted by the measure	Dynamic parking pricing seems an efficient tool. It can be unpopular among more resistant car drivers. WtP and participatory processes will support the measure implementation, additionally communication and raising awareness could be combined. PT capacity and intermodality should be fostered to encourage the shift from cars to other modes during the peak hours.	
LIS_01	RC	Seamless multimodality/intermodality	From the problem statement ("situation before"), one could infer that the measure description aims at shifting modal shifts among school-aged students transported from/to school by their parents. However, it seems the proposal aims to address road safety instead. Would it be worth make some edits in the measure description? It is unclear how traffic calming solutions will impact modal shifts. Although an excellent measure for road safety, it is likely that travel behaviour will just shift and adapt by dropping off/picking up kids farther away.	
LIS_01	RC	Social impact: Public and user health and wellbeing Coexistence&Living peacefully Security&Safety Reduce road deaths	Within UPPER, You are considering the provision of an alternative option to come to school along with this measure. Which actually aims to trigger a modal shift. Could you clarify if how the bike trains to school would be implemented	
LIS_01	RC	Active stakeholder engagement during measure development	How is the meausre being communicated to the key stakeholders mentioned in the description? Besides of communication and consultation, have the stakeholder being actively involved in measure planning, design and implementation? How are you dealing with potential backlash from parents and neighbors accostumed to drive the cars without major restriction in the intervention areas?	In case you are not aware of this guide yet: https://globaldesigningcities.org/publication/how-to-implement-street-transformations/
LIS_01	RC	Monitoring, evaluation and learning	Regarding U-tools support, you could consider using U-SUMP tool to monitor, visualise and communicate ongoing progress on this measure. You could plug in the different data sources (e.g., Hands-up survey database) and customise your own indicators. You could also include an indicator of numberof public space/road space intervened (as KU Leuven suggested in the measures description)	
ROM_01	RC	Monitoring, evaluation and learning	As this is the expansion of a measure implemented in 2017, what was the impact/results of the first phase in areas such as air pollution, traffic reduction and modal shift in the area?	
ROM_02	RC	Environmental impacts on CO2 emissions, energy use, and air quality.	Considering there is a modal shift, and a positive shift in user behaviour towards EV adoption, the energy source for EV charging is crucial. If the majority of the source is fossil fuels, in the long-run this needs to be addressed and checked as to how does the pollution from these energy sources for charging infrastructure impacts the air quality.	Identification of energy generation plants and mapping of air quality/pollution from the source level and addressing it in the LCA for the electric vehicle charging infrastructure.
ROM_02	RC	Target group/s that are mainly impacted by the measure	Restriction of vehicles (lower emission category) could lead to secondary routes being congested, which would generally not be the case prior to the implementation of the measure.	Development of response plans directing vehicles (through VMS, traffic light optimisation etc.) in the event of a congestion based on historical/dynamic data.

Measure ID	Appraised by	"Point of attention" category	Evaluation result: Point of attention/ Comment	Solutions/ Best practices/ References
IDF_03	RC	Active stakeholder engagement during measure development	Considering data simulations, it would require cooperation between multiple stakeholders including data exchange between them leading towards a dataset to be harmonised.	Preparations of NDAs between stakeholders (especially public and private actors) in advance to avoid any delays in digital twin simulations.
IDF_03	UITP	Mobility as a right: Universal accessibility leaving no one behind.	Understanding the different elasticities of the population requires a good foundation of demographic data - for this, surveys or other other national statistics data should be incorporated into the simulations. Within this, legislation barriers need to be assesed: what kind of financial instruments can be implemented? The most equitable solution is an income-based fee, which directly flows into the public transport budget (is this legally doable here?) What other instruments need to be taken into consideration?	Congestion charge within the city of Stockholm: here the finances generated are directly induced into the PT budget, creating both a push and pull measure. Legal situation needs to be assessed.
IDF_03	RC	Monitoring, evaluation and learning	As the measure involves exploiting simulation results via digital twin from IDF_02, it should be important to have considerations regarding anomalies detected (e.g., due to missing dynamic data, faulty sensors) during data collection and analysis. This requires cooperation between different stakeholders for data exchange and related protocols.	Practices for traffic prediction, anomaly detection and using machine learning techniques to tackle anomalies by IMEC/AIMSUN through TANGENT EU project.
LIS_01	RC	Environmental impacts on CO2 emissions, energy use, and air quality.	Are you considering tracking ex ante and post data on air quality. You could use low-cost air sensor monitor with a double-fold approach. Track the data, and engage stakeholders in the monitoring to mobilize participation and awareness raising	
LIS_01	IFP	Active stakeholder engagement during measure development	Consult with NGOs that work with school communities for a long time	Estrada Viva (APSI and ACA-M).
ROM_01	RC	Tailored communication for increased acceptance and buy-in	Do you have a communications strategy and campaign in place? What re the main key messages? How has been the coverage of the meaures in media outlets?	
ROM_01	RC	Active stakeholder engagement during measure development	Who and how have you involved stakeholders such as local business, urban logistics operators, and residents in the planning of the measures? What kind of activities have you conducted, what are the main concerns and benefits raised? Overall how do rate the acceptance of the measure among the main groups impacted?	

Annex 2: Monitoring templates of T3.5 measures

1.Measure Monitoring Template

Monitoring template for Measure XX_XX "Title of the measure"

Objectives of the measure

- List of general objectives of the measure.

Description of the measure

Description synthetising the long description from D2.2 Annex B.

Measure outputs:

List of concrete outputs delivered within the measure.

Related UPPER tools:

List of UPPER tools used in the implementation in the measure and description of why and how they will be us

UPPER

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 date when the step should be completed	Define what the output of the step will be e.g., Description of the area and use cases	Include any clarifications
2							
3							
4							
5							
	LAUNCH OF THE DEMO (please fill in the date**)**						

2.VAL_04

Monitoring template for Measure VAL_04 “To reduce travel times through the implementation of dedicated bus lanes”

Objectives of the measure

- Reallocate space from private car to PT by implementing a dedicated and segregated corridor for the bus.
- Increase the bus efficiency, punctuality, and frequency and reduce waiting times by implementing a BRT system and prioritizing bus transport with traffic light priority based on social optimum.
- Improve public transport in Poblats Marítims and other peri-urban areas of the city.

Description of the measure

This measure will assess, plan and finally test a dedicated bus lane (BRT) connecting the Maritime District with the core of the city through one of its main arteries (Av. Blasco Ibañez). This measure complements VAL_01, by implementing traffic light priority for public transport fleets and dynamic traffic management to guarantee efficient performance of the BRT lane. The assessment of this first dedicated lane will be used to identify and plan BRT lanes in other districts of the city.

Measure outputs

This measure will deliver:

- Traffic Signal Priority for PT in Blasco Ibáñez Avenue.
- Analysis of the impact of the BRT system in the arterial and its adjacent areas for studying the potential replication in other city corridors (U-SIM.plan).

Related UPPER tools:

The implementation of this measure can be actively supported by four IT tools from the UPPER toolkit:

- U-NEED: Analyse people needs in terms of PT in the artery and its adjacent areas.
- U-SIM.plan: Assessment & planning of a dedicated bus lane (evaluation of the impacts)
- U-SUMP: Support the communication of the impacts of the BRT system and how does it contribute to the sustainability goals. Analyse the evolution of certain KPIs (congestion, air quality,…) in the intervention area (Blasco Ibañez) and support the decision-making process in terms of new BRT deployments.

UPPER

Steps to ready-to-demo measure

#	Description	Involved partners/externals	Category of action (data/infrastructure/legal/safety/social)	Deadline	Monitoring indicator	Comments
			Preparation phase			
1	Select the location of the pilot	EMT, VAL	Social	M12	Location selected	DONE (Blasco Ibanez Avenue)
2	Preliminary assessment	EMT, VAL	Data	M16	Strategy description with list of actions	DONE
3	Study of the section	EMT, VAL	Technical	M18	Draft plan ready	DONE (strongly dependent on VAL_01)
4	Validation of the optimal solution	EMT, VAL	Technical	M18	Project plan ready	DONE
5	Preparation of the subcontracting process for the supply and installation of traffic light priority elements	VAL	Legal	M20	Tender launched	Currently in this phase (M20)
6	Execute the contract	Awarded company	Equipment/Software	M24	Equipment installed	Part of T6.2, not the preparation phase.
			Implementation phase			
1	Award the contract	VAL	Legal	M22	Contract awarded	Part of T6.2 (preliminary work for implementation)
2	Execute the contract	Awarded company	Equipment/Software	M24	Equipment installed	Part of T6.2 (preliminary work for implementation)

3. ROM_04

Monitoring template for Measure ROM_04 "To design the new high frequency and high-capacity PT infrastructure"

Objectives of the measure

- Developing the PT supply
- Increasing the Customer Satisfaction level on PT
- Maintaining an accessible local environment with development of tram lines
- Favour the modal shift towards PT and improving the city landscape

Description of the measure

The measure's activities will support the implementation of the new tramway lines and of the Metro lines extension. In this framework the measure will assess the scenarios before the new opening of new PT infrastructures and communicate the new PT services supply also during the works. In addition to new tramway lines and additional metro stops, vehicles procurement will increase PT capacity in Rome within this measure.

Measure outputs:

This measure will deliver:

- Final/executive design for the **2 tramway lines** and depot, implementation of a first tram line with definition of the requirements for the tendering process (TVA line 1st branch & Togliatti line)
- Start of procurement activities and launch of implementation for **2 tramway lines** (TERMINI Tor Vergata & Tiburtina-Verano line)
- Opening of **2 new metro stops** of the Metro C line (amba Aradam – Colosseo)
- Procurement of **40 new trams and 14 new metro trains**
- Design and participation process of **7 new tramway lines** (to be included in the future call for funding by the Transport Ministry)

Related UPPER tools:

The implementation of this measure can be supported by two IT tools from the UPPER toolkit:

- U-GOV can support the community engagement and the acceptance and knowledge of the new services.
- U-SIM.plan can support the existing modelling software to adapt the PT supply.

UPPER

Steps to ready-to-demo measure

#	Description	Involved partners/externals	Category of action (data/infrastructure/legal /safety/social)	Deadline	Monitoring indicator	Comments
Mixed preparation & implementation phases						
1	Design of the lines. **7 new tramway lines** (to be included in the future call for funding by the Transport Ministry)	City of Rome, Mobility Department, Roma Metropolitane SpA, ATAC, City Boroughs, RFI, Cultural heritage protection body, Universities, research insitutions	Infrastructure	11/2024	Participatory process (Conferenze dei servizi)	On-going (M20)
2	Final design, procurement, works, and start of operations of TVA tramline 1st branch and TOGLIATTI tramline	City of Rome, Mobility Department, Roma Metropolitane SpA, ATAC, RFI, Utilities, Invitalia, Contractors, Ministry of Transport and Infrastructures	Infrastructure	9/2026	EIA, launch of tenders, Start of works, Operation	2 tram lines: process followed until the kick off of the operation. Infrastructures funded by RRF with deadline 06/2026
		TOGLIATTI TRAMLINE	Infrastructure	03/2024 06/2024 06/2024 06/2026	Contract signing with contractor Validation and approval of the executive design (by city) Start of works End of works	
		1st BRANCH OF TVA TRAMLINE	Infrastructure	03/2024 06/2024 07/2024	Contract signing with contractor. Conclusion of approval of the final design. Validation	

UPPER

				09/2024 11/2024 06/2026	Approval of the executive project Start of works End of works	
3	Final design, procurement, start of works (TVA branch 2, Termini Tor Vergata and Tiburtina).	City of Rome, Mobility Department, Roma Metropolitane SpA, ATAC, RFI, Utilities, Invitalia, Contractors, Ministry of Transport and Infrastructures	Infrastructure	9/2026	EIA, launch of tenders, Start of works	2 tram lines: process until the end of works
		TIBURTINA-VERANO Tramline	Infrastructure	05/2024 12/2024 12/2024 02/2025 04/2025	Approval of final design by the special Commissioner. Start tendering of the integrated project Contract signature Approval of the executive design Start works	
		TERMINI TOR VERGATA Tramline	Infrastructure	02/2025 06/2025 10/2025 12/2025	Approval of final design Start tendering of the integrated project Approval of the executive design by the special Commissioner Start of works	
4	Procurement and commissioning of 40 trams 14 metro trains	City of Rome, Mobility Department, Roma Metropolitane SpA, ATAC, RFI, Utilities, Invitalia, Contractors, Ministry of Transport and Infrastructures	Infrastructure	9/2026	Contract signed	

UPPER

		TRAMS		10/2025 04/2026 Apr-Dec 2026 12/2026	Conclusion of purchase contract Delivery of first tram Commissioning first tram Delivery of 11 remaining trams Commissioning of all the 14 trams	It is expected that during UPPER 12 trains will be delivered and commissioned, and 14 trains will be delivered
		METRO TRAINS		01/2023 07/2023 03/2025 10/2025 Oct/25-apr26 11/2026	Conclusion of purchase contract Approval of the executive design Delivery of the 1st train Commissioning 1st train Delivery and commissioning of 11 trains Delivery and commissioning of the 14th train	The delivery of the 1st train is essential to unlock the delivery of the rest of the supply. That's why it takes more time.
5	Monitoring implementation	City of Rome, RSM	Data	12/2024 12/2025 12/2026	Increase in the number of tramways lines Increase in the number of km offered Number of vet/km offered	Compare previous and post situations

UPPER

4.LIS_02

UPPER

Monitoring template for Measure LIS_02 “Promote, extend services and prioritise PT”

Objectives of the measure

- Reduce travel times & disruptions of PT;
- Increase the commercial speed and reliability of bus and tram services;
- Improve road safety for bikes, cars and PT;
- Enforce compliance regarding the use of dedicated bus/tram lanes

Description of the measure

This measure will develop an advanced analysis of the network and a big data, data analytics and visualization tools to assess the PT network and analyse factors with higher negative impacts on commercial speed. Audit-type assessments shall be performed on the features of bus stops, road structure, bus services and intersections to identify opportunities for improvement. This information shall inform the creation of recommendations for the implementation of PT prioritization measures on the identified bottlenecks, to increase commercial speeds and reduce PT delays. In addition, this measure shall equip CARRIS buses with cameras to enable the automatic detection of non-compliant vehicles in the bus lanes, and the subsequent deployment of law enforcement mechanisms.

Measure outputs:

This measure will deliver:

- Demonstration of the potential use of camera-based enforcement mechanisms on buses and trams, specifically targeting illegal parking and bus lane use;
- Work with stakeholders to adopt a new regulatory framework, to enable automatic bus lane enforcement and issuing fines on transgressors;
- Analysis and report of significant bottlenecks for bus and trams commercial speed and identification of opportunities for improvement;
- Simulation of some corrective actions and a roadmap on the PT infrastructure adaptations to be implemented in the city.

Related UPPER tools:

- **U-NEED**: This tool will enable the evaluation of typical road traffic flows in the city, and the assessment of congestion hotspots and conflict areas, as well as excessive delays in PT services.
- **U-TWIN**: This tool shall allow the monitoring of the network and the real-time detection of incidents. Such information can be used to validate camera-based detections of incidents, as well as complement the U-NEED estimations regarding the evaluation of bottlenecks.
- **U-SIM.plan**: This tool will allow the evaluation of different strategies of PT prioritization, providing valuable insight about the most promising measures and their potential impacts on the PT services' reliability.
- **U-SIM.live**: This tool shall enable the real-time assessment of the network and the detection of incidents in realtime, as well as the prediction of demand and traffic conditions. The testing of potential corrective measures can help decision-makers assess which PT prioritization strategies to deploy in the moment.

UPPER

Steps to ready-to-demo measure

#	Description	Involved partners/externals	Category of action (data/infrastructure/legal/ safety/social)	Deadline	Monitoring indicator	Comments
			Sub-task: Bus Lane Enforcement			
1	Procurement of technologies for camera-based enforcement of bus lanes	CARRIS, Service /Equipment providers	Tender	30/06/2024 31/12/2024	Tender conclusion and provider selection Provider contracting	Technical & Legal challenges discussed in Rome 20/06/2024: Providers selected, waiting for 'OK' to contract
2	Pilot Definition	CARRIS	Decision Making/Technical	30/06/2024	Pilot test redefined.	Due to budget constraints, the initial pilot will be scaled down to 2/3 cameras.
3	Installation on fleet	CARRIS, Service /Equipment providers	Infrastructure	31/10/2024	Cameras installed on fleet	Quotes indicate the installation process is ~3 months, from the contracting date.
			LAUNCH OF THE DEMO (No onsite demo. Predicted use of U-NEED and U-SIM.plan to aid the analysis of the current network, and the simulation of potential enhancement strategies) 31/10/2024			
4	Analysis of operational data, and corridor prioritization	CARRIS	Data	28/02/2025	Data analysed, critical/priority corridors identified	
5	Data collection of non-compliance instances in bus lanes, PT operation speeds and private vehicle and PT traffic on major corridors	CARRIS, Lisbon Municipality/Municipal Police	Data	28/02/2025	Databases compiled	

UPPER

#	Description	Involved partners/externals	Category of action (data/infrastructure/legal/ safety/social)	Deadline	Monitoring indicator	Comments
6	Data collection on camera-based system performance	CARRIS, Service /Equipment providers	Data	28/02/2025	Databases compiled	
7	Report of findings to National Road Safety Authority, to help them draft the requirements for this kind of system and to develop new regulations to allow its implementation in the city	CARRIS	Legal	31/03/2025	Report sent	
8	Awareness raising campaigns regarding the impacts of illegal parking and use of bus lanes on the PT operation	CARRIS, Municipality, EMEL/Local Police	Social	31/03/2025	Communication actions planned and implemented	
Sub-Task: Analysis of the PT Network						
1	Data collection: PT operational indicators; congestion and traffic levels of private and PT vehicles on major areas of the city	CARRIS, Lisbon Municipality/Municipal Police	Data	30/04/2024	Databases compiled	
2	Data analytics & Identification of main network bottlenecks and conflict areas	CARRIS	Data	31/08/2024	Report on main bottlenecks and conflict areas	
3	Identification of feasible PT prioritization strategies. Simulation & selection of the most suitable ones	CARRIS, Lisbon Municipality	Decision making, Policy	31/08/2024	PT prioritisation strategies identified, simulation of potential outcomes performed	

6.BUD_06

Monitoring template for Measure BUD_06 “To improve the existing PT prioritizing tools in Budapest”

Objectives of the measure

- Working out public transport prioritizing measures in new locations around the city
- Investigating the efficiency and competitiveness of public transport prioritizing measures
- Increase public transport users in dedicated areas

Description of the measure

The measure will focus on the possible introduction of further interventions in brand new locations with the aim to prioritize public transport services. The process will feature the complex examination of the particular locations, including the traffic and travel patterns, infrastructural specifications, journey times and possible intervention options.

Measure outputs:

This measure will deliver:

- Priority list of the possible PT prioritization measures
- Implementation of PT prioritization measures in selected locations

Related UPPER tools:

U-SIM.plan

UPPER

Steps to ready-to-demo measure

#	Description	Involved partners/externals	Category of action (data/infrastructure/legal/ safety/social)	Deadline	Monitoring indicator	Comments
			Mixed preparation & implementation phases			
1	Data collection on the public transportation vehicles travel times and the effectiveness of the different interventions	BKK, Budapest Road operator	Data	Q1 2024	Analysis method selected	Process presented in Rome DONE
2	Analysis of the existing methods inside the BKK, which are focusing on the PT promoting tools	BKK, Budapest Road operator	Data	Q2 2024	Priority list of the possible implementations	Partly done, on-going (M20)
3	Prepare recommendations for the new measures, which will help to promote the PT	BKK, Budapest Road operator	Infrastructure, Legal, Social	Q3 2024	Recommended PT prioritizing tools	
4	Analyse expected effects of the recommended measures	BKK, Budapest Road operator	Data, Policy	Q4 2024	Updated monitoring information Time saved achievable by the different type of PT prioritization tools	

6.LEU_07

Monitoring template for Measure LEU_07 “Increase the quality of the PT services through traffic management and dedicated lanes for PT”

Objectives of the measure

- Improve the implementation process of dedicated lanes and PT traffic management
- Make policy and planning around solutions more evidence-based
- Make the PT offer more attractive through reduced travel times and improved reliability
- Improve the efficiency of bus operations throughout the city by prioritising PT

Description of the measure

The city of Leuven, the regional public transport operator and the regional authorities are currently working on redesigning the public bus system to create high quality public transport in several dimensions. Within this context, Leuven aims to redesign the different transport axes throughout the city to facilitate the creation of separate bus lanes and prioritise traffic signals for the main PT axes. This measure will contribute to the planning, monitoring and evaluation of this redesign process.

Measure outputs:

This measure will deliver:

- Analysis/Tools for selecting location and refining implementation method for bus corridors
- An analysis of further potential locations with attention to potential gains and costs
- Identification of 3 locations where priority for PT will be implemented through bus lanes and/or intelligent traffic lights
- Evaluation report.

Related UPPER tools:

- **U-NEED:** U-NEED will allow the city to have a deep understanding on the mobility patterns of the citizens and identify the potential locations where the dedicated PT lanes and traffic light priority can be implemented.
- **U-SIM (and more specifically, U-SIM.plan):** U-SIM.plan will be used to evaluate the potential impact of the creation of new dedicated PT lanes and make data-based decisions.

UPPER

Steps to ready-to-demo measure

#	Description	Involved partners/externals	Category of action	Deadline	Monitoring indicator	Comments
			Preparation phase			
1	Preparation for last phase of new and improved bus network starting 06/01/2025	De Lijn	Technical	31/03/2024	Approval council	Done (M19)
2	Local baseline measurements for delay, modal split	De Lijn	Data	30/06/2024	Analysis report	In progress, using own data (M19)
3	Analysis for selecting location and refining implementation method for bus corridors. Possibly taking into account deployment of self-driving shuttle in Leuven.		Data	31/08/2024	Analysis report	Depending on the timing for U-NEED and U-SIM. Plans for automated shuttle will be decided on by the beginning of 2025 by the PTO.
4	An analysis of further potential locations with attention to potential gains and costs and impact potential sites in correlation with future P&R's	U-NEED/ U-SIM?	Data	31/08/2024	Analysis report	On-going (M20)
5	Identification of 3 locations where priority for PT will be implemented		Technical	31/08/2024	Locations determined	On-going (M20)
			Implementation phase			

6	Implementation plan for the 3 locations	AWV, De Lijn	Technical	31/12/2024	Plans defined	
7	Implementation	AWV, De Lijn	Infrastructure	31/12/2025	Priority for PT implemented at 3 locations	
8	Evaluation of implemented actions	AWV, De Lijn	Data	30/09/2026	Evaluation report	

7.TES_03

Monitoring template for Measure TES_03 “To improve transit services through dynamic multimodal management of PT corridor”

Objectives of the measure

- Improve PT LoS along Egnatia street.
- Improve LoS of pedestrian infrastructure in Egnatia street.
- Improve accessibility to/from metro stations.
- Enhance city centre’s commercial character.

Description of the measure

This measure will propose a plan for the optimal management of PT and pedestrian flows along Egnatia street, as well as a plan for public space reallocation along this corridor. To reach the final proposal, several scenarios will be assessed through modelling and simulation. Appropriate 2D and 3D designs will be prepared for presenting the final plan for the reformation of Egnatia street.

Measure outputs:

This measure will deliver:

- Modelling of motorized traffic at corridor level.
- Modelling of pedestrian flows to/from metro stations.
- Detailed plan for optimal management of flows and reallocation of public space in Egnatia street.

Related UPPER tools:

U-SIM.plan and U-NEED: These two tools can be used in conjunction with existing traffic models that CERTH has developed for traffic simulation at corridor-level.

UPPER

Steps to ready-to-demo measure

#	Description	Involved partners/externals	Category of action	Deadline	Monitoring indicator	Comments
1	Specification of simulated study site	CERTH, TheTA	Technical	31/01/2024		DONE
2	Data collection	CERTH, TheTA	Data	29/02/2024	Data ready to be used in simulation	- Traffic Counts - Pedestrian Counts - PT Travel Times DONE
3	Definition of simulation scenarios	CERTH, TheTA	Technical	29/02/2024	Detailed description of simulation scenarios	Scenarios pertaining to different infrastructure designs, mode choices, and modal splits. DONE
4	Development of baseline simulation model	CERTH	Technical	31/03/2024	Simulation Animation	- Supply and demand side DONE
5	Calibration of baseline simulation model	CERTH	Technical	15/05/2024	GEH Statistic	Travel-time based calibration; Deviations between actual & simulated data DONE
6	Development of baseline simulation model variants according to specifications of each alternative scenario	CERTH	Technical	31/05/2024	Simulation Animation	- Hypothetical intermodal trips DONE
7	Simulation runs	CERTH	Technical	10/06/2024	Number of completed simulation runs	Done (M20)
8	Analysis and visualization of simulation results	CERTH	Technical	30/06/2024	Number and types of different plots	Done (M20)
9	Reporting	CERTH	Technical	19/07/2024	Final Report	Done (M20)

8.TES_06

Monitoring template for Measure TES_06 “Social optimum-based traffic management to reduce PT travel times and increase user satisfaction”

Objectives of the measure

- Reduce PT delay during peak hours.
- Improve user satisfaction.
- Reduce traffic congestion.
- Reduce pollutant emissions.

Description of the measure

This measure aims at advancing traffic management strategies in a specific corridor (3-4 intersections) with poor LOS (E or F) in Thessaloniki by implementing in the Traffic Control Center a C-ITS enabled and AI based bus priority service. A feasibility study will be carried out prior to the demonstration as well as simulation.

Measure outputs:

This measure will deliver:

- A method and a feasibility study for assessing intersections with high-volume PT vehicles (in a specific corridor incl. 3-4 intersections with poor LOS - E or F).
- A simulation with before/after intersection analysis.
- Physical implementation in the Traffic Control Center of a C-ITS enabled and AI based bus priority service.

Related UPPER tools:

U-NEED: It may help city authorities, PTOs and PTAs to understand the multimodal transport demand and how people move around the city, in order to identify the busy intersections.

U-GOV: Assist in the definition of scenarios.

U-SIM: For simulating the defined scenarios.

UPPER

Steps to ready-to-demo measure

#	Description	Involved partners/externals	Category of action	Deadline	Monitoring indicator	Comments
			Mixed preparation & implementation phases			
1	Specification of simulated study site	CERTH, TheTA	Technical	31/01/2024		DONE
2	Data collection	CERTH, TheTA	Data	29/02/2024	Data ready to be used in simulation	- Traffic Counts - Pedestrian Counts - PT Travel Times DONE
3	Definition of simulation scenarios	CERTH, TheTA	Technical	29/02/2024	Detailed description of simulation scenarios	Scenarios pertaining to PT priority at signalized intersections DONE
4	Development of simulation model	CERTH	Technical	31/03/2024	Simulation Animation	- Supply and demand Side DONE
5	Calibration of Simulation Model	CERTH	Technical	15/05/2024	GEH Statistic	Travel-time based calibration Deviations between actual & simulated data DONE
6	Development and simulation of algorithm for PT priority algorithm at traffic lights	CERTH	Technical	31/05/2024	Simulation Animation	Development of PT prio algorithm in traffic lights DONE
7	Simulation runs	CERTH	Technical	10/06/2024	Number of completed simulation runs	DONE
8	Analysis and visualization of simulation results	CERTH	Technical	30/06/2024	Number and types of different plots	DONE

9	Reporting	CERTH	Technical	19/07/2024	Final Report	DONE
10	Decision on deployment	TheTA, CERTH, Municipality	Legal/Technical	31/07/2024		DONE

9.OSL_07

Monitoring template for Measure OSL_07 "Pilot V2X to prioritize public transport"

Objectives of the measure

- Increase PT passengers' comfort and PT efficiency by speed bump reduction and PT prioritisation
- Test innovative solutions and use a smart traffic system to create safe & accessible crossings for vulnerable road users without disrupting the traffic flow

Description of the measure

This measure will use V2X smart speed bump (Actibump Edeva - Smart City Solutions) to provide connected, smart, and sustainable traffic relying on the collection, storage, and exploitation of several types of data. The V2X equipment is connected to a software as a service (SaaS) handling the hardware monitoring and presenting the data in a web interface.

Measure outputs:

This measure will deliver:

- V2X implemented in 2 to 4 corridors. We are going to search most efficient and suitable places in Oslo for V2X.
- Survey to PT users to evaluate the impact of the measure on their overall travel experience.

Related UPPER tools:

The implementation of this measure can be supported by two tools from the UPPER toolkit:

- U-TWIN and U-SIM.live: The tools can offer real-time and standardized information on different transport modes, incidents, delays etc

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Steps to ready-to-demo measure

#	Description	Involved partners/externals	Category of action (data/infrastructure/ legal/safety/social)	Deadline	Monitoring indicator	Comments
			Mixed preparation & implementation phases			
1	Data Collection of private vehicles and PT	NPRA (road owner)	Data	S1 2024	Completed database or report	DONE: measurement equipment installed in M15&19
2	Data analytics & Identification of necessary improvements in infrastructure	NPRA (road owner)	Data, Infrastructure	S1 2024	Recommendation of necessary improvements	Currently in this phase (M20): first analysis results change assumptions for necessary improvements
3	Identification of suitable places of national road networks in Oslo for V2X system implementation	NPRA (road owner), RUTER (PTA)	Infrastructure	S1 2024	List of suitable places	Currently in this phase (M20): Need to analyse new corridors
4	Acceptance of the V2X system implementation by stakeholders	RUTER (PTA), Oslo municipality	Social	S2 2024	Communication and engagement of stakeholders	DONE (M20)
5	Technology choice	NPRA (road owner), RUTER (PTA)	Technical	S2 2024	Decision on technology and implementation timeline	
6	Technology implementation	NPRA (road owner)	Infrastructure	S2 2024	V2X system in place and running	
7	V2X monitoring	NPRA (road owner), RUTER (PTA)	Data	Q2 2024	Report on potential PT prioritisation	

10.ROM_01

Monitoring template for Measure ROM_01 “To reduce private vehicles by implementing a ‘pollution charge’ scheme in the core part of Rome Zone 2”

Objectives of the measure

- Providing digital tools to support the access restrictions policies to the most polluting vehicles in the LTZ called “VAM” area (23 sqkm).
- Concluding the implementation of the electronic access gates.
- Ban the more pollutant private vehicles.
- Reduce vehicular pressure on the Historic Centre.

Description of the measure

The so-called VAM Area, implemented in 2017, is presently subject to time-based access restrictions for all vehicles with total length over 7,5 metre and for vehicles with emission standards lower than Euro3. It is active from 05.00 am to 12:00 pm and controlled by 21 e-gates. During the project lifetime the implementation of the electronic access gates along the perimeter will be completed with 53 missing for a total of 74 points of access.

A “congestion charge” policy will be introduced to limit access in the VAM zone for vehicles according to their emission category. This policy will favour the modal shift toward public transport if it improves in the meantime its attractiveness. The measure will define the policy, the comparison with similar measures across Europe, steps for the introduction, participated discussions, communication packages, day by day evaluation and continuous adaptation for the immediate large-scale application.

Measure outputs:

This measure will deliver:

- 53 electronic new access points
- New regulations for access (congestion charge)

Related UPPER tools:

The implementation of this measure can be supported by two IT tools from the UPPER toolkit:

- U-GOV for the acceptance and community engagement
- U-SUMP to monitor the effects of the measure.

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Steps to ready-to-demo measure

#	Description	Involved partners / externals	Category of action (data/infrastructure/ legal/safety/social)	Deadline	Monitoring indicator	Comments
			Mixed preparation & implementation phases			
1	Implementation of the electronic access poles	RSM	Infrastructure	2023	Deployment of access gates made of: cameras, poles, lanes, dynamic signage, connection to the MMC (Mobility Management Centre) for the detection of specific categories of vehicles	PON Metro 2014-20 Done
2	Analysis of the flows	RSM	Data	5/2024 5/2025 5/2026	- Traffic flows before/after for VAM and vehicle counting - Emissions before/after for VAM - Vehicle counting	According to request of authorization to Ministry + Emission Currently in this phase: collecting data
3	Agreement to access the national database of the vehicles' characteristics and owners	City of Rome, Mobility Department, Lazio Region	Data	9/2024	Definition of access modalities	According to Ministry authorization Currently in this phase: asked Lazio Region & Gov to cover access cost
4	Definition of the policy: local act to be issued	City of Rome, Mobility Department	Legal	9/2024	Local act issued	According to agreement with Lazio Region on Air Quality plan Currently in this phase: Lazio region responsible for Air Quality Plan
5	Application for authorisation to start operating the system by the Ministry of Infrastructures	City of Rome, RSM	Legal	11/2024	Authorisation received	

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6	Citizen engagement	City of Rome	Social	9/2024 6/2025 (revision of policy/limit increase)	Acceptance by the citizenship concerning the traffic restrictions.	Survey and campaigns for warning, incentives, and satisfaction
7	Integration with incentive and gradual transition systems (Move-in system and bonus pass) – Other step	RSM	Data	9/2024 9/2025	Proof of at least one successful operation	According to the different steps of the measure

11.ROM_02

Monitoring template for Measure ROM_02 “Promoting modal shift towards PT with the implementation of a LEZ in Rome Zone 3”

Objectives of the measure

- Progressively limiting access for vehicles to the “GREEN AREA” (156 skmq) according to their emission category.
- Monitoring of traffic flows by vehicle type
- Vehicular traffic fluidification (including PT)

Description of the measure

In November 2022 a municipal deliberation was issued defining the “Green Area” LTZ and the roadmap to ban the pre-EURO 5 vehicles circulating within. The measure combines policies and ITS to implement restrictions according to a Roadmap indicated by the City Administration. The measure includes the implementation of a total of 154 electronic access gates over the “Green Area” perimeter.

Measure outputs:

This measure will deliver:

- 154 electronic access gates
- Revised “Specifications Document” to define: the roadmap, the new regulations for access (permits for residents and freight delivery), the incentives, etc.
- New signalling.
- Large-scale implementation of the measure.

Related UPPER tools:

The implementation of this measure will be actively supported by two IT tools from the UPPER toolkit:

- U-GOV for the acceptance and community engagement
- U-SUMP to monitor the effects of the measure
- U-SUMP to monitor the effects of the measure

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Steps to ready-to-demo measure

#	Description	Involved partners/externals	City contact person	Category of action (data/infrastructure/ legal/safety/social)	Deadline	Monitoring indicator	Comments
Mixed preparation & implementation phases							
1	Implementation of the electronic access poles	RSM	Chiara Di Majo	Infrastructure	4/2024 4/2025	Deployment of access gates made of cameras, poles, lanes, dynamic signage, connection to the MMC (Mobility Management Centre) for the detection of specific categories of vehicles	First lot of 53 e-gates and central system installed with REACT EU funds to be tested as stand-alone system. 91 to be installed with Jubilee Funds. Currently in this phase
2	Analysis of the traffic and vehicles flows	RSM	Chiara Di Majo	Data	5/2024 5/2025	Traffic flows by euro category, vehicle type (cars, motorbikes, buses) and freight vehicles	Start with the 1st set of e-gates and check every year
3	Definition of the policy: Area & technology in quality and quantity	City of Rome, Mobility Department, RSM, Lazio Region	Chiara Di Majo	Legal	9/2024	- Revision of local act for traffic restrictions (what categories can/cannot access the zone)	The new policy document must comply with the regional regulation concerning the traffic emissions reductions Currently in this phase: Lazio region responsible for Air Quality Plan
4	Application for authorisation to start operating the system by the Ministry of Infrastructures	City of Rome, RSM	Chiara Di Majo	Legal	11/2024	Authorisation received	

5	Public acceptance assessment	City of Rome	Chiara Di Majo	Social	9/2024 9/2025	- Acceptance by the citizenship concerning the traffic restrictions - Assessment on of measure's social impacts	Surveys and campaigns before each step of the measure, for warning, incentives, and satisfaction
6	Integration with incentive and gradual transition systems (Move-in system and bonus pass)	RSM	Chiara Di Majo	Data	6/2024 6/2025	Proof of at least one successful operation	Currently defining incentive measure with Lazio Region

12.IDF_03

Monitoring template for Measure IDF_03 “Impact evaluation and future design of low emission zones and restricted traffic zones”

Objectives of the measure

- Obtain indirect impact evaluation of the implementation of the Low-Emissions Zones (LEZ) by the region.
- Define prospective scenarios concerning the implementation of restricted traffic zones on the territory.
- Obtain scenarios evaluation on Versailles Grand Parc's inhabitants' mobility, as well as greenhouse gas emissions and pollutant emissions.

Description of the measure

The objective of this action is to use the digital twin set up in IDF_02 as well as the data collected to observe the impact of the implementation of the low emission zone on the neighbouring territories and conduct a study on scenarios of implementing future new policies (LEZ, ZEZ, financial aid, ...) on the territory. In analysing the results, particular attention will be paid to determining how public transport can be strengthened to guarantee accessibility to the new low-emission zones.

Measure outputs:

This measure will deliver:

- Quantification of the impact on GHG and local pollutant emissions.
- Analysis of the impact on the public transport shift.
- Comparison of the different prospective scenarios.

Related UPPER tools:

U-SIM.plan

UPPER

Steps to ready-to-demo measure

#	Description	Involved partners/externals	Category of action (data/infrastructure/ legal/safety/social)	Deadline	Monitoring indicator	Comments
			Preparation phase			
1	Integration of current LEZ traffic restriction modelling in the digital twin to assess impact on VGP territory	IFP Energies Nouvelles	Digital Infrastructure	02/02/2024	LEZ integrated in digital twin	DONE
2	Modelling of different scenarios for modifying the behaviour of agents no longer able to use their vehicles (vehicle replacement, modal shift, change of route, etc.)	IFP Energies Nouvelles, VGP (Versailles Grand Parc), MGP (Métropole du Grand Paris)	Digital Infrastructure	29/03/2024	Scenarios' description & Design	DONE
3	Realization of various simulations and analysis of impacts on Versailles Grand Parc inhabitants	IFP Energies Nouvelles, VGP	Data, Social	26/04/2024	Reports on scenarios' impacts	DONE
			Implementation phase			
4	Identification of several proposed access restrictions on the VGP territory	VGP	Policy, Social, Legal	S2 2024	Descriptions of scenarios	
5	Modelling of these proposals in the digital twin	IFP Energies Nouvelles	Digital Infrastructure	S1 2025	Updated digital twin with new restrictions	
6	Realization of various simulations and analysis of impacts on Versailles Grand Parc inhabitants	IFP Energies Nouvelles, VGP	Data, Social	S1 2025	Reports on scenarios' impacts	
7	Analyse the needs of PT for LEZ demand fulfilment	Ile de France Mobilités, Other transport operators, VGP, IFP Energies Nouvelles	Data, Digital infrastructure	S2 2025	Completed digital twin	

13.LEU_02

Monitoring template for Measure LEU_02 "To study the needs of parking and public transport in different areas of the city"

Objectives of the measure

- To understand the needs for parking in the city
- To relate parking needs to the PT offer in order to increase PT use
- To improve the use of existing peripheral parking lots (P&R) with PT connection

Description of the measure

This measure consists of the analysis of the current use of parking space (P&Rs) and hubs in combination with PT. The aim is to identify social patterns, obstacles, and opportunities in these locations. In addition, this measure will use simulation tools to study the impact that the increased use of these parking sites would have in modal shift. This analysis forms the basis for the parking policy plan which will be adopted in the current SUMP. Based on the study, new small scale parking lots will be implemented. Improvements to the existing offer can also be implemented.

Measure outputs: This measure will deliver

- Analysis to support parking policy plan
- Analysis of new potential locations for peripheral parking lots (P&Rs).
- Analysis of needs and opportunities to improve the use of peripheral parking lots.
- Implementation of small-scale peripheral parking lot.
- Focused measures aimed at improving the service level at the existing parking lots, such as a hands-free shopping service.
- Increased number of peripheral parking space (P&R) with PT connection
- Evaluation of implemented actions.

Related UPPER tools:

- **U-NEED:** This tool will allow the city to have a deep understanding on the mobility patterns of the citizens and identify the main inefficiencies in the PT offer. The U-tool will provide suggestions on potential solutions (change the bus route or schedule, introduce new lanes, increase the capacity of the buses, introduce a P&R,…).
- **U-SIM (and more specifically, U-SIM.plan):** The potential solutions suggested by U-NEED will be then simulated by U-SIM.plan, to make the best choice to adapt the offer to the real demand.

UPPER

Steps to ready-to-demo measure

#	Description	Involved partners/externals	Category of action	Deadline	Monitoring indicator	Comments
			Preparation phase			
1	Analysis of the current use of P&Rs in combination with PT	Economy and trade department, De Lijn	Data	30/04/2024	Analysis report	Done
2	Determine ideal location of potential P&R's with stakeholders from different departments	Spatial planners, Economy and trade department, Regionet	Technical	30/04/2024	Spatial plan	Done
3	Analysis of new potential locations P&R's	U-NEED, U-SIM?	Data	31/08/2024	Analysis report	Depending on the timing for U-NEED and U-SIM In progress
4	Explore good practices for parking policy plan		Technical	31/08/2024	List of ideas/ input for the policy plan	Depending on initiatives for knowledge exchange with the UPPER-cities and partners in WP3 In progress
5	Analysis of needs and opportunities to improve the use of peripheral parking lots	Economy and trade department	Technical	31/08/2024	Requirements list	In progress
6	Determine framework/ principles for parking policy plan (locations, financial aspect, …)		Technical	31/08/2024	Framework/ principles for parking policy plan	In progress
7	Select location of future P&R's, determine price setting and ticketing system as input for the parking policy plan.		Legal	31/07/2025	Approvement of policy plan	Due to municipal elections in october 2024, the policy plan cannot be approved until 2025. Deadline depending on the outcome of the elections.

8	Follow up new parking Wetenschapspark for input cooperation agreement in function of use as P&R	Vzw beheerscomitee Wetenschapspark	Technical	31/12/2025	Input for the cooperation agreement in alignment with the framework for the parking policy plan.	Implementation parking scheduled for Q1/2 2026
Implementation phase						
9	Development of the implementation plan for one P&R		Technical	31/12/2025	Implementation plan	This step can only take place after the approval of the policy plan
10	Implementation of (small-scale) peripheral parking lot	Vzw beheerscomitee Wetenschapspark	Technical	30/06/2026		Depending on the completion of the building
11	Implementation of measures aimed at improving the service level at the existing parkings	Parking Vaartkom	Technical	30/06/2026	The measures are in place	

14.TES_04

Monitoring template for Measure TES_04 "To influence modal shift through congestion sensitive parking pricing"

Objectives of the measure

- Increase PT ridership during peak hours.
- Reduce private car trips during peak hours.
- Reduce traffic congestion issues.
- Reduce pollutant emissions.

Description of the measure

In the context of this measure, a detailed report proposing appropriate dynamic parking pricing policies will be created. To achieve this, a dedicated survey regarding citizens' WtP will be carried out as well as participatory processes involving the Municipality. Based on these, different pricing scenarios will be defined and simulated to investigate the corresponding modal shift.

Measure outputs:

This measure will deliver:

- Estimating WtP for parking in the city centre.
- Modelling modal shifts due to different parking pricing policies and their impact on transportation network.
- Report on appropriate dynamic parking pricing policies in Thessaloniki's city centre.

Related UPPER tools:

U-SIM.plan: It can be used in conjunction with Thessaloniki's strategic traffic model, developed by CERTH, for identifying the impact of modal shift due to different parking pricing policies.

U-GOV: Assist in the implementation of participatory processes for the definition of parking pricing scenarios.

UPPER

Steps to ready-to-demo measure

#	Description	Involved partners/externals	Category of action	Deadline	Monitoring indicator	Comments
			Mixed preparation & implementation phases			
1	Data collection (users' survey)	CERTH	Data	31/12/2023	Responses collected (at least 150)	Done
2	Data analysis	CERTH	Data	29/02/2024	Estimation of WtP for parking and modelling of modal shifts	Done
3	Traffic simulation different pricing scenarios	CERTH	Technical	31/05/2024	Estimation of traffic impacts of the different parking pricings	The modal shifts due to different parking pricings (output of step 2), will be used as an input in the traffic simulation Done
4	Participatory processes	TheTA, Municipality, CERTH	Social/Technical	31/07/2024	Recommended parking policies based on the outputs of the previous steps and the feedback from various stakeholders	U-GOV can be used for facilitating participatory processes Since this measure does not have actual implementation, participatory processes can also be extended in WP6

15.LIS_01

Monitoring template for Measure LIS_01 “Restrict car access in the city”

Objectives of the measure

- Influence student’s mindset towards active modes and boost children’s autonomy;
- Increase safety at school perimeter;
- Improve public space;
- Reduce congestion

Description of the measure

This measure proposes the implementation of traffic restrictions around municipal schools and other facilities to promote safer and more active modes around schools.

Measure outputs:

This measure will deliver:

- 4 pilot school traffic restrictions project;
- a guide describing the process for future uptake.

Supporting activities:

- Public space transitory design;
- Participatory actions with the school community, parish councils and citizens (mostly residents);
- Communication activities.

Related UPPER tools:

- **U-NEED**: This tool may help define the specific perimeter to be restricted, while contributing to the understanding of the mobility flows;
- **U-SIM.plan**: This tool may serve the evaluation of the effect of traffic restrictions and the impact on nearby streets;
- **U-GOV**: This tool shall enable participatory actions.

UPPER

Steps to ready-to-demo measure

#	Description	Involved partners/ externals	Category of action	Deadline	Monitoring indicator	Comments
			Mixed preparation & implementation phases			
1	Data analysis	CML (DMM/DEPM)	Data/ Technical	March 31st 2024	Data analysed regarding municipal School projects per Parish councils	Done
2	Selection of schools	CML (DMM/DEPM)	Social/ Technical	March 31st 2024	4 Schools identified	Done
3	Engagement of Parish councils' Engagement of Schools'	Parish councils Schools (and respective clusters)	Social	March 31st 2024	Number of Parishes and Schools engaged	Parish councils' + 4 Schools (and its clusters) commitment Done
4	Data collection of movement in the surrounding school entrance streets (current & on-site)	CML (DMM/DEPM)	Data/ Technical	May 31st 2024	Data collection for each school	Done
5	Definition of traffic restrictions points; (eventual) tender	CML (DMM/DEPM)	Technical/ Social/ Legal	June 30th 2024	(eventual) tender processes launched & finalised	(eventual) tender: infrastructure and marketing Done
6	Pop-up's planning & testing	CML (DMM/DEPM) Municipal Police Schools & Parish Councils Students & Community	Technical/ Social	June 30th 2024	Pop-up pilots	Participatory actions Done