OPTI-UP

D.2.3.2 – Final solution for

improved PT network efficiency in the cities of Paks and Osijek

Version 3.0

June 2026

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Abbreviations

AF	Application form
DRT	Demand-responsive transport
KPI	Key Performance Indicator
PT	Public transport

1. Background

1.1. About the thematic solution

The OPTI-UP project focuses on optimising public transport (PT) networks operation in small and medium-sized cities in Central Europe by integrating urban planning with data-driven approaches and promoting environmentally friendly mobility solutions. The approach was tested through three pilot projects, each addressing a specific thematic solution. Each thematic solution comprised two solution variants, implemented within a pilot action (PA) area:

- Demand-responsive transport (DRT): Modena (Italy) variant and Grosuplje (Slovenia) variant,
- PT network optimisation: Paks (Hungary) variant and Osijek (Croatia) variant,
- Alternative fuel technologies: Pécs (Hungary) variant and Český Krumlov (Czech Republic) variant.

The final thematic solutions consolidate knowledge and lessons learned from data-driven decision-making in PT planning, the implementation of pilot actions, and feedback obtained through user surveys and stakeholder consultations. These consultations provided valuable recommendations for improving the solutions, scaling them up, and ensuring their replicability in areas facing similar public transport challenges.

The overarching aim of each thematic solution is to provide decision-makers with a practical tool to support the selection, planning, and implementation of appropriate measures, thereby enabling the gradual improvement of public transport systems in selected areas.

This final solution specifically delivers the **PT network optimisation** solution. It provides guidelines on how to plan an efficient PT network in line with land use planning. Its objective is to support the introduction of PT network optimisation in order to increase public transport efficiency and stimulate transport demand through analytically grounded and interdependent service development, using data-driven resources, including land use statistics, demographic trends, and transportation data.

1.2. Structure of the PT optimisation solution

The PT optimisation solution encompasses two distinct implementation variants: one carried out in Paks (Hungary) and the other in Osijek (Croatia). The final PT optimisation solution integrates both variants by:

- Presenting a comprehensive, generalised approach to the selection, planning, and implementation of PT optimisation, ensuring a cohesive (common) framework; and
- Incorporating the specific approaches and outcomes of each variant, with references to their implementations as documented in the OPTI-UP pilot action reports.

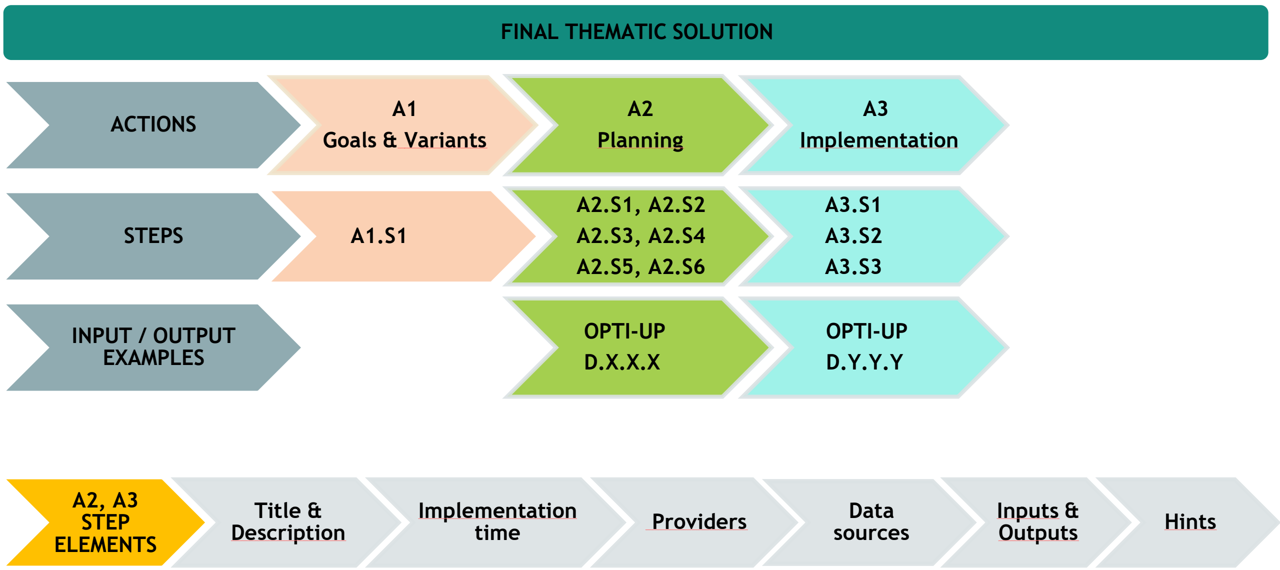
The PT optimisation solution is structured around three core actions: **A1**, **A2**, and **A3**.

Action **A1** serves as a baseline action that provides guidance on assessing whether PT network optimisation is relevant for and beneficial to the improvement of a specific public transport system. Specifically, step **A1.S1** defines the objectives of the PT network optimisation solution, establishes decision-making criteria, and outlines the proposed approaches for implementing the different solution variants.

Actions **A2** and **A3** focus on the planning and implementation phases of the solution, respectively.

All three actions are divided into a series of sequential steps (e.g. A1.S1, A2.S1–A2.S6, and A3.S1–A3.S3). Each step provides practical guidance for carrying out specific activities within the respective action, enabling a step-by-step approach to selecting the solution variant, planning it (A2), and implementing it (A3).

Figure 1: Structure of final thematic solution



Each step within Actions A2 and A3 is described using a consistent set of key elements explained below:

- **Title & Description**: Describes the purpose of the step and the key activities involved (e.g. selecting a transport modelling tool, defining scenarios for solution simulation, conducting evaluations, or collecting target values).
- **Implementation Time**: Provides an indicative assessment of the duration of the step activity using qualitative categories such as short, medium, or long (e.g. a relatively long-term process compared to other steps).
- **Providers**: Identifies the entity responsible for carrying out the tasks (e.g. a public transport modelling expert) as well as the stakeholders involved in or contributing to the step (e.g. end users, consultants, authorities, unions, public transport operators, or public transport authorities).
- **Data Sources**: Lists potential sources of data, such as online databases, service providers, experts, equipment suppliers, national statistics offices, transport operators, or existing national or municipal transport models.
- **Inputs & Outputs**: Specifies the input data or external services required to perform the tasks (e.g. transport demand and supply data) and the expected outputs of the activity, such as documents, software or hardware tools (e.g. a transport modelling report, a transport model with scenario data, templates of terms of cooperation, or examples from pilot action areas provided in the appendix).
- **Hints & Tips**: Provides additional recommendations and lessons learned from the pilot actions (e.g. the importance of involving an experienced and reputable transport modeller to ensure efficiency and quality).

The identified **Inputs & Outputs** of each step may include references to documents that present concrete examples of the final PT network optimisation implementation, as demonstrated in the OPTI-UP project pilot actions in Paks (Hungary) and Osijek (Croatia), respectively.

Descriptions of actions **A1**, **A2**, and **A3** are presented in the tables outlining the final solution, structured according to key step elements. Each step is linked to concrete examples of solution variants (Paks or Osijek), where applicable. These examples are documented in the OPTI UP project deliverables and are clearly referenced using the corresponding deliverable codes (e.g., D.2.1.1).

1.3. Outline of PT network optimisation solution

The outline provides an overview of the actions and steps within the PT network optimisation solution.

Action	Step
Action A1: Selection of the solution variant	Step A1.S1: Description of the main features, goals and decision criteria
Action A2: Planning and fine-tuning of the PT network optimisation solution	Step A2.S1: Collection of initial data
	Step A2.S2: Building a transport model
	Step A2.S3: Simulation of the solution through transport model scenarios
	Step A2.S4: Definition of the final solution for the selected area
	Step A2.S5: Definition of final solution implementation
	Step A2.S6: Definition of Key Performance Indicators
Action A3: Implementation of PT network optimisation solution	Step A3.S1: Monitoring of the implemented final PT network optimisation solution
	Step A3.S2: Evaluation of the implemented final PT network optimisation solution
	Step A3.S3: Ensuring sustainability and planning of scaling up of the solution

2. PT optimisation solution guidelines

2.1. A1: Selection of the variant solution

2.1.1. A1.S1: Description of the main features, goals and decision criteria

The OPTI-UP project provides two solution variants for improving PT network efficiency. One solution variant was implemented as a pilot action in **Paks** (Hungary), and the other as a pilot action in **Osijek** (Croatia).

The following table illustrates the main features of the setup and operation of the PT network optimisation solution variants.

Table 1: Description of the main features of PT network optimisation solution variants

Paks	Osijek
• Deployment of a new bus line • Launch on 1 September 2025 to match peak travel demand of a school year • The operation consists of a fixed route with several intermediate stops served in both directions • The service is integrated into the existing transport network, using current vehicles without increasing fleet size or total mileage • A 6-minute end-to-end travel time ensures a rapid connection • A structured timetable is applied, differentiated by weekdays, school days, weekends, holidays, and summer periods. • Improvement of efficiency, accessibility, and spatial coverage of the existing local transport network • A model for replication in other underserved parts of the city	• Introduction of a new direct bus line connecting residential areas with the industrial zone • Implementation is based on existing fleet, staff and operational resources, ensuring no negative impact on the existing network • Operation of the new line with a regular, clock-face timetable (e.g. 1-hour frequency interval) to ensure simplicity and predictability for users • Integration with the existing network through transfer opportunities (e.g. tram and bus lines), without major changes to other lines • Continuous monitoring of performance and user feedback (ridership data, surveys, operational indicators) to assess effectiveness and support future network optimisation

The decision on which PT network optimisation solution variant to apply can be made on the basis of the decision criteria presented below. The criteria are listed in order of priority, from highest to lowest.

Table 2: Goals of PT network optimisation solution variants and decision criteria for their selection

Step element	PT network optimisation
Main goals	**Common goals:** • Improve direct connectivity among parts of the city

	• Increase PT system efficiency and utilisation and reduce the proportion of passenger car use - i.e. individual transport **Specific goals:** Paks: • Focus on improving connectivity by integrating settlements that have not previously been served by scheduled local public transport services into the network Osijek: • Focus on improving connectivity between densely populated residential areas and key employment zones, reducing need for transfers • Simplify and streamline the public transport network to enhance usability and make it easier for passengers to understand and navigate • Reduction of high PT operational costs per passenger/km • Test actual demand and behavioural response to network changes as a basis for wider PT network reorganisation
Decision criteria for selection of the solution	**Common decision criteria:** • Missing regular (scheduled) public transport links, inadequate connectivity within the area • Potential to increase ridership and improve operational efficiency through passenger uptake and thereby utilisation of existing PT capacity **Specific decision criteria:** Paks: • Limited availability of scheduled local public transport connections to key destinations within the settlement (e.g. schools, kindergartens, shopping areas), with only partial coverage provided by intercity bus services • Weak integration between local and intercity transport due to poor timetable coordination and limited alignment of services • Strong potential to encourage modal shift from private car use to public transport, contributing to reduced traffic and lower air pollution Osijek: • Need for direct connections between key origins and destinations (e.g. residential areas and workplaces), minimising the need for transfers • Demonstrated demand for the new service based on direct requests and feedback from local residents • Need to simplify the public transport network and improve usability by reducing complexity and making services clearer and more intuitive for users

2.2. A2: Planning and fine-tuning of PT network optimisation

2.2.1. A2.S1: Collection of initial data

Activity/aim: This fundamental activity focuses on identifying and understanding the needs and observations of users, transport operators, or public transport authorities (PTAs) who have recognised public transport (PT) issues. The activity involves the systematic collection of relevant data, which enables thorough analyses to validate the identified issues and explore potential PT solutions. The data are collected for the following analyses:

- Spatial-demographic analysis,
- PT operation status,
- PT demand analysis,
- PT financial analysis,
- Transport modelling,
- Users' feedback analysis.

Table 1: Collection of initial data for variant solutions

Step element	**PT network optimisation**
Task provider	The transport expert gathers data, performs analyses, prepares data reports, and develops a Local Plan for public transport development based on input data analyses.
Implementation time	Medium: 4-5 months
Involved Stakeholders	• Providers of data sources: PTA, PTO, Statistical offices, ministry of transport, municipality, citizens/users
Data sources	• National statistical offices, existing national, regional or municipality bodies (*national, regional or local transport models, transport plans, SUMP*), *online information*, transport operators (*transport operational data*), users' surveys, *existing studies, traffic attracting institutions on the planned connection route (education, healthcare, employers)*
Inputs	• Data collection model: - Spatial Demographic Data: ➢ Population trend (National statistical Office) ➢ Population structure by age and gender (National Statistical Office) ➢ Population density (National Statistical Office) - Public transport operational indicators: ➢ Fleet composition (PTO) ➢ Key operational statistics PT lines (PTO, PTA) - Public transport demand analysis: ➢ Demand trend in the past five years (PTO) ➢ Monthly demand (PTO) ➢ Hourly demand (PTO) ➢ Derived demand statistics (PTO)

	- Public transport financial indicators: ➢ Cost and revenue trend ➢ Cost and revenue structure • Users' needs survey questionnaire: **Paks**: D.1.3.1_Local Plan for the city of Paks, ch.2.3; **Osijek**: D.1.3.1_Local Plan for the city of Osijek, ch.2.3
Outputs	• Presentation of data in a table of graphs (D.1.1.2_Unifed database of collected public transport systems, Paks: worksheet "Paks", Osijek: worksheet "Osijek") • Analysis of input data (D.1.1.1_ Comprehensive data report on existing public transport networks and best practices, find references to Paks and Osijek in the text) • Users' needs survey results: Paks: D.1.3.1_Local Plan for the city of Paks, ch.2.3; Osijek: D.1.3.1_Local Plan for the city of Osijek, ch.2.3 • Local plan - list of PT actions and KPI-s for monitoring and assessment of the implemented solutions, ch.5, ch.8, ch.9 (Paks: D.1.3.1_Local Plan for the city of Paks, Osijek: D.1.3.1_Local Plan for the city of Osijek)

Hints & tips: Taking into account user feedback on the current state of PT operations, as well as their suggestions for improvement and input on proposed solutions, is essential. This helps ensure greater acceptance of changes and reduces potential resistance to implementation.

2.2.2. A2.S2: Building of a transport model

Activity/aim: The most efficient way to predict the impact of an applied PT network optimisation in the observed PT area, test the proposed KPIs, and select the most relevant of them for evaluating the implemented solution, is through transport modelling. This approach also provides insight into baseline and target values needed for KPI evaluation, particularly in cases where no historical KPI data are available.

Transport model can be fully built in a dedicated transport modelling software or aided by the external mathematical models and descriptive statistics for final interpretation of the model results. Usually, a four-step transport model is available that consists of four modelling steps:

- Trip generation[1]
- Trip distribution[2]
- Mode choice[3]
- Route assignment[4].

If a transport model already exists, it should be updated with the most recent data and, where necessary, enhanced with additional features to ensure it serves as an accurate baseline model for the specific PT network optimisation analysis.

Table 2: Building a transport model

Step element	PT network optimisation
Task provider	The transport expert implements and updates the transport model using the collected data and adds specific features needed to model and evaluate the PT network optimisation solution.
Implementation time	• Short: 2 months (if only minor transport model updates are needed) • Medium: 6 months (where extensive analyses, e.g. on-field surveys are needed) • Long: 12 months (for building transport model from scratch)
Involved Stakeholders	External transport model and data providers (transport experts, PTO) for communication and explanation of implementation of the existing transport model
Data sources	• For building and updating the transport model: - National bodies (national transport model administrator, SUMP, reports and guidelines on transport model, PT offer, passenger demand), - PTO (vehicle operational data, passenger demand, AVM raw data, ticket validations or passenger counting), - European Environment Agency – gas emission levels), - Paks specific data source: literature for the basic passenger traffic estimation formula: ➢ UITP (International Union of Public Transport). “Public Transport: Network Planning”

[1] How many trips originate and end in each transport model zone?
[2] Where are people travelling to and from?
[3] What transport mode do people chose for each trip?
[4] Which routes do travellers take, and what are the resulting traffic volumes on each transport network link?

	➢ KTI "Transport and Mobility" professional-scientific journal
Inputs	• PTV VISUM (transport modelling software) • Existing transport model in VISUM: four-step travel demand model, providing PT data - PuT (OD matrix), bus and railway stops & network lines (shapefiles), zones, trips among zones, vehicle types, timetables etc. • Reports on the existing transport model • Other transport models • Updated PT offer (vehicle counting) and demand (users surveys, passenger counting) • Different costs (PTO, fuel, parking, etc, depending on the level of details of transport model) • **Paks** specific input for the transport model: - Data required to apply the basic formula for estimating passenger demand on a bus route (Q = P × R × M × A × F): ➢ Q = number of passengers on the line in a daily period ➢ P = population in the catchment area of the line ➢ R = proportion (share) of the population using transport daily (mobility rate) ➢ M = modal share (share of all trips made by bus) ➢ A = attractiveness of the line (quality of connection, directness, speed, comfort) ➢ F = frequency factor (higher frequency means higher usage) ➢
Outputs	• Updated baseline transport model VISUM (demand in public transport; demand in private transport; analytical maps - volume/capacity ratio etc.) - **Paks**: D.1.3.1_Local Plan for the city of Paks, ch.6.1; **Osijek**: D.1.3.1_Local Plan for the city of Osijek, ch.6.1

Hints & tips: Transport modelling is typically conducted using specialised software tools such as PTV VISUM, Aimsun, and others, and therefore requires advanced technical expertise. This includes experience in handling input data, calibrating models, and interpreting results. The quality and reliability of modelling outputs depend heavily on the availability and proper preparation of input data, as well as on the assumptions applied during the process. Consequently, results should always be interpreted with professional judgement.

In situations where internal capacity is limited or experienced staff are not available, it may be more efficient to engage external experts or consultancy services. This approach can help ensure higher-quality results, faster delivery, and access to proven methodologies, particularly when dealing with complex public transport network optimisation tasks.

Paks additionally relied on several national studies, guidelines and articles when developing the transport model:

- The connections between sustainability and transport organization, proposals for cost-effective mobility solutions, (2023 Hungarian Transport Association)
- Criteria system for the creation and qualification of a database containing Transmodel standard timetable and network data for local and intercity public transport (2011. April 14. Ministry of National Development)
- Evaluative analysis and development of public transport load models (2005. Balázs Horváth)

- Synthesis-based solution for urban bus transport operational planning (2021. November 2. Nagy Albert Óbuda University)
- System dynamics as a new option for demand modelling of transport systems. (2012. Horváth Richárd).

2.2.3. A2.S3: Simulation of the solution through transport model scenarios

Activity/aim: In order to verify the expected impacts pursued by the goals of implementation of PT network optimisation and meeting the KPI targets to be achieved the scenarios of implementation of the variant solution are created and simulated in the transport model (e.g. VISUM).

The modelled scenarios measure a change of selected KPIs (e.g. passenger flow distribution, gas emissions, travelled kilometres, cost of operations (fuel), volume of passengers) from the baseline state to the state after the applied modelled scenario (solution) and meeting the set targets.

Table 3: Simulation of scenarios of implementation of the solution

Step element	**PT network optimisation**
Task provider	Transport expert with extensive experience in transport modelling
Implementation time	Short: 1-3 months (depends on type of measures modelled)
Involved Stakeholders	PTO, PTA, Municipality for intermediate verification of the results, in particular the observed anomalies.
Data sources	Updated baseline transport model implemented in the transport planning and traffic modelling software tool (**Paks** and **Osijek**: PTV VISUM)
Inputs	• PTV VISUM transport modelling tool • Baseline transport model VISUM (**Paks**: D.1.3.1_Local Plan for the city of Paks, ch.6.1; **Osijek**: D.1.3.1_Local Plan for the city of Osijek, ch.6.1) • Proposed scenarios: (**Paks**: D.1.3.1_Local Plan for the city of Paks, ch.6.2; **Osijek**: D.1.3.1_Local Plan for the city of Osijek, ch.6.2)
Outputs	• Results of transport model scenarios (**Paks**: D.1.3.1_Local Plan for the city of Paks, ch.6.2; **Osijek**: D.1.3.1_Local Plan for the city of Osijek, ch.6.2)

Hints & tips: It is essential to work with a well-updated and properly calibrated transport model, as the reliability of simulation results depends directly on the quality of the underlying data and assumptions. If the input data are outdated, incomplete or inaccurate, the model will produce misleading results, which can lead to incorrect planning decisions. Therefore, regular updates, validation against real-world observations and continuous calibration are crucial to ensure that the model reflects actual travel behaviour and network conditions, providing a sound basis for decision-making.

2.2.4. A2.S4: Definition of the final solution for the selected area

Activity/aim: Based on initial analyses involving analysis of the spatial demographic data, public transport (PT) operational indicators, PT demand patterns, and financial performance included in transport modelling, the proposed **PT network optimisation has been comprehensively defined** and tailored to the specific characteristics of the intervention area.

The development of the final solution has been tailored in order to align with the established transport goals and expected outcomes, to ensure consistency with the priorities of decision-makers and funders, the availability of resources, and the operational capacities of service providers, as well as the existing monitoring and evaluation capabilities.

The final solution is detailed in the **Final Solution Implementation Plan**, which outlines the service design, deployment strategy, and performance monitoring framework.

Table 6: Fine-tuning of the final solution

Step element	PT network optimisation
Task provider	A team of transport experts performs final analyses, proposes and fine-tunes the final solution in cooperation with the involved stakeholders: - Local authority responsible for PT planning and decision-making - PTO - responsible for operational implementation - External experts/consultants (where applicable) – support in modelling, analysis and evaluation
Implementation time	Short/medium: 3 - 6 months
Involved Stakeholders	• For discussion on the conditions of the solution to be feasible and acceptable: - Municipality - a decision maker, transport authority, ordering & funding of PT services - PTO - providing experience, on-field knowledge and operational data - National authority bodies (ministries, funding bodies) - Local community and users (citizens, commuters, employees in the area) - Institutions and businesses located along the new PT route
Data sources	• Results of previous research and planning (desktop analyses, transport modelling, local plan) • Consultation meetings with the involved stakeholders • Results of the survey on PT users' needs (**Paks**: D.1.3.1_Local Plan for the city of Paks, ch.2.3; **Osijek**: D.1.3.1_Local Plan for the city of Osijek, ch.2.3)
Inputs	• Results of transport modelling (mobility gaps, missing connections), requirements of local communities, decision makers (strategic objectives), experience and knowledge of the operators - operational data (update on timetables, vehicles, vehicle occupancy data, costs of operation, staff, emissions) • Results of transport model scenarios (**Paks**: D.1.3.1_Local Plan for the city of Paks, ch.6.2; **Osijek**: D.1.3.1_Local Plan for the city of Osijek, ch.6.2)

Outputs	• Description of the defined solution expected impacts - D.2.1.2 Pilot action report Paks and Osijek project areas (**Paks**: ch.2.1 & 2.2, **Osijek**: ch.3.1 & 3.2)

Hints & tips: The definition of the final PT network optimisation solution should be based on a balanced approach that combines analytical results with practical feasibility. While data analysis and transport modelling provide a strong technical foundation, it is equally important to ensure alignment with available resources, institutional capacities and stakeholder expectations. A solution that is technically optimal but not operationally feasible or supported by key stakeholders is unlikely to be successfully implemented, therefore continuous coordination between planners, operators and decision-makers is essential throughout the process.

2.2.5. A2.S5: Definition of final solution implementation

Activity/aim: For the **implementation** of the final solution, all activities must be clearly defined, covering the entire process from planning and user communication, securing resources (internal or procurement), permits and funding, through deployment, to monitoring, evaluation, and promotion of results to users and stakeholders.

The activities should be systematically organised within a detailed time plan to ensure coordinated and timely execution, available in the **Final Solution Implementation Plan**, also including stakeholder engagement, identifying relevant actors and their roles, as well as an assessment of potential risks associated with delivering the solution, along with appropriate mitigation measures.

Table 4: Definition of implementation phases for the final solution

Step element	**PT network optimisation**
Task provider	Transport solution project manager suggests implementation phases in cooperation with external consultants
Implementation time	Short: 1 - 3 months
Involved Stakeholders	• For revision and feedback on the PT network optimisation implementation plan: - Municipality (manager of PT in the study area, ordering and funder of PT services) - PTO (definition of operational resources, capacities and operational procedures)
Data sources	• Consultation meetings with the involved stakeholders on the basis of previous analytics and modelling
Inputs	• Revision and suggestions underpinned by former analytics and data (PT operational data, ridership / ticketing data, financial data, user surveys and feedback, PT routes, timetables, available fleet and staff etc.), knowledge of operational and formal procedures and capacities of operators
Outputs	• Final Solution Implementation Plan - D.2.1.2 Pilot action report Paks and Osijek project areas (**Paks**: ch.2.1 & 2.2 &2.3, **Osijek**: ch.3.1 & 3.2 & 3.3) • Plan of stakeholders' engagement - D.2.1.2 Pilot action report Paks and Osijek project areas (**Paks**: ch.2.2.2, **Osijek**: ch.3.2.2) • Assessment of risks - D.2.1.2 Pilot action report Paks and Osijek project areas (**Paks**: ch.2.2.3, **Osijek**: ch.3.2.3)

Hints & tips: A well-structured implementation plan should ensure that all phases—from planning to evaluation—are clearly defined, realistic and aligned with available resources and institutional capacities. Special attention should be given to communication with users and stakeholders, as acceptance plays a key role in the success of the solution. At the same time, continuous monitoring and flexibility are essential, allowing timely adjustments in response to operational challenges and real user behaviour.

2.2.6. A2.S6: Definition of Key Performance Indicators

Activity/aim: Monitoring of the implementation of a solution is crucial, and Key Performance Indicators (KPIs) are essential tools for monitoring of the performance of the solution.

Systematic monitoring allows for:

- tracking the progress of implemented activities, enabling fine-tuning of the solution and adjustments of operational deviations and responding to feedback from users and operators; and
- conducting regular, real-time assessments of performance against predefined target values expressed through the KPIs.

The definition of KPIs, along with the associated monitoring tools and data sources, is provided in the **Final Solution Implementation Plan** and used in the monitoring report.

Table 5: Definition of Key Performance Indicators for the final PT network optimisation solution

Step element	**PT network optimisation**
Task provider	Transport solution project manager in cooperation with external transport expert in modelling/planning/analytics provides definition of KPIs for PT network solution performance monitoring
Implementation time	Short: 1 – 2 months
Involved Stakeholders	• Operational data providers (PTO)
Data sources	• Own previous analyses, modelling and reports • List of available input data for calculation of KPIs (passenger counts, ticketing data, timetables, delays, km, costs, revenues)
Inputs	• Users' survey needs feedback - **Paks**: D.1.3.1_Local Plan for the city of Paks, ch.2.3; **Osijek**: D.1.3.1_Local Plan for the city of Osijek, ch.2.3 • Results of transport model scenarios (**Paks**: D.1.3.1_Local Plan for the city of Paks, ch.6.2; **Osijek**: D.1.3.1_Local Plan for the city of Osijek, ch.6.2) • Expertise and experience from involved stakeholders (interpretation of analytics and modelling & definition of baseline and target values) • List of available KPIs: **Paks**: D.1.3.1_Local Plan for the city of Paks, ch.9; **Osijek**: D.1.3.1_Local Plan for the city of Osijek, ch.9
Outputs	- List of applied KPIs (definition, data sources, baseline and target values) - D.2.2.1_Comprehensive evaluation report and recommendations for thematic solutions scaling up (**Paks**: ch.3.2.3, **Osijek**: ch.3.2.4): name, input data, calculation formula, data source, KPI calculation tool

Hints & tips: When defining KPIs, it is important to focus on a limited number of clearly measurable and relevant indicators that directly reflect the objectives of the solution, such as ridership, occupancy, cost efficiency and service reliability. KPIs should be supported by reliable and regularly available data sources, and baseline values must be established prior to implementation to enable proper comparison. In addition, simple and transparent monitoring tools should be set up in advance, ensuring that performance can be tracked continuously and that results can be easily interpreted and used for timely decision-making and adjustments.

2.3. A3: Implementation of PT network optimisation solution

2.3.1. A3.S1: Monitoring of the implemented PT network optimisation solution

Activity/aim: The process of monitoring the **implementation** and **performance** of the public transport network optimisation begins with the launch of the service into operation. It is supported by dedicated **Monitoring Tool**, which enables the collection of operational and other input data, as well as the periodic calculation of KPIs.

For **implementation** monitoring, the Monitoring Tool provides detailed information on when and how each implementation activity has been carried out.

For **performance** monitoring of the PT network optimisation, the Monitoring Tool supports the collection of relevant operational data, such as date and time of departure, number of passengers, type of vehicle used, capacity of vehicles, cost of departure, number of kilometres operated. It also enables the continuous calculation of KPIs on a regular basis (e.g. weekly).

Table 6: Monitoring of the implemented PT network optimisation solution

Step element	PT network optimisation
Task provider	The planning and analytics transport expert collects data from the PTO or PTA, keeps records, pre-processes data to fit the Monitoring Tool where needed, and performs real-time monitoring of implementation and performance.
Implementation time	Duration of the monitoring period (e.g. during pilot activity or long-term…)
Involved Stakeholders	• Providers of the operational data (PTO, PTA) • Municipality (input data on promotion) • Users (providing feedback)
Data sources	• PTO - spreadsheet for input data (via e-mail) • Municipality
Inputs	• Final Solution implementation plan & monitoring tool - D.2.1.2 Pilot action report Paks and Osijek project areas (**Paks**: ch.2.3, **Osijek**: ch.3.3) • Users' feedback questionnaire (implemented online or in person) – available in D.2.2.1 – APPENDIX to Comprehensive evaluation report and recommendations for thematic solutions scaling up (**Paks**: ch.C.3, **Osijek**: ch.D.3) • Empty "Performance monitoring tool" for input data collection and calculation model for calculation of KPIs from the operational data (Excel spreadsheet)
Outputs	• Final solution implementation monitoring tool (filled in) - D.2.1.2 Pilot action report Paks and Osijek project areas (**Paks**: ch.2.3, **Osijek**: ch.3.3) • Users' feedback survey – collected data, stored in the spreadsheet for analysis

	• Calculated KPI-values on the weekly basis: in the "Performance monitoring tool" (Excel spreadsheet), stored for analysis

Hints & tips: Effective monitoring should combine tracking of implementation activities with continuous performance monitoring through KPIs, ensuring both operational control and evidence-based decision-making. It is important to establish simple but robust monitoring tools in advance, enabling consistent data collection and clear reporting. Regular analysis of collected data allows early detection of issues such as low ridership or operational deviations, making it possible to fine-tune the service in real time and improve overall performance and user satisfaction.

2.3.2. A3.S2: Evaluation of the implemented PT network optimisation solution

Activity/aim: The evaluation of the implementation and performance of the PT network optimisation, including the final conclusions, is carried out through the analysis of monitoring results and the incorporation of stakeholder feedback and recommendations on the implementation.

The evaluation of the solution **implementation** provides a report on how and when the activities were carried out. More importantly, it identifies implementation difficulties, deviations, and mitigation measures, resulting in a final **SWOT analysis** of the implementation process.

The evaluation of solution **performance** presents weekly trends in KPI changes compared to the baseline values and assesses the achievement of target values during the observation period. Based on the KPI analysis, an overall assessment of the PT network optimisation solution is provided.

Table 7: Evaluation of the implemented PT network optimisation solution

Step element	PT network optimisation
Task provider	Transport expert provides analyses, evaluations and reporting of implemented activities and monitoring of KPIs and cooperates with **project manager** in conducting consultation of stakeholders; together they prepare the conclusions.
Implementation time	Short: 2 – 3 months after conclusion of monitoring
Involved Stakeholders	PTO, Municipality, PTA, passengers (for presentation of the results and getting feedback)
Data sources	Collected data through monitoring of implementation and monitoring by using “Monitoring tools” and users’ survey database (Excel…)
Inputs	• Final solution implementation monitoring tool (filled in) - D.2.1.2 Pilot action report Paks and Osijek project areas (**Paks**: ch.2.3, **Osijek**: ch.3.3) • Users’ feedback survey - collected data, stored in the spreadsheet for analysis • Calculated KPI-values on the weekly basis: in the “Performance monitoring tool” (Excel spreadsheet), stored for analysis
Outputs	• Implementation monitoring **report**: - D.2.1.2 Pilot action report Paks and Osijek project areas (**Paks**: ch.2.3, **Osijek**: ch.3.3) • Difficulties and deviations from the plan - D.2.1.2 Pilot action report Paks and Osijek project areas (**Paks**: ch.2.4, **Osijek**: ch.3.4) • SWOT analysis of implementation - D.2.1.2 Pilot action report Paks and Osijek project areas (**Paks**: ch.2.5, **Osijek**: ch.3.5) • Evaluation of performance - KPIs: D.2.2.1 – APPENDIX to Comprehensive evaluation report and recommendations for thematic solutions scaling up (**Paks**: ch.C.2, **Osijek**: ch.D.2)

	• Evaluation of users' feedback: D.2.2.1 – APPENDIX to Comprehensive evaluation report and recommendations for thematic solutions scaling up (**Paks**: ch.C.3, **Osijek**: ch.D.3) • Comprehensive conclusions on implementation and performance of the solution – D.2.2.1 – Comprehensive evaluation report and recommendations for thematic solutions scaling up (common SWOT analysis: ch.6.1.2; key results and reached expectations: **Paks**: ch.6.2.1.3, **Osijek**: ch.6.2.1.4; key common outcomes: ch.6.2.2.2)

Hints & tips: Evaluation should combine both implementation assessment and performance analysis to provide a complete understanding of the solution's effectiveness. While implementation reporting focuses on whether activities were carried out as planned and highlights any deviations, performance evaluation should rely on objective KPI trends compared to baseline and target values. A balanced evaluation approach, supported by clear data and structured reporting, enables decision-makers to identify strengths, weaknesses and opportunities for further improvement, ensuring that future adjustments or scaling of the solution are based on evidence.

2.3.3. A3.S3: Ensuring sustainability and planning of scaling up of the solution

Activity/aim: Planning of improvements and scaling up of the implemented PT network optimisation is a direct response to implementation and performance monitoring, with the aim of enhancing its efficiency, sustainability, but also supporting its **scalability** and **transferability**. This process involves complying with financial, operational, and institutional conditions, as well as providing recommendations **for ensuring the long-term sustainability** of the solution and its **scaling-up** (further development). Scaling up may also include transferring the solution to other areas (replicability), particularly neighbouring municipalities and regions facing similar PT challenges.

Evaluation of implementation results is a prerequisite for planning of modifications to the PT network optimisation. The resulting plan should provide clear guidance for future actions to ensure sustainability, specifying the measures to be implemented, the responsible providers, and the required resources.

Continuous performance monitoring of the implemented solution provides essential input for improvements, upscaling, and replication. Plans for sustainability and scaling up should be developed in cooperation with relevant stakeholders, in order to incorporate practical insights into financial, operational, and organisational (institutional) conditions, as well as the available options for further development.

Table 8: Planning of scaling up of the solution

Step element	**PT network optimisation**
Task provider	The transport expert and project manager propose the conclusions of the implementation and performance analysis as input for the stakeholder discussions to get feedback on recommendations for upscaling and replicability and prepare a report.
Implementation time	Short: 2 months (preparation of the discussion and reporting)
Involved Stakeholders	• Included in consultation process: - PTA (transport model administrator, formal procedures) - PTO (definition of operational resources, capacities and operational procedures), - Municipality (location of implementation of the solution and PT ordering and funding) and neighbouring municipalities - National authorities (providing funding) - Users (passenger) - Relevant infrastructure providers
Data sources	• Results of own evaluation of the implemented solution
Inputs	• Implementation monitoring **report**: - D.2.1.2 Pilot action report Paks and Osijek project areas (**Paks**: ch.2.3, **Osijek**: ch.3.3) • Difficulties and deviations from the plan - D.2.1.2 Pilot action report Paks and Osijek project areas (**Paks**: ch.2.4, **Osijek**: ch.3.4) • SWOT analysis of implementation - D.2.1.2 Pilot action report Paks and Osijek project areas (**Paks**: ch.2.5, **Osijek**: ch.3.5)

	• Evaluation of performance – KPIs: D.2.2.1 – APPENDIX to Comprehensive evaluation report and recommendations for thematic solutions scaling up (**Paks**: ch.C.2, **Osijek**: ch.D.2) • Evaluation of users' feedback: D.2.2.1 – APPENDIX to Comprehensive evaluation report and recommendations for thematic solutions scaling up (**Paks**: ch.C.3, **Osijek**: ch.D.3) • Presentation and questions for the stakeholders' consultation
Outputs	• Guidance for future actions for sustainability - D.2.1.2 Pilot action report Paks and Osijek project areas (**Paks**: ch.2.7, **Osijek**: ch.3.7) • Consultation of stakeholders: D.2.2.1 – APPENDIX to Comprehensive evaluation report and recommendations for thematic solutions scaling up (**Paks**: ch.C.4.3, **Osijek**: ch.D.4.3) • Common lessons learned and suggestions for replicability (measures, responsibilities, recommendations) - D.2.2.1 – Comprehensive evaluation report and recommendations for thematic solutions scaling up, ch.6.3

Hints & tips: Ensuring long-term sustainability and successful scaling of the PT network optimisation solution requires a structured approach that combines evaluation results, KPI monitoring and continuous stakeholder engagement. Special attention should be given to financial, operational and institutional feasibility, as these factors strongly influence whether a solution can be maintained and expanded. If improvements require infrastructure changes (e.g. new stops, terminals or road adjustments), it is essential to involve all responsible stakeholders early in the planning process and to start preparation and implementation on time. Delays in infrastructure adaptation can significantly limit the effectiveness of the solution, therefore proactive coordination and timely action are key for achieving planned goals and enabling successful scaling or replication in other areas.