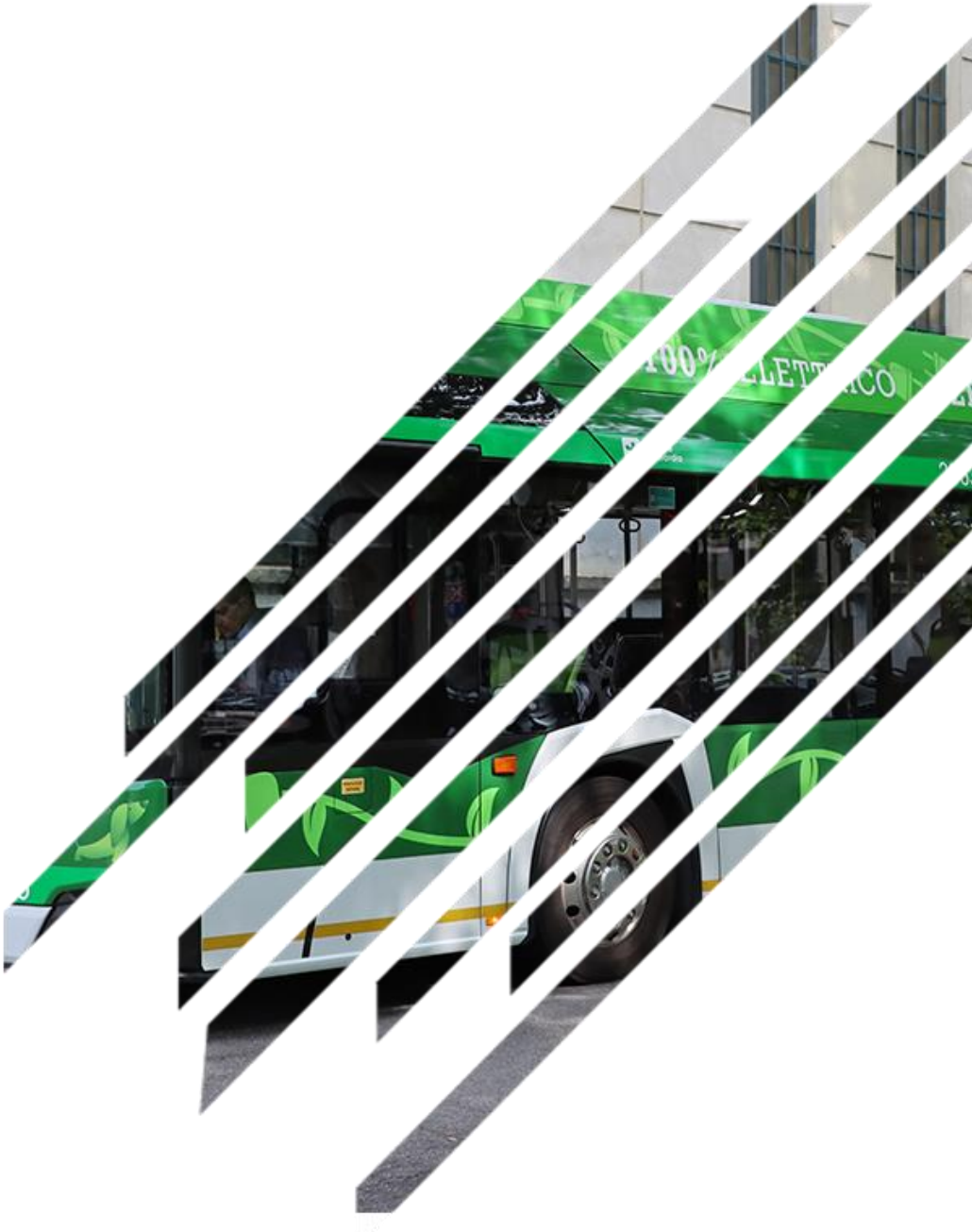
Smart Public transport Initiatives for climate Neutral cities in Europe

D1.2 SPINE Framework for Innovative PT solutions



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Contributions from	All city partners as well as scientific and technical partners have contributed to D1.2 through their valuable inputs especially regarding the description of the SPINE measures and implementation plans.		

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Glossary of terms and abbreviations used

Abbreviation / Term	Description
AML	Lisbon Metropolitan Area
ANTW	Antwerp
API	Application Programming Interface
BARR	Barreiro
BMC	Business Model Canvas
BOL	Bologna
BRT	Bus Rapid Transit
CH4	Methane
CO	Carbon monoxide
CO2	Carbon dioxide
EV	Electric Vehicle
FFPT	Fare-Free Public Transport
GA	Grant Agreement
GDYN	Gdynia
HERA	Heraklion

1 According to SPINE's Quality Assurance Process

H2S	Hydrogen sulphide
IA	Area of Influence
KPI	Key Performance Indicators
LEM	Local Evaluation Manager
LEZ	Low Emission Zone
LL	Living Lab
MaaS	Mobility as a Service
NO2	Nitrogen Dioxide
OBB	Online Bulletin Board
OD	Origin-Destination
PALM	Las Palmas
PEM	Project Evaluation Manager
PIMUSSVA	Comprehensive Sustainable and Safe Urban Mobility Plan for the City of Valladolid
PM2.5, PM10	Particulate Matters
P+R	Park and Ride
ROU	Rouen
SBNK	Sibenik
SCP	Smart City Platform
SO2	Sulfur dioxide
SUMP	Sustainable Urban Mobility plan
TALL	Tallinn
TEN-T	Trans-European Transport Network
VALL	Valladolid
VMP	Vehicles of Personal Mobility
VOC	Volatile Organic Compounds
WHO	World Health Organization
WP	Work Package
ZILI	Zilina

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Executive Summary

Deliverable 1.2 is part of Work Package (WP) 1 and is aligned with Objective 1 of the SPINE Project. It aims to analyse the form, physical and functional structure, natural environment, and public realm, within which Public Transport systems operate, to define innovative measures and new approaches of significant impact, while developing a new integrated framework to facilitate the co-creation and co-management of innovative mobility solutions that will be affordable, inclusive and resilient.

Deliverable 1.2 is related to all WP1 tasks and aims to achieve the WP1 objectives as follows:

- T1.1 Mapping maturity level and foreseen interventions per city: To achieve T1.1 objectives we have reviewed and we present the status of the SPINE cities in terms of urban development and mobility (existing mobility services, interventions planned or implemented through their SUMPs), technological readiness (existing IT platforms, available data sources, transport models, etc.) and co-creation experience (existing media and communication channels of the cities, previous experience on co-creation activities). In addition, as part of T1.1 a mapping of each SPINE solution to the cities is carried out.
- T1.2 Impact Assessment and Continuous Evaluation: To achieve the goals of T1.2, this deliverable reviews existing frameworks regarding the impact assessment (e.g. CIVITAS framework), and further presents the SPINE Impact assessment and twinning framework.
- T1.3 Definition of initial basket of solutions: To achieve this, D1.2 presents and describes the initial basket of SPINE solutions and maps them to the cities.
- T1.4 Collaborative Business and Governance Models for PT-led Mobility: The goal of this task is met through the development and presentation of the business models of the solutions to be implemented in the SPINE cities, the definition of the roles of the different stakeholders and the identification of potential barriers in an early stage.

To fulfill the objectives of this deliverable, a well-defined roadmap consisting of different steps was followed. To collect the essential data underpinning the development of this deliverable, a series of engaging activities were undertaken, including a comprehensive questionnaire survey administered to the city representatives. Subsequent to this, follow-up interviews/workshops were conducted to delve deeper into pertinent subjects, ensuring a holistic and informed perspective.

This approach of inclusive engagement and collaborative work embodies the spirit of the SPINE project, where interdisciplinarity and cross-sectorial collaboration are considered important drivers for the successful implementation of innovative urban mobility solutions.

For the development of this deliverable, the following SPINE documents were taken into consideration:

- Grant Agreement (GA), Reference number: 101096664, to ensure that the agreed activities and outputs are delivered in this deliverable;
- D1.1 SPINE Living Labs Inception Report, especially in the parts considering the SPINE solutions that will be considered in SPINE cities, the KPIs to measure and monitor the measures' impact and the cities' plan to implement the SPINE measures.

1 Introduction

This deliverable serves to present a comprehensive and detailed overview of:

- **The maturity level of the SPINE cities** providing valuable insights into their current status in terms of urban development, mobility, technological readiness, co-creation experience, etc. (Chapter 3),
- **The initial basket of solutions and their mapping to the SPINE cities**, that will be communicated to WP2 and WP4 (Chapter 4),
- **Prototype business and governance models for each identified solution** offering a glimpse into the potential operational frameworks and governance structures (Chapter 5),
- **The impact assessment and twinning framework**, shedding light on the evaluation methodologies and collaborative initiatives (Chapter 6),
- An **implementation plan tailored for the SPINE mobility solutions** to be deployed in the Living Labs, paving the way for successful execution and monitoring of the proposed interventions (Chapter 7).

By addressing these critical elements, this deliverable will contribute significantly to the overall success of the SPINE project, setting the ground for the implementation of innovative solutions for public transport while empowering cities to embrace them.

1.1 Mapping SPINE Outputs

The purpose of this section is to map SPINE's GA commitments, both within the Deliverable 1.2 content and the description of WP1 Tasks (T1.1, T1.2, T1.3, T1.4), against the project's respective outputs and work performed.

Table 1: Adherence to SPINE's GA Deliverable & Tasks Descriptions

SPINE GA Component Title	SPINE GA Component Outline	Respective Document Chapter(s)	Justification
DELIVERABLE			
D1.2 SPINE Framework for Innovative PT solutions	Definition of the initial basket of solutions to be communicated to WP2 and WP4.	Chapter 4	Chapter 4 defines the initial basket of solutions based on desk research and the inputs received from the questionnaire.
	Presentation of the impact assessment and twinning framework	Chapter 6	Chapter 6 presents the impact assessment and twinning framework, while it initially presents the existing approaches.
	Mapping of the maturity levels and foreseen interventions per city	Chapters 3 and 4	Chapter 3 documents the maturity level of each SPINE city, presenting the current mobility setting, the existing digital enablers and the cities' experience in co-creation activities. In addition, Chapter 4 maps the SPINE solutions to the cities.
	Prototype business and governance models per identified solution.	Chapter 5	Chapter 5 presents the prototype business and governance modes per identified solution.
	An implementation plan for the SPINE PT-centered mobility solutions to be deployed in the Living Labs (detailed and tailored scoping and implementation plan	Chapter 7	Chapter 7 presents the detailed implementation plan of the SPINE solutions for each city.

	for each LL) based on the mature and up to date information that will become available at the time of project initiation. The plan will include a detailed timeplan, business and governance models, operations processes, feasibility study for the designed innovations, associated KPIs, co-creation aspects and the ICT tools/components to be deployed.		
TASKS			
T1.1 Mapping maturity level and foreseen interventions per city	Review the SUMP documents and process in each city (lead and twin) in the SPINE consortium and consider the current situation of the urban space and setting.	Chapter 3	Especially, Section 3.1 presents the goals and interventions that are planned or implemented through the cities'' SUMPs or other policies
	Basic mapping of the initial basket of solutions identified in the proposal stage with each city, feeding T2.1, and identified further interventions or pathways that would be beneficial to the cities. It provides a necessary mapping of the maturity level and sets the ground for the allocation of interventions per city.	Chapter 4	This chapter provides a description of the SPINE measures and presents a table with a mapping of each solution to the cities based on the WP1 questionnaire and the discussions with the cities.
	Provides a mapping of the media channels and other communication channels necessary both for the successful implementation of LLs and solutions and for identifying communication channels for the dissemination of the project.	Chapter 3 and 7	Especially, Section3.3 will present the existing media and communication channels of the cities, while in Chapter 7 the implementation plan describes the SPINE approach on this aspect.
	Undertakes the subtasks of mining social media data for the purposes of the maturity level mapping and setting up the online bulletin board.	Chapter 3	In Chapter 3, we will present the mining social media data for the purposes of the maturity level mapping. In Section 7.2, we present the set-up of online bulletin boards.
	Collects all necessary, city-specific data (from social-media mining, available secondary sources, existing model and simulation datasets, previous co-creative experiences and labs) and facilitates the data transfer to WP3.	Chapter 3	A discussion on the data is provided in Section 3.4, while the data available for SPINE is presented in Annex IV.
T1.2 Impact Assessment and Continuous Evaluation	Defines the knowledge base framework of the assessment and transferability of SPINE solutions (Impact Assessment and Twinning Framework by M9). It sets and acknowledges the baseline indicators for each LL and city, creating and inventory of indicators (such as KPIs, SUDIs, SUMIs Knowledge base/inventory (types of KPIs, review of CIVITAS methodology, further enhance and adapt it). The task will detail the baseline, benchmarks and	Chapter 6	This chapter will review existing frameworks regarding the impact assessment and twinning (e.g. CIVITAS framework), and will further present the SPINE Impact assessment framework

	assumptions for measuring the impact of interventions ……		
	Develops the twinning framework, with specific guidelines and steps on what and how is communicated and in which way it is efficiently transferred from the lead to the twinning cities.	Chapter 6	Especially, Section 6.2 will present the SPINE's framework for twinning.
T1.3 Definition of initial basket of solutions	Defines the initial basket of innovative solutions which will be presented to the LLs at the beginning of the co-creation process, listing also competing solutions and products that are already available on the market….	Chapter 4	This chapter will present and describe the SPINE solutions and will map them to the cities.
T1.4 Collaborative Business and Governance Models for PT-led Mobility	Identify the key actors in the urban mobility context involved in the multimodal mobility ecosystem and defining the roles and responsibilities of each key actor, with the local setting in mind. It defines a set of common goals, addressing challenges and barriers and prepares specific sessions to be introduced during the LLs that are concerned with the structure of the collaborative business and governance models. Covers ticket integration and PPP collaboration models with the goal of capturing business and governance requirements for each qualified solution, through iterative discussions in the lead LLs.	Chapter 5	This chapter will present the business models of the different pilots. The business models are developed to identify the roles of the different stakeholders and potential barriers in an early stage.

1.2 Deliverable Overview and Report Structure

Chapter 2 presents the methodological framework for developing this deliverable, while also presenting the SPINE methodology and the steps to develop the prototype business and governance models.

Chapter 3 provides an overview of the maturity level and readiness of the SPINE cities concerning their urban space and mobility status, data availability, transportation models, IT systems, existing communication channels, and their experience in engaging citizens and local stakeholders through co-creation activities.

Chapter 4 provides an in-depth presentation of the initial basket of SPINE solutions and their mapping with each specific SPINE city. This section offers a description of each SPINE measure, accompanied by comprehensive specifications for its implementation within each individual SPINE city.

Chapter 5 presents the business models of the lead cities (i.e. Antwerp, Tallinn, Las Palmas and Bologna) using the business model canvas.

Chapter 6 outlines the impact assessment and twinning framework to be utilised in the SPINE project. This section delves into the methodologies and approaches that will be employed to evaluate the project's impact on various aspects, as well as the framework for facilitating collaboration and knowledge exchange among the cities.

Chapter 7 presents a detailed implementation plan for each city, focusing on their time plan, operational processes, co-creation aspects, etc.

Chapter 8 concludes the deliverable.

The deliverable also includes five Annexes as follows:

- Annex I: Questionnaire distributed to the SPINE cities as part of WP1
- Annex II: The Business Model Canvas: A quick introduction for Cities
- Annex III Social media accounts for SPINE cities
- Annex IV: Collection of Secondary data from SPINE cities
- Annex VI: Sentiment analysis for all Facebook accounts.
- Annex VI: List of Indicators used in SPINE for the impact assessment of the implemented measures.

2 Methodology

2.1 SPINE Methodology

SPINE takes place in 11 European Living Labs (LLs). LLs are innovative and collaborative ecosystems that serve as real-world testbeds for exploring, co-creating, and evaluating new technologies, products, services, and policies. They provide a unique environment where various stakeholders, including researchers, businesses, government agencies, and citizens, come together to tackle complex challenges and address societal needs. LLs offer a space for experimentation, enabling the development and validation of novel solutions in authentic settings, such as cities, communities, or specific domains. In a LL, participants actively engage in the design, implementation, and evaluation of innovations, ensuring that solutions are user-centered and fit the needs of the target population. This user-centric approach fosters open dialogue, collaboration, and knowledge exchange, aiming at co-creating more effective and impactful solutions. LLs emphasise the importance of real-world feedback and iterative improvement, allowing for continuous learning and refinement throughout the innovation process. By bridging the gap between research, industry, and society, LLs accelerate the translation of ideas into tangible solutions, driving sustainable and inclusive innovation. They create an environment where experimentation is encouraged, risks can be taken, and diverse perspectives are valued.

The SPINE Living labs utilise an Equity Centered Design Thinking approach especially tailored for the SPINE project. It begins by empathising with the users of the solutions and then proceeds to define a plausible range of solutions. Key areas of emphasis include equity, accessibility, affordability, and inclusiveness. The next step involves ideating, where collective co-creation and refinement of the solutions take place. Prototyping follows, along with implementing, testing, and assessing the impact of the solutions. Finally, successful solutions are amplified in cities across Europe. The focus of all solutions, whether push or pull measures, revolves around enhancing public transportation (PT) offerings, addressing the diverse needs of current and potential PT users.

SPINE adopts a multi-sector lens, recognising that individuals have unique experiences and intertwined social identities such as gender, race, class, sexual orientation, physical ability, and more, rather than fitting into a single target group based on specific characteristics. These user definitions within SPINE are referred to as "user constellations" of the LLs. The success of the LLs is dependent on the active engagement and diversity of a wide range of participants. A diverse group of actors and stakeholders, including citizens, vulnerable groups and advocates, local businesses, decision-makers, transport sector stakeholders, urban planners, local influencers, and ambassadors will co-create in the LLs. They acknowledge the existing condition in each city and LL, identifying existing barriers and co-creating ways to overcome them. A crucial aspect of equity-centered community design involves recognising the systemic causes of inadequate PT services and passenger dissatisfaction, leading to reduced accessibility not only to transportation but also necessary activities and unequal access to opportunities. Power dynamics within the LLs' activities are also acknowledged.

The overall concept of the LLs can be described as a "think globally, act locally" approach, emphasising global and European goals while emphasising the importance of applying solutions at the local level. To ensure genuine and active participation in the LLs, a variety of methods and tools will be employed. These include process facilitators (such as reminders, local awareness campaigns, and social media outreach), offering diverse communication and participation channels (both physical and virtual), and accommodating native language settings to promote honest participation and prevent the exclusion of non-native speakers.

The SPINE methodology contains 6 steps visualised in Figure 1 and summarised below.

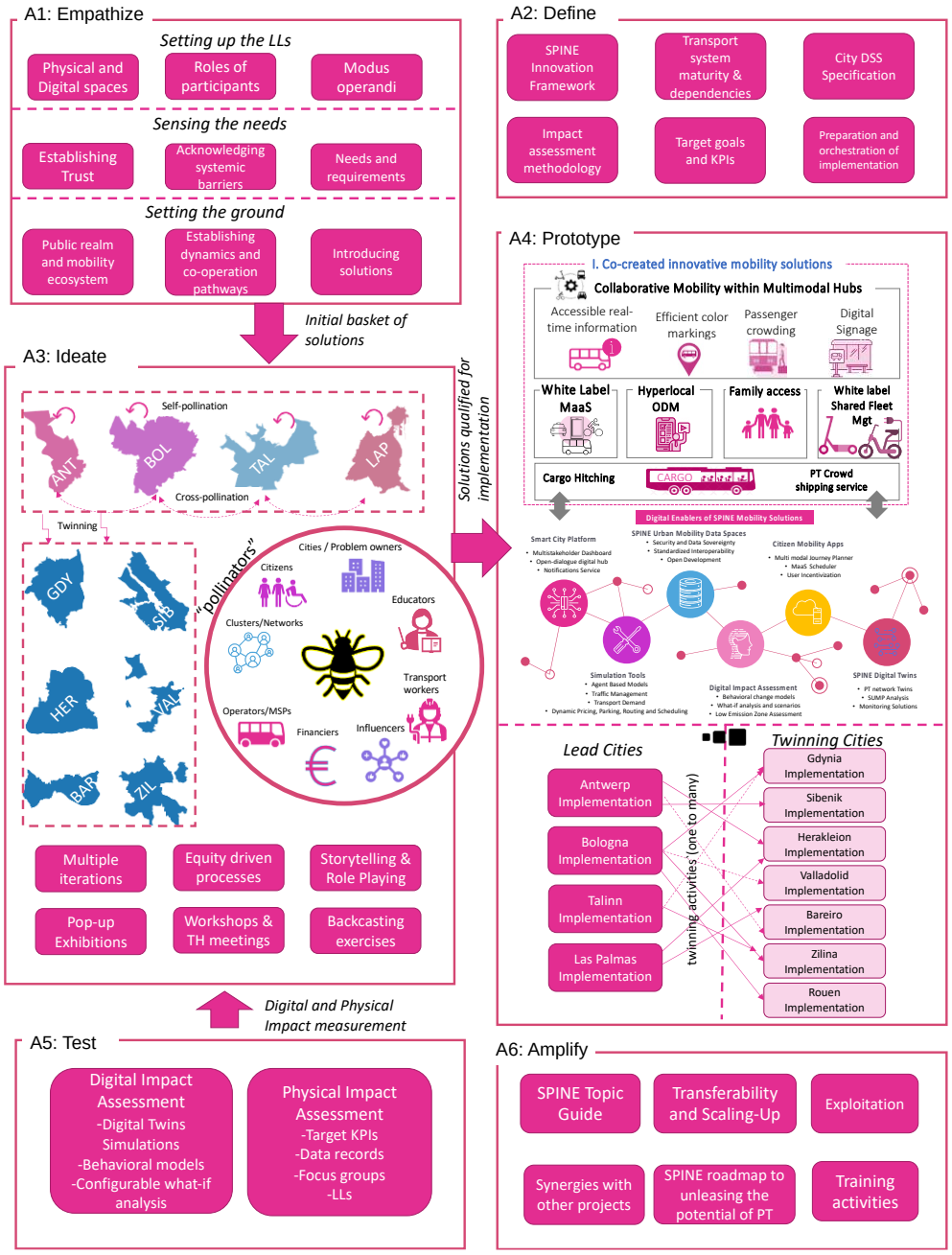


Figure 1. SPINE Methodology

A1 - Empathize: The initial step in building empathy involves organising interactive events (both physical and digital) facilitated by the LLs. These events aim to explore the needs of the user constellations. During these sessions, a variety of ideas, solutions, existing prototypes, services, and policies available at the local and regional levels are introduced as the starting point for the co-creation process. The Empathise step serves multiple purposes: a) establishing trust among participants and solidifying the dynamics of the LLs; b) understanding the needs and requirements of LL participants and local advocates; c) reviewing local SUMPs and policy documents related to mobility and environment to identify relevant goals, objectives, and solutions aligned with SPINE's objectives; d) conducting data mining and ethnography to analyze trends in mobility discussions on online platforms. This analysis helps identify online communities, trends, and influential voices related to mobility and public transportation. The LLs address community needs and requirements by working with the initial set of SPINE solutions and technologies.

A1.1 - Diversity, Gender, and Inclusion approach: In this way, the diversity, gender and inclusion approach of the SPINE project will emphasise, not only the physical accessibility of mobility services, but on the matter of discrimination against users because of their gender identities, ethnic origin, age or disability across the Living Labs. With this approach, the SPINE project and its mobility measures aim at improving equitable access to transportation for diverse populations, enhancing the accessibility for women and girls in all their diversity, especially the convenience and usability related to sexual harassment and discrimination. Indicative examples include:

- By implementing integrated mobility services at multimodal hubs, SPINE can enhance equitable access to transportation for diverse populations, an example could be introducing on-demand free-of-charge mobility services for refugees in the case of Gdynia.
- On-demand mobility services by gender can be used to see if there are significant differences in PT usage by gender and see if there is a need to study the reasons behind it.
- Creating priority systems for PT and improving traffic flow could reduce waiting time. These measures, alongside improving real-time passenger information, could increase the sense of security, especially early in the morning or late at night, for groups of women and girls in all their diversity, thus enhancing the accessibility and usability of PT services.

A2 - Define: This step involves defining interventions, indicators, and frameworks. It includes presenting a concrete SPINE innovation framework and assessing the maturity level of the transport systems in the Lead and Twinning cities. Additionally, impact assessment and twinning methodologies are finalised, along with setting specific target goals, Key Performance Indicators (KPIs), and baseline values. Business and governance models related to specific solutions in each city are also presented.

A3 - Ideate: This phase is dedicated to cultivating an idea incubator, trading perspectives between stakeholders and supporting innovative approaches. SPINE LLs will form teams among participants from different LLs, selecting individuals with diverse disciplinary, knowledge, and sectoral backgrounds. This mix of perspectives aims to stimulate debates and reflections by encouraging the exploration of alternative, conflicting, and even radical ideas that others are invited to endorse. Through 3 iterative sessions, we will identify existing barriers and drivers, resulting in a refined list of co-created solutions that serve as pathways towards achieving project objectives and target impact indicators. This initial "filter" will qualify a subset of solutions, while disqualified ideas will undergo critical assessment and discussions to document the barriers perceived by the LLs and potential pathways to overcome them. The LLs function as shared physical and digital spaces where participants collaborate to co-create and tailor innovative solutions, ensuring a suitable subset of solutions for implementation in their respective cities. Various methods and tools aimed at supporting this process will be tailored for each and every LL digital and physical co-designing, perspective-making/taking sessions and serious games, back-casting exercises, structured discussions, etc.

Furthermore, a series of pop-up exhibitions, supported by local organisations and networks, are planned to raise awareness and widely disseminate the efforts of the LLs. These exhibitions lay the foundation for successful solution implementation in the cities. Additionally, digital tools are employed during this phase to model LL interventions and, in conjunction with advanced behavioral econometric models, test-drive the subset of solutions qualified during the initial iterations of the LLs. This step-by-step approach necessitates a more frequent schedule of iterations, meetings, and events within the LLs. The Ideation step carefully sifts through potential solutions, identifying those to be implemented in the LL or pilot city. The phase concludes with a curated and tailored list of solutions, which undergo assessment in SPINE's digital tools, documenting their anticipated impacts.

A4 - Prototype: The carefully curated list of solutions for each LL will be physically implemented in 4 Lead Cities and 7 Twinning Cities. The initial list of solutions comprises push and pull measures, which will undergo refinement and implementation within the LLs. In addition to the core Design Thinking (DT) models, we will launch an Open-dialogue digital hub to facilitate the adaptation and transferability of solutions. This hub will include a digital space that promotes the exchange of information and knowledge among policymakers, citizens, LL participants, passengers, operators, and other stakeholders. It will serve as a digital platform for discussing open topics, customising and fine-tuning solutions and reporting problems and barriers to implementation. A live, location-based sub-module will be incorporated to enable the reporting of issues and problems throughout the city.

The next stage in the prototyping phase is raising awareness of SPINE solutions by rebranding PT campaigns. Given the diverse backgrounds, cultures, perspectives, and disciplines of LL participants, the initial objective of the rebranding PT campaigns is to establish a common language across the LLs. Tools such as idea dashboards will be utilised to track progress during LL meetings and monitor the evolution of ideas and reactions to solutions. As a second step in the rebranding activities, we plan to leverage pop-up exhibitions in the SPINE cities. These exhibitions will feature images, objects, and artifacts to encourage citizen interaction with our proposed solutions with specific open questions in each city. The main goal of these pop-up exhibitions is to foster critical thinking among participants, observe their interactions with various displays of open questions and proposed solutions, and gather quantitative and qualitative data on key drivers of modal shift to PT and satisfaction with PT services. Materials from the exhibitions will be shared with other cities to effectively illustrate the solutions implemented in different parts of Europe and promote their

scalability. Documentation of the pop-up exhibitions will result in published material and successful rebranding efforts.

Furthermore, city-specific mobile applications (the Citizen App) will be developed or enhanced to promote mobility solutions and push-and-pull measures aligned with each city's goals. These apps integrate existing assets and are further enhanced within SPINE based on implemented mobility solutions. The Citizen App facilitates communication between the city and its citizens, serving as a citizen engagement platform with features such as travel logging, providing users with personalised information on mode usage, travel times, costs, activity patterns, and emissions.

A5 - Test: The prototypes deployed in participating cities undergo final evaluation using both quantitative and qualitative techniques. Questionnaires, focus groups, and other methods are employed to measure KPIs and overall scores for the target impact indicators. Parallel to this evaluation, a workstream envisions future scenarios where core target impacts, such as increased PT share and user satisfaction, are realised. This helps identify the necessary steps to reach these scenarios, including understanding barriers and opportunities at each stage of solution development and implementation. The adaptive and agile approach is essential for tailoring solutions to the specific needs of the LLs.

A6 - Amplify: The final step focuses on actions to amplify the project's impact, establish effective communication and exploitation of results, facilitate knowledge transfer to other European cities, conduct training and knowledge-sharing initiatives, and document lessons learned from the LLs' experience. The key outcome is the "SPINE roadmap to unleash the potential of PT", which consolidates the knowledge generated in SPINE. This roadmap includes specific scenarios, strategies to overcome barriers, and well-defined pathways to unlock the true potential of public transportation.

SPINE places great emphasis on fostering collaboration within and between the LLs. Guided by skilled designers and facilitators, LL participants will embark on a transformative journey through the six design steps of the SPINE methodology (A1-A6). Through this process, SPINE aims to challenge mindsets and behaviors, acting as an incubator for cultivating different perspectives and co-creating innovative solutions for urban and peri-urban transportation. The diverse participation within the LLs will stimulate meaningful debates and reflections among the participants. Simultaneously, local partners of SPINE will serve as facilitators and moderators in the design thinking spaces, capturing and documenting this process for knowledge retention and digital storytelling.

In addition to the physical design thinking spaces, we will also employ online spaces and digital platforms as an integral part of the LL activities. These asynchronous discussion groups will provide an additional dimension to the design thinking process. The digital platform offers opportunities for analysis, enabling participants to respond to specific questions, comment on each other's posts and engage in group discussions. Each digital space will consist of approximately 30 participants and run for three days, with new questions and discussion topics introduced each day. We plan to conduct at least three digital spaces per city to explore transport user needs, identify challenges and barriers to policy implementation, and discover opportunities for innovative solutions. We anticipate the participation of over 300 individuals from diverse stakeholder groups, including academia, public authorities, cities, and transport-related companies. The digital spaces will be utilised in two project phases: initially during WP1 for the initial assessment, and later during WP3 to enhance the digital testing sessions by reevaluating indicators and facilitating the testing phase.

2.2 Methodology followed for D1.2

To achieve the objectives of D1.2 (as outlined in Chapter 1), the methodology stream depicted in Figure 2 was followed including the below four distinct steps.

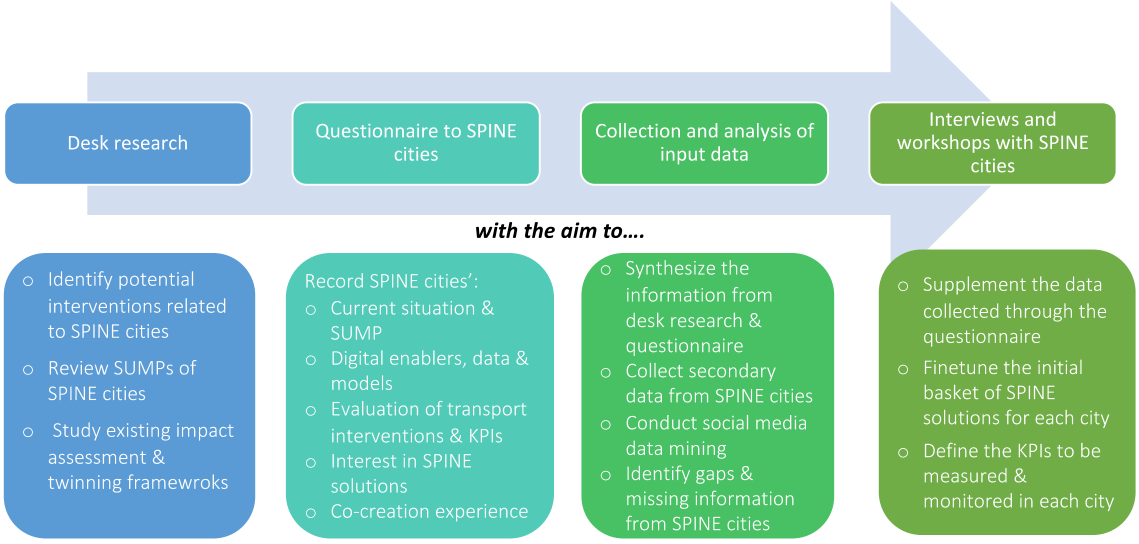


Figure 2. Methodological steps followed for the development of D1.2

Desk research was our initial activity, aimed at establishing the foundation for the objectives of this deliverable. The SPINE Grant Agreement set the framework for the measures to be implemented in the SPINE cities. However, our desk research played a vital role in identifying potential implementation approaches for each SPINE measure. Additionally, an in-depth review of the cities' policy documents, including their Sustainable Urban Mobility Plans (SUMPs) and other relevant policies related to mobility, environment, and planning, allowed us to gain insights into the current urban space and its settings. This comprehensive review helped highlight the policy goals, objectives, and city interventions that hold relevance to the SPINE project. Furthermore, it enabled us to establish a clear connection between the SUMPs and the SPINE solutions. Lastly, as part of this step, we studied existing impact assessment and twinning frameworks associated with urban mobility (see Chapter 6).

Questionnaire: One of the key distinguishing features of SPINE is the active participation of both the Scientific and Technical (S&T) partners and the cities in various stages of the project's development. In this step, collaboration was fostered through the creation of a comprehensive questionnaire, which was subsequently distributed to the SPINE cities to gather valuable information about their:

- *Current mobility setting*, with a specific focus on existing mobility services, information about the Public Transport (PT) system for the city (e.g., existing technological innovations on the PT system);
- *SUMP and relevant policy documents*, encompassing the proposed measures and the Key Performance Indicators (KPIs) to gauge their success;
- *Digital enablers*, such as IT systems (e.g., operational platform, digital twin, etc) utilised to manage and support transport operations within the city;
- *Data availability* related to mobility within the city;
- *Existing transportation simulation models* used in the city;
- *Current media and communication channels* used by city representatives and PT operator(s);
- *Indicators defined in their SUMPs* to evaluate transport interventions;
- *Interest in SPINE solutions*, along with details such as the experimentation area, measure implementor (e.g., city authority, PT operator, other mobility service providers (MSPs), etc.), key implementation milestones, affected KPIs and expected output;
- *Co-creation experience*, including the type of co-creation activity (Living Lab, workshops, etc.), the target participants, and other relevant details.

The development of the questionnaire was led by the WP1 Leader (UAEGEAN) with the collaboration of other S&T partners (HU, AIMSUN, IBI, CMO, etc.). Once finalised, the questionnaire was distributed to the cities' representatives, who were asked to provide the requested information. The questionnaire can be found in Annex I.

Collection and Analysis of data: This step involved synthesising and analyzing the data obtained from both the desk research and the questionnaire. The collected information was carefully examined to identify any gaps or missing data, prompting us to explore the need for further

discussions with the cities to fill these knowledge voids. Additionally, we gathered secondary data from the cities, which will be transferred to WP3 to aid in the development of SPINE measures and modeling activities. Finally, an essential component of this step was the data mining process, wherein social media data from city authorities and local PT operators was carefully extracted and analysed. This provided valuable insights into public sentiments, trends, and perceptions related to urban mobility and PT transport.

Interviews and workshops with SPINE cities: This step encompassed a series of consecutive discussions with the cities, aiming to gather additional information for the questionnaire. In addition, we conducted further workshops and interviews to fine-tune the SPINE measures to be implemented in each city and establish the KPIs for monitoring progress throughout the SPINE project. These collaborative workshops and interviews were organised by UAEGEAN and HU, with the active involvement of other S&T partners. The valuable insights and feedback provided by the cities played a pivotal role in shaping the project's direction, ensuring that the SPINE solutions are tailored to meet the unique mobility needs of each participating city. Through these engagements, we fostered a strong partnership with the cities, enhancing the project's overall success and impact.

2.3 Business models methodology

For the development of SPINE prototype business and governance models, four different interviews were performed with representatives of each one of the Lead cities. Prior to the interview date, cities handled a questionnaire with eight questions and a Business Model Canvas (BMC) with notes in it. The stakeholders were asked to get familiar with the canvas and to answer the questions before the interview date. In the document sent to the cities, there was a short introduction about business models and an explanation of the relevancy of the workshop (see Annex II). The document also introduced the vision of SPINE in 4 concrete goals:

1. Combine existing and new mobility measures to improve the quality and competitiveness of public transport.
2. Co-create with ecosystem actors inclusive, resilient and sustainable mobility solutions.
3. Create an integrated approach to public transport with other mobility services using AI/data-driven simulation tools to capture ecosystem dynamics and trigger behaviour change.
4. Create a condensed policy document with knowledge from the co-creation exercises and recommendations for implementing mobility solutions.

These goals are a summary of the ones presented in the section of Ambitions, in the GA.

The interviews followed a semi-structured format to allow the stakeholders to freely express their views on how they foresee the city would deliver the SPINE value proposition. During the one-and-a-half hour (on average) of each interaction, the stakeholders worked together, complementing their perspectives on the proposed solutions (see Chapter 5). In the case of Tallinn, there was a single representative of the city. From Antwerp, two city representatives participated in the workshop. In Bologna, two representatives of the city and one from the public transport operator attended, while the administrative body of the city Las Palmas was represented by the consultancy Cinesi. The results of the interviews are summarised in four different BMC (See Chapter 5).

3 Maturity level and readiness of the SPINE cities

This chapter seeks to offer a comprehensive overview of the maturity level and readiness of the SPINE cities concerning their urban space and mobility status, data availability, transportation models, IT systems, existing communication channels, and their experience in engaging citizens and local stakeholders through co-creation activities. By delving into these critical aspects, we aim to assess the cities' preparedness for embracing the SPINE project's innovative solutions and collaborative approaches to sustainable urban mobility.

3.1 Current situation of urban space and mobility setting

In the rapidly evolving landscape of urban mobility, the SPINE cities stand as a compelling and dynamic representation of the diverse states of maturity within this vital sector. As we delve into the intricacies of each city's mobility infrastructure, we find ourselves immersed in a fascinating tapestry of unique challenges, innovations, and visions for the future. Embracing various stages of development and displaying distinct approaches, these cities offer valuable insights into the ongoing transformation of transportation and mobility. In this section, we embark on an in-depth exploration of the state of mobility in the SPINE cities, uncovering the contrasting dynamics that define their urban mobility ecosystems. By understanding these divergent experiences, we aim to glean critical lessons and pave the way for a more sustainable and connected urban future. Thus, to do so, in this section we will provide an overview of the current state of mobility in the different cities of SPINE (both Leading and Twinning) as well as the interventions and/or the solutions that have been planned or implemented in each city policy documents.

3.1.1 Antwerp

Antwerp is a city in the northern region of Belgium, known for its rich history, stunning architecture, and vibrant cultural scene. It is the second-largest city in Belgium, after Brussels, and has a population of over 500,000 people. Antwerp is a major port city and is located on the Scheldt River, which connects to the North Sea, making it an important hub for international trade and commerce.

3.1.1.1 Current Mobility Status

The accessibility of Antwerp city and port, along with measures taken to tailor networks to the needs of city dwellers and visitors. The city takes measures described in the 'Master plan 2020, Building blocks for the expansion of the Antwerp Mobility Master Plan (Alix Lorquet et al 2012), which contains measures for the supra-local networks of all modes. This document is part of the Sustainable Urban Mobility Plans for Antwerp. The plan emphasises the importance of tangential connections and nodes to make the multimodal system function coherently and efficiently. Besides removing bottlenecks on the larger network, plans are being developed for the residential centers and living environments. An extensive urban tram network, a finely-meshed cycling network, and an intuitive local road network are the basis for ensuring and enhancing quality of life. In Table 2 we can find the key planned interventions for mobility in Antwerp's Master Plan:

Table 2: Aspect of mobility services in Antwerp

Aspect of Mobility	Description
Supra-Local Network	- Implementation of measures from the 'Master Plan 2020' for all transport modes. - Focus on tangential connections and nodes for efficient multimodal transportation.
Urban Transport	- Plans to remove bottlenecks on the larger network.
	- Extensive urban tram network, cycling network, and local road network.
	- Development of a robust train, tram, and bus network for efficient public transport.
	- Prioritisation of tramway over buses within the city.
	- Advocacy for a feasibility study on freight railway line 11.
Parking and Accessibility	- Establishment of parking facilities and transportation options at strategic locations.
	- Promotion of co-modality and recognition of supra-local infrastructures' importance.
	- Collaboration with Flanders on the expanded Master Plan 2020 for better supra-local accessibility.
Supra-Local Network Development	- Implementation of well-designed interchange complexes.
	- Emphasis on smooth transitions between main roads and connections to the local road network.

Cycling Network	- Safe and convenient cycling routes within the city.
	- Main cycle network under the jurisdiction of Flanders and the province of Antwerp.
	- Focus on eliminating missing links, conflict-free intersections, and accommodating electric bicycles.
Waterborne Transportation	- Optimisation of the Albert Canal with the construction of five new bridges.
	- Exploration of waterborne transportation for residents and visitors.
	- Promotion of sea and river cruises and examination of water buses and water taxis for additional connections.
Long-Distance Connections	- Exploration of connections between the inner city and Waasland, and Klein-Brabant and Eilandje.
	- Optimisation of passage width and height on the Albert Canal for larger vessels.
	- Development of a modern and safe pipeline network.
Multimodal Interchanges	- Focus on establishing smooth exchanges between different transport networks.
	- Key supra-local nodes and poles include the port, airport, HST station, IC/IR stations, and river cruises terminals.
	- Introduction of Park & Ride facilities at city edges with tram and cycling connections.
	- Emphasis on optimising port access within the Trans-European Transport Network (TEN-T).

3.1.1.2 Interventions planned in the SUMPs

Antwerp has a more favourable modal split than the average in Flanders, with 53.7% of Antwerp residents commuting to work sustainably. However, the policy aims at a further modal shift in the coming years, especially in favour of cycling and public transport. To achieve this, consultations will be held with mobility partners such as SNCB, a train operator for the city and a separate cycling memorandum will be created.

The city will strengthen the image of public transport, taxis, and innovation in car-sharing, with the strategy of nodes and Park & Ride's acting as a catalyst in stimulating the desired modal shift. The city wants optimal travel times, transport capacity, frequencies, information, and infrastructure for train, tram, and bus passengers. Losing time because of difficult interchanges is pernicious, and the city aims to discuss this on an ongoing basis.

Table 3: Interventions planned in SUMPs

Intervention Area	Planned Interventions
Urban Access Roads	- Establishment of three hierarchies: Stone roads, Urban roads, and District roads with specific functions and design requirements.
	- Focus on traffic flow, quality of life, and road safety.
Multimodal Nodes	- Creation of multimodal nodes along the Singel and Ring Road, facilitating access to train stations, tram and pre-metro lines, and cycling routes.
	- Provision of facilities for cyclists, car parking, and easy accessibility by various modes of transportation.
Modal Shift Strategy	- Aim for a modal split of 50-50 by 2020, with a focus on cycling and public transport.
	-Consultations with mobility partners, separate cycling memorandum, and strengthening the image of public transport.
Smart Traffic Management	- Implementation of smart measures for optimal traffic flow and safety.
	- Focus on economic and social fabric, accessibility of essential urban functions, multimodal accessibility of port and business parks, and differentiated commerce and hospitality.
Road Safety	- Proactive approach to avoid conflicts between different modes of transport.
	- Measures to prevent accidents and improve traffic management, including speed control and secure routes to schools.

These interventions aim to enhance the overall mobility, accessibility, and safety of the city of Antwerp, while also promoting sustainable transportation options and efficient traffic management.

3.1.2 Tallinn

Tallinn, the capital city of Estonia, offers a compelling case study for examining mobility patterns and transportation infrastructure in an urban context. With a population of approximately 445,005 residents and an area spanning 159 km2 across eight city districts, Tallinn presents a rich and diverse landscape for exploring the complexities of urban mobility. The city's transportation system encompasses various modes, including an extensive public transport network consisting of trams, trolley buses, and regular buses. Additionally, walking and private car usage are significant components of Tallinn's mobility landscape. By delving into Tallinn's transportation infrastructure and analysing the interplay between public transport, walking, and private cars, valuable insights

can be gained into the challenges and opportunities associated with promoting sustainable and efficient mobility in a capital city setting.

3.1.2.1 Current Mobility Status

Tallinn's mobility ecosystem includes a well-developed public transport system, a focus on walking and cycling, and efforts to promote sustainable transportation options such as electric vehicles. The introduction of the Fare-Free Public Transport policy, as a part of the 2035 Strategic plan, aimed to encourage public transport usage and reduce reliance on private cars. The city also faces challenges related to increasing private car ownership and harbor traffic management.

Table 4: Available modes of transportation in Tallinn

Mode of Transportation	Description
Public Transport	- Extensive network including 5 tram lines, 8 trolley bus lines, and 57 regular bus lines.
	- Accounts for a substantial share of trips in the city, with 40% of all trips in 2012.
Fare-Free Public Transport (FFPT)	- Introduced in 2013 to encourage a modal shift from private cars to public transport.
	- Tallinn was the first European capital to offer FFPT to all residents.
Rail Services	- Estonian railway network connecting Tallinn to major cities in the country.
	- Train station serves as a transportation hub with connections to other modes.
Cycling	- Extensive network of cycling routes and paths.
	- Dedicated bicycle lanes and pedestrian paths ensure safety and convenience for cyclists.
Ferry Services	- Regular ferry connections to nearby islands, facilitating travel and goods transportation.
Taxi Services	- Traditional taxi companies and app-based ride-hailing services available.
	- Competitive pricing and availability for flexible transportation.
Pedestrian Infrastructure	- Well-designed sidewalks, crossings, and pedestrian-only zones.
	- Encourages walking for short trips and promotes a pedestrian-friendly environment.
Electric Vehicles (EVs)	- Growing interest in EVs as eco-friendly transportation.
	- Modest but promising uptake of EVs within the public transport sector.
Harbor Traffic	- Harbors in the Tallinn region play a vital role in goods and passenger transport.
	- Effective management is essential for logistics and international connections.

3.1.2.2 Interventions planned in SUMPs

The SUMP of Tallinn's currently being finalized, thus, a translation in English couldn't be provided. Nonetheless, the SUMP is developed according to the 2035 Strategic Development Strategy which, for the project purposes has been considered the SUMP. In Table 5 can be found find an overview of the Strategic Goals of Tallinn while in Table 6 can be found the area of actions for the city

Table 5: Strategic goals of Tallinn

Strategic Goals	Explanation
Healthy Mobility	Increasing the share of active types of mobility in city traffic improves people's health. Good connections and the implementation of universal design principles ensure that everyone can access their destinations.
Friendly Urban Space	Increasing the share of sustainable types of mobility, safer traffic and the balanced division of street space as well as well-designed streets make for a human scale urban environment. The connection centres of public transport will be designed as parts of quality urban space.
Green Transformation	Increasing the share of sustainable types of mobility and switching to alternative fuels reduces CO_2 emissions and stress on the natural environment.
Home that includes the street	Reducing parking and speeds in calm traffic areas and promoting environmentally friendly types of mobility makes for more attractive space and cleaner air. Good public transport and light traffic connections increase the value of homes.
Creative Global City	Good intra-city and regional connections promote entrepreneurship and good international connections improve the competitiveness of Tallinn.

Table 6: Area of actions in Tallinn

Area of Action	Key Courses of Action
Regional and International Mobility	1) Joint mobility organisation with state and neighbouring local authorities. 2) Integrated route network and convenient connection possibilities. 3) Single zone-based fare system. 4) Improved access to public transport. 5) Establishment of 'Park & Ride' car parks. 6) Development of cooperation between Tallinn-Helsinki and the state. 7) Financing of regional public transport. 8) International associations and cooperation projects.
Parking suitable for the city environment	1) Updating parking principles and standards. 2) Establishment of parking infrastructure. 3) Development of parking charges.
Sustainable financing	1) Devising a co-funding model for development of regional public transport, infrastructure and mobility services. 2) Involvement of the private sector in financing the infrastructure.
Traffic control and planning	1) Development of Tallinn mobility model. 2) Development of adaptive traffic control system. 3) Expansion of public transport priority system. 4) Establishment of green corridor for traffic flows. 5) Expansion of vehicle monitoring system.

These courses of action are aimed at achieving a sustainable transport system in Tallinn that is safe, efficient, and environmentally friendly. The key focus areas include regional and international mobility, parking suitable for the city environment, sustainable financing, and traffic control and planning. The development of an integrated route network, convenient connection possibilities, and a single zone-based fare system are expected to reduce the number of cars on the road and improve access to public transport. Additionally, sustainable financing and involvement of the private sector in financing infrastructure are expected to support the development of the transport system. Finally, the development of an adaptive traffic control system, expansion of public transport priority system, and establishment of a green corridor for traffic flows are expected to reduce congestion and improve traffic flow, while the expansion of vehicle monitoring system is expected to improve safety.

3.1.3 Bologna

As an emblematic Italian city, Bologna faces diverse mobility challenges arising from its dense population, historical significance, and role as a major cultural, academic, and economic hub. Bologna's urban mobility system serves a significant annual ridership of approximately 130 million passengers. It includes 12 train and subway stations catering to around 15 million urban train passengers and a trolleybus network serving about 40 million passengers yearly. Private cars dominate the modal share at 42%, followed by walking at 27% and public transportation at 21%. Bologna is making strides in electric mobility with a growing number of electric vehicles, and the city promotes cycling with 2,500 bicycles and e-bikes for public use. While air pollution levels are rated at 2 on the World Health Organization (WHO) scale (0 to 10), income disparities persist, with an average annual income per inhabitant of €28,048. Shared mobility is encouraged with 220 car-sharing vehicles (including 120 electric ones) and a substantial fleet of shared bicycles and e-bikes, though electric scooters are notably absent.

3.1.3.1 Current mobility status

To assess the state of urban mobility in Bologna, we rely on data from reputable sources, including Ecosistema Urbano, Legambiente, ISTAT, ACI, ANCMA, and Motus-e. The data covers the period up to December 2019, with some variables dating back to 2018. The analysis encompasses multiple facets of urban mobility, including public and private transportation modes, electric vehicle adoption, cycling infrastructure, pollution levels, income disparities, and taxi services.

Bologna's public transportation system serves approximately 130 million passengers annually, translating to an average of 286 passengers per inhabitant. The city is equipped with 12 train and subway stations, catering to around 15 million urban train passengers yearly. Additionally, filobus (trolleybuses) are a popular mode of transportation, serving approximately 40 million passengers annually.

Table 7: Aspects of urban mobility in Bologna

Aspect of Urban Mobility	Description
Public Transportation	- Serves approximately 130 million passengers annually.
	- 12 train and subway stations, catering to around 15 million urban train passengers yearly.
	- Filobus (trolleybuses) serve approximately 40 million passengers annually.
Modal Share of Transportation	- Private cars: 42%
	- Walking: 27%
	- Public Transportation: 21%
	- Cycling: 5%
	- Motorcycles: 4%
Private Vehicles and Electric Mobility	- Total cars: 208,487
	- Total motorcycles: 57,704
	- Electric cars: 182
	- Electric motorcycles: 73
	- Electric trucks: 34
	- Electric special vehicles: 2
Cycling Infrastructure	- Network of 2,500 bicycles and e-bikes available for public use.
	- 0.29 square meters of pedestrian zones per inhabitant.
Air Pollution Levels	- Pollution rating of 2 on a scale of 0 to 10, based on WHO standards.
Income Disparities	- Average annual income per inhabitant: €28,048.
Taxi Services	- Total taxis: 706
	- Electric taxis: 1
Shared Mobility	- Car-sharing: 220 vehicles, with 120 of them being electric.
	- Bicycles and e-bikes: 2,500 available for shared use.
	- E-scooters: 0

Bologna's urban mobility landscape includes a well-utilised public transportation system, a shift towards sustainable modes of transport, and efforts to mitigate air pollution. The presence of electric vehicles and shared mobility options aligns with the city's commitment to cleaner transportation. Addressing income disparities and further enhancing shared mobility services can contribute to a more equitable and sustainable urban mobility ecosystem.

3.1.3.2 Interventions Planned in the SUMPs and other Policy Documents

Table 8: Interventions Area of Bologna

Intervention	Description
Objective: Reduce Traffic Emissions by 40% by 2030	- Aligned with EU goals and the Paris climate agreement.
Participation in SUMP Development	- Over 6,000 participants from associations, organisations, companies, and civilian groups involved since 2016.
General Objectives of SUMP	- Accessibility, climate protection, air pollution reduction, and road safety.
Promotion of Active Mobility	- Increase distance travelled on foot by 50,000 km by 2030.
	- Extend pedestrian spaces by 20% of the total area in each municipality.
	- Achieve a 23% walking mode share of total trips in the metropolitan area and 27% within Bologna by 2030.
Promotion of Cycling	- Increase bicycle travel by 1 million km by 2030.
	- Develop 18 new major metropolitan cycling routes.
Pedestrian-Friendly Infrastructure	- Enhance the quality of sidewalks and pedestrian areas.
	- Implement safety measures to reduce conflicts and risks for pedestrians.
Traffic Management	- Implement environmental Limited Traffic Zones (LTZ) and Pedestrian Traffic Zones (PTZ).
	- Gradually introduce a maximum speed limit of 30 km/h in urban residential streets by 2025.
	- Further reduce speed to 10 km/h in areas near schools and with children and elderly populations.
Cycling Networks	- Develop two integrated cycling networks by 2030: daily journeys and tourist cycling.
	- Expand existing cycling routes from 246 km to 944 km.
Bike-Sharing and Support	- Expand bike-sharing programs and cycling support services.
	- Implement anti-theft measures.
	- Provide incentives for bicycle cooperatives and e-bike purchases.
Enhanced Railway System	- Increase train frequency to every 15 minutes through main stations.
	- Expand seating capacity for trips over 15 minutes.

Tramline Expansion	- Construct four interconnected tramlines connecting railway stations and urban areas.
Bus Rapid Transit (BRT)	- Implement seven suburban BRT corridors with scheduled timetables and interchanges.
Metropolitan Public Transport (MPT)	- Integrate various modes of transportation: railway, BRT, trams, urban and suburban bus networks.
Reintroduction of Tram System	- Reintroduce the tram system with the Red Line running through key areas.
Mobility Hubs	- Build Mobility Hubs at 30 railway stations and terminals for intermodal travel and services.
Road Safety Targets	- Reduce congested road sections by 65%.
	- Halve the number of road accident victims.
	- Aim for zero children killed on the road.
Environmental Sustainability	- Reduce CO2 emissions from cars and commercial vehicles by 16%.
	- Reduce CO2 emissions from metropolitan public transport by 53% by 2030.

3.1.4 Las Palmas

Las Palmas de Gran Canaria is a city and municipality located on the island of Gran Canaria, part of the Canary Islands archipelago in Spain. It is the largest city in the Canary Islands and one of the most important ports in Spain. The city has a population of 381,847 people (2009) and a motorisation rate of 531 automobiles and motorcycles per 1,000 inhabitants.

3.1.4.1 Current Mobility Status

According to a detailed study carried out in in 2014 and 2015, the mobility patterns of the residents of Las Palmas de Gran Canaria are characterised by a low number of daily trips per person (2.08), with the private car being the predominant mode of transportation. Of all trips made by residents, 67% are made by car, followed by 15.1% on foot, 13% by public transport, 0.4% by bicycle, and 4.5% by taxis and other means of transport.

Table 9: Aspects of mobility in Las Palmas

Aspect of Mobility	Key Points
Modal Share	- Low number of daily trips per person (2.08).
	- 67% of trips made by residents are by private car.
	- 15.1% of trips are on foot, 13% by public transport, 0.4% by bicycle, and 4.5% by taxis and other means.
Comparison with Other Municipalities	- Low daily trips per person compared to other municipalities.
	- 87% of daily trips made by residents are intramunicipal, highlighting the city's role as a center of activity.
Distribution of Modal Shares (Intramunicipal)	- Slight increase in walking (from 15.1% to 15.6%).
	- Public transport usage remains at 13%.
Motorisation Rate (Las Palmas de Gran Canaria)	- 531 vehicles per 1,000 inhabitants.
	- Motorcycle mobility represents only 1% of total trips.
	- Bicycles have limited presence in daily mobility.
Use of Public Transportation	- Higher usage in lower city areas and areas with parking regulations.
	- Parking difficulties and costs identified as barriers to public transport use.
Pedestrian Mobility	- Accounts for only 15% of total trips despite favorable weather conditions.
Mobility Trends (2010-2020)	- Limited change in modal share over the years.
	- Private car usage remains dominant at 84.20% in 2020.
Use of Public Road Space	- 80% of public road space reserved for private vehicle use.
Challenges in Public Space Design	- Narrow sidewalks, insufficient spaces, and barriers affecting accessibility.
Commercial and Leisure Structure	- Concentration of commercial and leisure activities in large areas.
	- Connection of pedestrian mobility with the commercial sector and tourism is crucial.
Transformation of Public Space	- Shift towards pedestrian-friendly designs, avenues, wider sidewalks, and pedestrianisation of roads.
Recovery of Streets for Interaction	- Aim to transform streets into spaces for interaction and diverse activities.

Las Palmas de Gran Canaria faces challenges related to a dominant reliance on private cars, limited use of public transport, and a need for improved pedestrian infrastructure. The city aims to promote sustainable mobility, enhance accessibility, and create more pedestrian-friendly spaces to improve the quality of life for its residents.

3.1.4.2 *Interventions planned in the SUMPs*

Gran Canaria's SUMP is an old document, as it comprised actuations until 2012. Nonetheless, other policy documents were provided by the Townhall and thus, the following information has been developed using the "LPA_GC Movilidad en Transformación" report.. The objectives of the Policy Documents can be found in Table 10.

Table 10: Policy documents and Initiatives in Las Palmas

Policy Document/Initiative	Key Points and Implementation Details
Pedestrian Mobility Enhancement	- The city is focused on enhancing pedestrian mobility, including the redesign of streets and public spaces to prioritise pedestrians.
	- Criteria for redesign include promoting multifunctionality, facilitating human relationships, ensuring visual impression and ease of orientation, and prioritizing pedestrian safety and comfort.
First Major Pedestrianisation Action (2012)	- Implemented on Mesa y López Avenue, featuring reversible materials like paint, planters, and bollards.
	- The project aimed to create pedestrian-friendly spaces with benches and green areas.
Modernisation of Public Transportation (2011-2013)	- Over 500 actions were implemented to create accessible and non-discriminatory itineraries, including accessible routes between key points.
	- Introduction of Zonas 30 to enhance pedestrian and cyclist safety by reducing speed limits to 30 km/h and limiting vehicle use in designated areas.
	- Use of hierarchical classification and criteria to determine Zonas 30 and prioritise local or residential streets for accessibility and coexistence.
	- Expansion of public transportation coverage and introduction of new routes.
	- Fleet renewal program with 82 new, modern, and eco-friendly vehicles.
Promotion of Bicycle Usage	- The goal is to shift from recreational to functional use, increasing modal shares from 0.4% to 3.8% within five years.
	- Bicycle training and promotion activities in schools, reaching 8,000 users/year.
	- Creation of a network of cycling routes to improve connectivity and encourage bicycle use as a transportation alternative.
Parking Infrastructure and Regulation	- Management of parking spaces, including regulated parking areas (Blue Zone) and application (LPA Park) to streamline the parking system.
	- Increase in the number of regulated parking spaces in residential areas to protect residents and provide more parking options.
Promotion of Motorcycles and Mopeds	- Measures to encourage the use of motorcycles and mopeds, including Advanced Zones for Motorcycles (ZAM) and modifications to traffic light-controlled pedestrian crossings.
	- Reduction of the Municipal Vehicle Tax for motorcycles and mopeds by 50%.
Modernisation of Taxi Services	- Introduction of new regulations to modernise the taxi sector, including vehicle age limits, emissions standards, full-time hours, and safety enhancements.
	- Expansion of taxi stops in high mobility areas to improve service availability.
High-Capacity Collective Transport System (BRT)	- Implementation of a BRT system to meet high mobility demands in the Ciudad Baja, with bi-articulated vehicles, exclusive platforms, and traffic light priority.
	- Proposals for a route from Maternal-Insular Hospital complex to La Isleta-Plaza Manuel Becerra, with ongoing studies to determine the final route.
	- Expected improvements include enhanced frequencies, interurban links, efficiency, reduced waiting and journey times, safety, and comfort for users.

These initiatives and policy documents aim to transform mobility in Las Palmas de Gran Canaria, promoting sustainability, accessibility, safety, and efficiency in the city's transportation systems.

3.1.5 Gdynia

Gdynia is a city in Poland that has been actively involved in initiatives aimed at promoting sustainable transport and reducing car use. To this end, the city has implemented a number of "soft" measures, such as information and communication campaigns, promoting alternative modes of travel such as walking, cycling and public transport. Gdynia has also been involved in various educational and promotional actions, including the European Car Free Day, Bicycle May, European Cycling Challenge, Walking Bus, and Parking (r)evolution.

3.1.5.1 *Current mobility status*

Gdynia has been systematically monitoring the transport behaviour of its residents for over twenty years. The Public Transport Authority of Gdynia conducts surveys every 2-3 years through individual, standardised interviews with representative sample of 1% of residents. The mobility survey research was carried out in 2018 and found that the average daily number of mechanised journeys in Gdynia, excluding pedestrians, was 1.65. Of these, approximately 44% are home journeys, 23% are work

journeys, and almost 12% are for personal errands. More information on the Mobility Aspects of Gdynia can be found in Table 11.

Table 11: Mobility aspects in Gdynia

Mobility Aspect	Successes	Challenges
Transport behaviour	- Systematic monitoring of residents' transport behaviour;	- Increasing share of travel by private car;
	- Numerous mobility management activities targeted at the target groups: students and employees;	- High share of personal car for travel to/from work;
	- Consistent development of low-carbon public transport.	- An ageing population;
		- Proximity to the seaport and heavy freight traffic.
Mechanised journeys	The average daily number of mechanised journeys (excluding pedestrians) in Gdynia was 1.65 (1.57 in 2013).	
Purpose of journeys	Approximately 44% of non-foot journeys are home journeys, 23% are work journeys and almost 12% are for personal errands.	
Modal share	The majority of trips are made by car (58%, an increase of almost 5% compared to 2013).	The share of public transport in travel is steadily declining. Only less than 1% of non-foot journeys are made by bicycle.
		Among the working population, 55% declare that they always or mostly use a car for their commute.
Commuting	The most mobile group is the economically active and studying group, who make 2.35 trips/day (2.04 in 2013).	- Commuting to work and places of study is dominated by Gdynia.
	According to 2013 CSO data, the number of people working in Gdynia was 69.9 thousand, while the number of students was 32 thousand.	- Travel time to the workplace by public transport was almost twice as long as by car.
	Commuting to work and places of study is dominated by Gdynia, which accounts for 67.1% and 63% of total trips respectively.	
Modal split of students	According to additional surveys carried out in 2014 among students of Gdynia secondary schools:	Among pupils and students, 54.9% commute to their place of study in Gdynia. The vast majority (82.1%) always or mostly commute to/from their place of study by public transport.
	- Middle school students mainly used public transport for their urban journeys (79% of their journeys).	
	- Among high school students, 83% of their journeys were made using public transport.	
Individual motorisation	The number of passenger cars in Gdynia between 2009 and 2015 increased by 23% to 134,000 vehicles.	The individual motorisation rate increased from 440 to 542 passenger cars per 1,000 inhabitants.

3.1.5.2 Interventions planned in the SUMPs

Gdynia, a vibrant city in Poland, has been diligently working on its SUMP to address the challenges and opportunities related to urban mobility. The city's efforts have seen notable successes and identified key areas for improvement, all aimed at creating a more pedestrian and cycling-friendly environment, reducing emissions, and promoting sustainable transport choices. Gdynia's SUMP demonstrates a comprehensive approach to sustainable urban mobility, addressing various aspects of pedestrian management, parking, public transport, cycling infrastructure, and long-term scenario planning.

Table 12: Intervention areas of Gdynia's SUMP

Intervention Area	Key Highlights
Pedestrian Management	- Restriction of parking in central Kościuszki Square and Świętojańska Street for a safer pedestrian-friendly area.
	- Implementation of accessibility standards in public spaces and accessibility map and audit for people with reduced mobility.
	- Improvements in pedestrian infrastructure around schools and coastal areas to promote safety and active transportation.
Challenges	- Need for comprehensive pedestrian traffic studies to optimise movement.
	- Competition for limited space in the inner city, requiring thoughtful planning for pedestrians, cyclists, and motorists.
	- Necessity for traffic calming measures in the central part of the city.
Parking Management	- Implementation of a paid parking zone in the downtown area to manage demand.
	- Development of new cycle parking facilities and underground car parks.
Challenges	- Ongoing efforts to create alternative parking options outside the inner city, promoting park and ride (P+R) facilities.
	- Need to manage parking demand effectively and change parking habits.
Public Transport	- Zarząd Komunikacji Miejskiej (ZKM) operates a network of 85 bus lines covering 293.2 km.
	- Introduction of low-carbon strategies like CNG-powered buses to reduce environmental impact.
Challenges	- Focus on integrating public transport with non-motorised modes and implementing intelligent traffic management systems.
Cycling Infrastructure	- Offering 39 road sections with over 56.1 km of cycling paths and bicycle racks.
	- Plans to develop a coherent and safe cycling transport system, aiming for the 8/80 concept of accessibility and safety for all ages.
Challenges	- Need for better connectivity to ensure smooth and direct cycling connections.
Scenario Planning	- Forecasting urban mobility development through four scenarios, guiding mobility strategies from sustainable to unsustainable mobility.
	- Each scenario provides specific measures to achieve sustainable mobility goals.
Overall Approach and Vision	- Holistic approach prioritising pedestrian and cycling-friendly spaces, low-carbon and integrated public transport, and rational transport choices.
	- Aim to create a greener, safer, and more vibrant city while preserving the environment for future generations.

3.1.6 Sibenik

The coastal city of Šibenik, with its unique blend of historical charm and natural beauty, faces a critical juncture in managing its mobility and transportation infrastructure. As urbanisation and economic development surge, the need to address transportation challenges and embrace opportunities for sustainable mobility becomes paramount. This section delves into the current state of mobility in Šibenik, analysing its road infrastructure, non-motorised transportation options, parking system, bus transport infrastructure, and existing transportation demand and traffic flows.

3.1.6.1 Current mobility status

The analysis of the existing transportation demand and traffic flows has been done by utilising data derived from a calibrated traffic model developed within the Master Plan of Sustainable Urban Mobility of the City of Šibenik (2016).

In terms of modal split, Šibenik exhibited a distribution in 2019, with private cars being the dominant mode at 83%, followed by public transportation at 13%, and walking and cycling contributing 4% to the city's diverse mobility landscape.. Further analysis of the frequency of using different transportation modes revealed that within the Šibenik settlement, private cars remain the dominant mode, while local bus transportation, cycling, and taxi services are more commonly used compared to other surrounding urban settlements. In those areas, regional bus transportation plays a more significant role.

Table 13: Mobility Aspects of Sibenik

Mobility Aspect	Key Highlights
Transportation Modes	- Private cars dominate daily trips, accounting for 83% of journeys.
	- Local bus transportation, cycling, and taxi services are more common within Šibenik, while regional bus transport plays a significant role in surrounding areas.

Challenges	- High level of motorisation poses challenges for traffic management and sustainability efforts.
	- Need to promote alternative modes of transportation to reduce reliance on private cars.
Road Infrastructure and Transit Traffic	- Total road network length of 621.6 km, including highways, state roads, county roads, local roads, and unclassified roads.
	- Transit traffic from Adriatic Highway (state road D8) creates congestion in the urban fabric.
Challenges	- Consideration of innovative traffic management strategies and alternative routes for transit traffic.
Non-Motorised Transportation	- Pedestrian network spans approximately 177 km within the administrative area of Šibenik.
	- Lack of marked bike lanes, paths, or designated cycling roads, but introduction of bike-sharing system and electric scooters.
Challenges	- Enhancing pedestrian safety and connectivity, expanding cycling infrastructure to reduce traffic congestion and emissions.
Parking System	- Šibenik has 31 public parking lots with 2,071 parking spaces subject to charging.
	- Pricing varies by zone and time of year; recent addition of underground garage increased capacity in city center.
Strategies	- Consider creation of "park and ride" facilities to incentivise commuters to use public transport and reduce congestion in city center.
Bus Transport	- Šibenik's public bus transport network includes 107 bus stops, with 60% within the city.
	- Shortcomings include lack of proper markings, route numbers, schedules, and informative elements at bus stops.
Strategies	- Plans to install information displays at 17 locations to provide real-time bus schedule and arrival information.
	- Improving visual identity of public transport system to enhance attractiveness and efficiency.

Šibenik's transportation analysis highlights the need for promoting alternative transportation modes, improving road infrastructure and traffic management, enhancing non-motorised transportation options, and optimising the public transportation system to create a more sustainable and efficient urban mobility environment.

3.1.6.2 Interventions planned in the SUMPs

Šibenik's SUMP aims to address challenges related to transportation while enhancing the city's overall mobility. By prioritising equitable public transport, creating a people-centric urban space, advancing intermodal transport, and integrating intermodal transport and mobility management, Šibenik aims to create a sustainable and accessible urban mobility system. This comprehensive approach seeks to improve the quality of life for residents and promote Šibenik as a model city for sustainable urban mobility in the region. To do so, the plan sets forth four key objectives that form the cornerstones of Šibenik's mobility strategy.

Table 14: SUMP's objectives in Sibenik

Objective	Key Highlights
Objective 1: Equitable and Sustainable Urban Mobility for All Residents	- Focus on reducing reliance on private cars through public transport improvements.
	- Comprehensive revamp of public urban transport system, including management, development, and infrastructure.
	- Integration of various transport modes to enhance regional connectivity and social inclusion.
	- Establishment of intermodal transportation hubs (Crnica and Mandalina) to enable sustainable regional growth.
Objective 2: Creating a People-Centric Urban Space for Personal Mobility	- Integration of natural and built environments for people-centric living.
	- Traffic optimisation in historic core to improve flow and accessibility while preserving cultural heritage.
	- Creation of pedestrian zones near major attractions and optimising stationary traffic.
	- Preservation of the historic core's authenticity and significance for residents and visitors.
Objective 3: Advancing Intermodal Transport and Mobility Management	- Emphasis on intelligent transportation systems (ITS) for traffic optimisation and ecological balance.
	- Establishment of intermodal hubs (Crnica and Mandalina) to streamline transitions between transport modes.
	- Implementation of ITS solutions, including traffic management systems and real-time traveller information.
	- Integration of ITS with regional and national systems for adaptive and responsive transportation network.
Objective 4: Integration of	- Improvement of infrastructure and organisational capacities for freight traffic management.

Intermodal Transport and Mobility Management for Traffic and Goods	- Focus on optimising traffic organisation in the historic core to reduce congestion during peak tourist seasons.
	- Long-term mobility monitoring system to track traffic demand effectively and plan future intermodal solutions.

3.1.7 Heraklion

Heraklion, the largest city on the island of Crete, Greece, is facing significant mobility challenges due to its historical urban development characterised by sprawl, incohesive planning, and car dependency. While there have been improvements in the public transport system, the city still grapples with traffic congestion and air pollution.

3.1.7.1 Current mobility status

The urban environment of Heraklion presents unique challenges, such as narrow streets, limited parking spaces, and a sense of enclosure in existing neighbourhoods. These factors hinder the efficient flow of traffic and discourage sustainable mobility options.

Currently, the city is working to address these challenges and improve mobility through various measures. One of the main objectives is to promote walking as a viable mode of transportation. Initiatives include upgrading sidewalks, improving pedestrian crossings, and creating accessible bus and taxi stops. Efforts are also being made to enhance the pedestrian-cycling network, encouraging more people to use bicycles for short-distance trips.

Heraklion is also focusing on enhancing its public transport system thorough improving existing routes, installing new and accessible stops and stations, and integrating various modes of transport to enhance multimodality.

To reduce the impact of private vehicles on traffic congestion and pollution, Heraklion is working on implementing traffic management solutions. This involves establishing a traffic control center, installing variable message systems to inform drivers of speed limits and real-time network situations, and developing smart systems to manage short-term parking and prevent illegal parking.

Furthermore, the city is considering a shift towards clean vehicles to reduce greenhouse gas emissions and improve air quality. This includes gradually replacing municipal and public transport fleets with clean alternatives and developing an e-mobility charging network.

While these initiatives are underway, Heraklion still faces challenges in securing sufficient funding for some measures and gaining widespread public acceptance for certain changes. Nevertheless, the city is committed to improving its state of mobility to enhance the quality of life for its residents and create a more sustainable and accessible urban environment.

3.1.7.2 Initiatives contemplated in the SUMPs

Comprehensive packages of measures have been formulated as part of the city's SUMP, focusing on eight themes to address various aspects of transportation and urban mobility in the city. These packages encompass various strategies, infrastructure upgrades, incentives, and awareness campaigns to achieve the objectives of Heraklion's SUMP. The plan addresses both the city center and regional settlements within the municipality, tailoring mobility improvements to the unique needs and characteristics of each area. Overall, the plan reflects a comprehensive and forward-thinking approach to sustainable urban mobility, aiming to create a more efficient, environmentally friendly, and enjoyable transportation system in Heraklion.

Table 15: SUMP's objectives in Heraklion

SUMP's Packages	**Key Objectives and Measures**
1 Improvement of Traffic Conditions and Road Safety	- Enhance traffic flow and reduce congestion.
	- Implement smart traffic management systems.
	- Optimise road infrastructure for improved safety.
2 Promotion and Support of Sustainable Transportation	- Promote walking, cycling, and public transit.
	- Increase public transportation frequency and accessibility.
	- Establish dedicated cycling lanes.
	- Provide incentives for sustainable travel choices.
3 Upgrading the Quality of the Urban Environment	- Enhance public spaces and create green areas.
	- Reduce pollution through electric vehicles and cleaner transportation alternatives.
4 Rational Management of the Freight Transportation System	- Efficiently manage freight transportation to minimise disruptions and reduce environmental impacts.

5 Energy and Electrification	- Promote energy efficiency and electrification of transportation.
	- Encourage the use of electric vehicles and establish charging infrastructure.
6 Seasonal Management and Port Operation	- Effectively manage seasonal transportation demands.
	- Optimise port operations to accommodate increased visitor arrivals.
7 Management of Movements and Operation of N. Kazantzakis Airport Area	- Improve transportation connectivity to and from the airport.
	- Enhance passenger experience and reduce traffic congestion in surrounding areas.
8 Contribution of Sustainable Mobility to Tourism Activity	- Promote sustainable mobility options for tourists.
	- Offer eco-friendly tours, bike rentals, and pedestrian-friendly attractions.

3.1.8 Valladolid

Valladolid's mobility landscape is a dynamic and essential component of the city's urban fabric. While walking remains the predominant mode of transportation, there has been a slight decrease in its share, indicating potential changes in urban mobility and lifestyle choices

3.1.8.1 Current Mobility status

The growth experienced by the city of Valladolid in the last forty years has shaped a model of land use characterised by residential dispersion and spatial segregation from productive activities (employment). This phenomenon is well exemplified by industrial estates like San Cristóbal and Argales or residential developments such as Arca Real and Pinar de Jalón, as well as the growth of suburban areas like Arroyo de la Encomienda and Laguna de Duero, among others, functioning as bedroom communities.

This model has promoted a car-centric approach over public transportation and non-motorised travel when it comes to commuting between the city and its metropolitan surroundings, and more recently within the city itself, for movements from peripheral neighbourhoods and industrial estates. Consequently, significant disbenefits have emerged, including traffic congestion, increased accident rates, higher emission of pollutants, etc., leading to a decline in the quality and livability of urban areas.

Table 16: Mobility aspects of Valladolid

Mobility aspect	Key Findings and Analysis
Global Mobility and Evolution	- A shift in transportation modes was observed from 2001 to 2015, with a slight decrease in walking trips (54.8% to 52.9%), an increase in private vehicle use (27.8% to 30.0%), and a modest rise in public transport usage (12.7% to 13.1%).
Road Network and Parking	- Valladolid's road network varies, with narrow streets in the city center and newer areas having wider sidewalks and green spaces. Traffic restrictions, pedestrian zones, and sidewalk expansions have been implemented to improve pedestrian mobility. Efforts are ongoing to enhance mobility in the Historic Center. Pedestrian mobility is challenged by the Pisuerga River and railway tracks. Ongoing railway integration projects aim to address these barriers.
Public Collective Transport	- Valladolid's public urban transport network, operated by AUVASA, is extensive, with high stop coverage (72.04% within 150 meters and 97.33% within 300 meters of each bus stop). Passenger numbers showed a declining trend from 2007 to 2014, with work-related trips being the primary reason for using public transport. Adjustments to service frequency were introduced in the "Plan de Adecuación Horaria 2020" to improve the passenger experience.
Taxi Services	- No specific data is provided in this section.
Cycling Mobility	- Valladolid has an extensive bicycle lane network but lacks proper connections between lanes, leading to confusion among users and inconsistent signage. Private bicycles are the predominant mode of cycling (97.4% of trips). Gender differences exist, with more men using private bicycles and more women using public bicycles. Challenges include the lack of continuity in the bicycle network.
Pedestrian Mobility	- Efforts have been made to improve pedestrian mobility, including traffic restrictions, pedestrian-only zones, and sidewalk expansions. Challenges in pedestrian mobility include barriers created by the Pisuerga River and railway tracks. The railway integration project aims to address these barriers.
Road Safety	- No specific data on road safety is provided in this section.

3.1.8.2 Interventions planned in the SUMPs

The city's goals for sustainable mobility are included in the Comprehensive Sustainable and Safe Urban Mobility Plan for the City of Valladolid (PIMUSSVA) published in 2020. The overall objective of PIMUSSVA is to achieve a city model where citizens carry out their journeys in a sustainable and

safe manner. To achieve this ambitious goal, several specific objectives have been formulated to align with national and international mobility objectives.

Table 17: SUMP's objectives for Valladolid

Objective	Key Measures and Action Plans
Promote non-motorised travel	- Encourage walking and cycling to improve the quality of life and sustainability.
Increase public transport usage	- Adopt a multimodal approach to increase public transport's share in the modal split. - Reorganise the public transportation network to align it with current demand and mobility patterns.
Prioritise pedestrians in public spaces	- Prioritise pedestrians over cars to ensure equitable distribution of public space.
Encourage clean vehicles	- Promote clean vehicles to reduce emissions of air pollutants and greenhouse gases.
Enhance road safety	- Reduce accidents across all modes of transportation with the goal of zero accident victims.
Implement mobility management measures	- Encourage the preferential use of sustainable modes and efficient car use through integrated mobility planning and management.
Coordinate mobility policies with urban planning	- Integrate and coordinate mobility policies with urban planning to reduce travel distances and facilitate access to public transport and non-motorised mobility.
Improve journey design and realisation	- Align mode usage and trip planning with a competitive sustainable transport model known as Smart Mobility.

Below are listed measures and key action plans of Valladolid related to the above objectives.

Table 18: Key action plans of Valladolid

Actions	Expected outcome
Promote non-motorised travel	- Encourage walking and cycling to improve the quality of life and sustainability.
Increase public transport usage	- Adopt a multimodal approach to increase public transport's share in the modal split. - Reorganise the public transportation network to align it with current demand and mobility patterns.
Reorganisation of the Public Transportation Network	- Gather travel information through fieldwork, surveys, and active communication channels.
	- Analyze mobility habits and changes due to the COVID-19 pandemic.
	- Conduct new mobility surveys to understand the demand and needs of citizens.
	- Redesign the public transportation network to improve coverage, accessibility, and connection points.
Encourage clean vehicles	- Create pedestrian zones in city centers and peripheral neighbourhoods.
	- Enhance the quality of life for citizens and boost commercial activity.
	- Define pedestrianisable areas, develop pedestrianisation projects, and improve lighting in poorly lit areas to enhance safety.
Creation of a Pedestrian Itinerary Network	- Design pedestrian networks for habitual and leisure mobility.
	- Cover the mobility needs of Valladolid's citizens and prioritise pedestrian access.
	- Plan, develop, and implement pedestrian itineraries
Improvement of Permeability	- Reduce barrier effects caused by railway lines.
	- Enhance the Pisuerga River as an integrating area and city connector
	- Improve existing crossings and create new pedestrian and cyclist footbridges
Improvement of Universal Accessibility	- Ensure full access to urban spaces, goods, and services for all individuals.
	- Eliminate architectural barriers, install podotactile flooring for visually impaired individuals, and provide audio information panels at bus stops.

Through the implementation of these measures and action plans, Valladolid aims to achieve a sustainable and safe urban mobility model. The city seeks to promote non-motorised travel, increase public transport usage, prioritise pedestrians, encourage clean vehicles, enhance road safety, implement efficient mobility management, coordinate policies with urban planning, and improve journey design, ultimately improving the quality of life for its residents while addressing environmental and social challenges.

3.1.9 Barreiro

Barreiro is a municipality located in Portugal, covering an area of approximately 197.98 km^2, with a population of about 241,860 inhabitants, according to the 2011 Census figures. The municipality is

part of the Plano De Mobilidade E Transportes Intermunicipal (PMTI) intervention area, which includes adjoining areas of the municipalities of Moita, Palmela, Setúbal, Sesimbra, and Seixal.

3.1.9.1 Current Mobility Status

The study is organised into five phases, including start-up, characterisation and diagnosis, scenarios construction and strategy definition, action plans: proposals and intervention and investment programs, and finally, monitoring and evaluation. The objective of the study is to develop an intermunicipal mobility and transport plan for the area of influence of TTT (South Bank) through the operationalisation of multimodal and intermodal transport systems. The plan includes mobility and transport territorial action plans (PATMT) and mobility and transport local action plans (PALMT) to ensure an integrated approach to mobility planning. The following table summarises the parishes that are part of the PMTI intervention area.

Table 19: Characteristics and Key Data of Barreiro

Area/Population Unit	Characteristics	Key Data
Barreiro	Municipality in Portugal with a population of approximately 241,860 inhabitants (2011 Census).	- Total number of daily trips: 49,700 - Percentage of trips to and from Lisbon and IA: 11% - Percentage of trips made by public transport: 44% - Percentage of trips made for reasons other than work/study/on business: 28% - Population unit with the highest number of trips per person per day: Barreiro-Santo António da Charneca-Alhos Vedros and Moita - Population unit with the lowest number of trips per person per day: Coina-Palhais - Percentage of trips made for reasons other than work/study/on business in Alto do Seixalinho and Lavradio parishes: 35-37%
IA Population Units	Divided into seven Population Units (PUs) with different characteristics and mobility patterns.	- Total daily movements between IA and Lisbon: 49,700 - Total daily movements between IA and AML North (excluding Lisbon): 9,946 - Flows across the Tagus towards Lisbon and the North AML: 60,000 - Flows within South AML: 87,000 - Internal flows within IA: 264,000 - Population unit with the highest number of trips per person per day: Barreiro-Santo António da Charneca-Alhos Vedros and Moita - Population unit with the lowest number of trips per person per day: Coina-Palhais
Population Distribution and Demographics	Six areas of concentration of resident population, representing 91.6% of the total population of IA.	- 56% of the population is between 25-65 years old. - 26% are under 25 years old. - 18% are over 65 years old.
Mobility Patterns	Three main flow systems identified: flows across the Tagus towards Lisbon and the North, flows between IA and the southern edge of AML, and flows between three parishes in the catchment area of IA.	- Percentage of trips made by public transport: around 44% - Percentage of trips made for reasons other than work/study/on business: 28% - Key movements between IA and outside (AML): - Towards Lisbon and North AML: 60,000 trips/day - Within South AML: 87,000 trips/day - Internal flows within IA: 264,000 trips/day - Total daily movements between IA and Lisbon: 49,700 - Total daily movements between IA and AML North (excluding Lisbon): 9,946
Public Transport Usage	Variations in the percentage of public transport use among different Population Units (PUs).	- Percentage of Public Transport Use in Different Population Units: - Barreiro-Santo António da Charneca-Alhos Vedros: 46% - Seixal: 38% - Moita: 25% - Quinta do Anjo: 28% - Fernão Ferro: 30%

These data provide an overview of Barreiro's current mobility status and its IA, highlighting differences in public transport usage, population distribution, and mobility patterns among different areas and population units within the region. The information also underscores the importance of public transportation and the need for potential improvements, such as expanding urban-type services and considering fare integration between different modes of collective transport.

3.1.9.2 Interventions planned in SUMPs

The SUMPs for the Area of Influence (AI) of the Lisbon Metropolitan Area (AML) are comprehensive strategies designed to tackle the multifaceted mobility challenges faced by the region. To address these challenges, a wide array of interventions will be implemented, incorporating both short-term measures and long-term developments. These interventions aim to create a cohesive and

sustainable urban transportation system that caters to the needs of residents, businesses, and visitors while promoting environmental responsibility and social well-being.

Table 20 summarises the challenges faced by Barreiro and the proposed interventions to address these challenges in the context of Sustainable Urban Mobility Plans (SUMPs).

Table 20: Challenges and Interventions in Barreiro

Challenges and Interventions for Barreiro	**Proposed Interventions**
Challenge 1: Achieving a Balanced River Crossing	- Enhance cross-river public transport connectivity, including potential ferry service improvements and new river crossings. - Promote economic development in the southern bank to reduce commuting dependence on the northern bank.
Challenge 2: Promoting Territorial Integration	- Identify specialised economic zones and attract investments. - Optimise public transport routes to connect specialised areas efficiently. - Encourage mixed-use developments and strategically locate residential areas near economic centers and transport hubs.
Challenge 3: Evolving Accessibility Frameworks	- Develop a future-proof public transport network based on travel patterns and population growth projections. - Modernize and improve the reliability of existing public transport infrastructure. - Prioritise accessibility to major transport hubs for economic growth.
Challenge 4: Enhancing Accessibility to Workplaces and Services	- Expand public transport coverage to underserved areas within Barreiro. - Implement efficient park-and-ride facilities. - Promote bicycle use through cycling lanes and bike-sharing schemes. - Develop intermodal transport hubs for seamless transfers.
Challenge 5: Promoting Sustainable Mobility	- Prioritise pedestrians and cyclists by redesigning urban spaces, implementing traffic calming measures, and enhancing road safety. - Launch educational campaigns to raise awareness of sustainable mobility benefits. - Integrate micro-mobility solutions like e-scooters and bike-sharing systems for first and last-mile travel.

3.1.10 Zilina

Žilina is a city in northwestern Slovakia, known for its industrial and economic significance, with key sectors such as automotive, engineering, electronics, and IT. The city benefits from its strategic location near the borders with the Czech Republic and Poland, and it is well-connected by road and rail networks. Žilina has a rich cultural heritage with historical landmarks like the Church of the Holy Trinity and vibrant cultural institutions. The University of Žilina contributes to its educational landscape, and residents enjoy a good quality of life surrounded by picturesque landscapes, including the Lesser Fatra and Tatra mountains, providing recreational opportunities.

3.1.10.1 Current Mobility status

Žilina, Slovakia, is actively advancing its urban mobility to create a more efficient and sustainable transportation system. This includes improving public transportation, optimizing traffic management, and enhancing road infrastructure. The city is addressing challenges such as parking shortages and promoting non-motorized transport networks for pedestrian and bicycle mobility.

Table 21: Current Mobility Status in Zilina

Aspect of Mobility	Description
Public Transportation	Efforts in Žilina to improve public transportation include the deployment of low-floor buses and trolleybuses, constituting about 30% of the total fleet. Expansion plans are in place to increase their numbers and enhance bus stop infrastructure for passenger convenience and vehicle maintenance.
Traffic Management	Žilina has 17 intersections with traffic lights, but lacks a central traffic management system. To boost public transport efficiency, the city is implementing traffic prioritization technology at these intersections, reducing delays and optimizing passenger boarding.
Road Infrastructure	Žilina lacks higher-class roads like highways and expressways, but is considering dedicated lanes for public transport to improve speed and efficiency.
Parking and Non-Motorized Transport	Parking shortages and disorganized public parking lots are challenges faced by Žilina. The city is focusing on creating suitable non-motorized transport networks to encourage pedestrian and bicycle mobility for short-distance travel.

Traffic Surveys and Analysis	Traffic surveys and mobility analyses have been conducted to assess passenger volume, traffic patterns, and parking shortages. Data from the toll system revealed significant transit traffic in Žilina, aiding in decision-making for mobility improvements.
Pedestrian and Non-Motorized Roads	Pedestrian traffic plays a vital role, constituting 25% of all traffic in Žilina. The city aims to establish conditions conducive to pedestrian and non-motorized transport, including parallel pedestrian and bicycle roads, recognizing their importance for short-distance travel.

3.1.10.2 Interventions planned in SUMPs

In the context of Zilina's transportation infrastructure, several key implementations are being considered to address traffic and mobility challenges. The following table summarises the key transportation infrastructure plans and implementations in Žilina, including highway completion, ring road construction, dedicated lanes for public transport, railway junction Modernisation variants, and more.

Table 22: Transportation and Infrastructure Plans for Zilina

Transportation Infrastructure Plans for Žilina	**Key Implementations**
Highway Completion	- Completion of D1 and D3 highways to divert transit traffic away from the city center, reducing congestion and load on local roads.
Ring Road Construction	- Construction of the IV. ring road with interchange I/64, including the extension of 1. May Street and bus station relocation.
Dedicated Lanes for Public Transport	- Creation of dedicated lanes for public transport to enhance speed and competitiveness, with specific streets identified for these lanes.
Modernisation of Žilina Railway Junction	- Upgrading tracks, bridges, platforms, traction lines, signaling, and security equipment. - Transition to more efficient AC electric traction. - Reconstruction of Žilina railway station.
Variants for Railway Junction Modernisation	- Evaluation of variants, including zero variant (no Modernisation), green variant (120 km/h), orange variant (140 km/h), and purple variant (station buried underground).
Chosen Railway Modernisation Variant	- Selection of the green variant for Modernisation due to its technical benefits, feasibility, and cost-effectiveness.
Impact on City Objects and Spatial Plan Adjustment	- Relocation of establishment work, creation of barrier-free transfer junction at Žilina passenger station, and parking development concepts. - Differentiation between short-term and long-term parking. - Development of cycling routes and service equipment.
Water Transport Terminal (Vázská water route)	- Proposal for a transport terminal at the confluence of the Váh and Kysuca rivers. - Note: Water transport development potential is limited.

This table summarises the key transportation infrastructure plans and implementations in Žilina, including highway completion, ring road construction, dedicated lanes for public transport, railway junction Modernisation variants, and more.

3.1.11 Rouen

Nestled along the tranquil banks of the Seine River, Rouen stands as a historical gem and a testament to the resilience of urban evolution. As one of France's oldest cities, Rouen has witnessed the ebb and flow of time, its cobblestone streets echoing tales of medieval grandeur and modern aspirations. Among the myriad of challenges faced by contemporary cities, mobility has emerged as a defining factor in shaping urban life. In the context of Rouen, the city's mobility landscape has undergone a transformative journey, driven by an unwavering commitment to sustainable development and a vision for a more interconnected and efficient transportation system.

3.1.11.1 Current status mobility

The current status of mobility in Rouen is a reflection of its ongoing efforts to adapt to the evolving transportation landscape. Rouen's mobility ecosystem is a multifaceted network comprising various modes of transportation, all aimed at enhancing accessibility, reducing congestion, and promoting sustainable mobility options. In the following table, is presented the Rouen current transportation scheme:

Table 23: Current mobility transportations in Rouen

Public Transportation	TCAR operates 2 tramway lines, 4 Bus Rapid Transit (BHNS) lines, 24 bus lines (including 5 FAST lines), and 4 collective taxi lines, serving a total of 45 municipalities. In 2021, total network trips increased by 23.1% compared to 2020, despite a 9.9% decrease compared to the 2016-2021 period.
Rail System	Plans to upgrade rail infrastructure to accommodate growing demand, reduce bottlenecks, and improve rail connectivity, aiming to encourage train usage as a reliable and sustainable mode of transportation.
Interurban Lines	Focus on reducing journey times and increasing service frequency for departmental interurban lines to promote public transport usage, resulting in reduced traffic congestion and improved accessibility for commuters.
Decentralized Public Transport	Transitioning from a centralized to a more interconnected and decentralized public transport structure to enhance accessibility and offer seamless connections across the urban landscape, encouraging higher public transport ridership.
Tramway and TEOR Optimization	Measures to optimize capacity, improve efficiency, and address congestion during peak times for tramway and TEOR lines, including increased service frequency, infrastructure upgrades, and intelligent traffic management systems.
Integration of Transport & Urban Planning	Recognizing the importance of aligning transportation planning with broader urban development strategies to create a cohesive and harmonious urban environment that supports resident well-being and economic development.
Bike Sharing	In 2021, the city's bike-sharing service had 29 stations and saw a 6% decrease in rentals compared to 2020. The number of long-term subscribers significantly dropped by 59% in 2021, with shifts in age demographics. Rentals experienced fluctuations during the year, with notable increases in March, April, and May, while the summer months saw decreases. The most substantial traffic was observed on roads leading to the metropolitan core, with several points of high traffic and heavy truck traffic on specific routes.

Following the mobility status, Rouen has deployed several initiatives to achieve sustainable mobility objectives. Table 24 summarises the key mobility initiatives in Rouen, including the Low Emission Zone, financial support programs, the Mix laboratory, public transportation enhancements, and cycling infrastructure developments.

Table 24: Key mobility Initiatives in Rouen

Rouen's Mobility Initiatives	**Key Information**
Low Emission Zone for Mobility (ZFE-m)	- Covers 13 municipalities in Rouen Normandy. - Aims to reduce air pollution caused by road traffic and promote alternative transportation. - Restrictions on Crit'Air 4, 5, or NC vehicles. - Exemptions and financial support programs in place.
Financial Support Program	- Offers up to 4,000 euros (5,000 euros for ZFE-m residents) for vehicle retrofitting or replacement with green/Crit'Air 1 vehicles, electric bicycles, or cargo bikes. - Combines with state subsidies. - Aid program for Seine-Maritime residents working in the ZFE-m. - Partnerships for low-income households.
Mix - Laboratory of Innovative Mobilities	- Emerging from the "Rouen Normandie - Intelligent Mobilities for All" project. - Located in Rouen city center. - A living lab for future mobility solutions in Normandy. - Collaboration between researchers, entrepreneurs, institutions, and residents.
Public Transportation Enhancements	- Lovélo electric bicycle rental service expansion. - Covoit'ici carpooling lines connecting Rouen with Val-de-Reuil and Barentin. - 10% increase in services, expanded lines, improved frequencies, and operating hours for Astuce public transport network. - Transition to 100% renewable energy for buses. - Frozen public transport fares and free travel on Saturdays during air pollution alerts.
Cycling Infrastructure	- Construction of new cycle lane along Boulevard de l'Europe. - "Réseau Express Vélo" project aims to create over 200 kilometers of cycling infrastructure by 2026. - Development of various bike parking services.

3.1.11.2 Interventions planned in Rouen's SUMP

In light of the specific issues and opportunities outlined in the policy documents, the Rouen Normandy Metropolis has identified crucial areas that require targeted interventions and improvements in the transportation system, that will be tackled in coordination with the rest of the Normandy area. Mentioned opportunities can be found in Table 25

Table 25: Intervantions planned in the SUMP

Area	Description
Rail System Upgrade	The existing rail system faces structural constraints, particularly at the junctions and configuration of Rouen Rive Droite station. To meet growing demand and optimize operations, the metropolis plans to invest in upgrading rail infrastructure. This involves

	enhancing rail capacity, reducing bottlenecks, and improving overall rail connectivity to encourage residents to choose trains as a reliable and sustainable mode of transportation.
Interurban Line Enhancement	Departmental interurban lines, primarily serving schools, experience uncompetitive journey times. Recognizing their potential to connect communities and enhance regional mobility, the metropolis aims to reduce journey times and increase service frequency. By making these lines more attractive to passengers, the goal is to boost public transport usage, leading to reduced traffic congestion and improved accessibility for commuters.
Decentralized Public Transport	The urban public transport network currently operates centrally, limiting travel possibilities and potentially leading to suboptimal routing for passengers. To enhance accessibility and provide seamless connections across the urban landscape, the metropolis plans to transition towards a more interconnected and decentralized public transport structure. This approach aims to efficiently link various neighborhoods and urban centers, encouraging higher public transport ridership.
Tramway and TEOR Optimization	The tramway and TEOR lines experience high ridership but face saturation during peak times, resulting in congestion and potential delays. To address this challenge, the metropolis intends to optimize capacity and enhance the efficiency of these public transport modes. Measures include increasing service frequency, upgrading infrastructure, and implementing intelligent traffic management systems to improve their reliability and attractiveness.
Integration of Transport & Urban Planning	Recognizing the importance of aligning transportation planning with broader urban development strategies, the metropolis aims to consider the impact of transportation infrastructure on urban spaces. The goal is to ensure that transportation complements the overall vision for sustainable growth, creating a cohesive and harmonious urban environment where transportation choices support resident well-being and economic development.

In conclusion, the mobility plan of the Rouen Normandy Metropolis sets ambitious objectives and strategies to address current and future transportation challenges. Through sustainable urban development, improved accessibility, and enhanced intermodal connectivity, the metropolis aims to provide its residents with a transportation system that is efficient, environmentally responsible, and tailored to their diverse needs. By fostering economic growth, promoting sustainable energy use, and considering environmental and health impacts, the metropolis demonstrates its commitment to creating a more livable and prosperous urban environment for its citizens. With data-driven decision-making and collaboration between stakeholders, the metropolis is poised to realize its vision of a more connected, sustainable, and resilient transportation network for the future

3.2 Existing digital enablers in SPINE cities

This section aims to present the existing city-specific digital enablers related to mobility, encompassing various IT systems (e.g. operational platform, digital twin, etc) utilised to manage and support transport operations within the city and current transportation simulation models employed by the cities. These digital enablers will serve as valuable inputs for WP3, providing support for the implementation of the co-crated SPINE solutions and the development of modelling activities.

Table 26 and Table 27 present a comprehensive overview of the existing IT systems and transportation simulation models found in each city participating in the SPINE project. This information has been gathered through the questionnaire administered during WP1 and relevant interviews and workshops, ensuring a detailed and well-rounded understanding of the digital enablers in place within each city.

Table 26. Existing transportation simulation models in SPINE cities

Cities	Existing transport simulation models
Antwerp	Transportation models: macroscopic (VISUM) and microscopic (VISSIM) models
Bologna	PTV VISUM transportation macroscopic model for the entire metropolitan area from 2018.
Tallinn	PTV VISUM macroscopic transportation model from 2021 AIMSUN hybrid (macro- and mesoscopic) model
Las Palmas	A 4-step PTV VISUM macroscopic transportation model, based on data from mobile phones from 2021.
Gdynia	A 4-step macroscopic PTV VISUM transport model implemented within the TRISTAR system. Validation of the model was done in 2016. A 4-step mesoscopic SATURN transport model is also available in Gdynia. Validation of the model was done in 2016. Gdynia has also a microscopic VISSIM model which has available results obtained from the macro and mesoscopic model.
Sibenik	A multimodal traffic model in PTV VISUM from 2016 which is currently updated in the context of a study for the integration and organisation of PT
Heraklion	No relevant model
Valladolid	A 4-step PTV VISUM macroscopic transport simulation model

Barreiro	No relevant model
Zilina	A 4-step PTV VISUM macroscopic transport simulation model
Rouen	No relevant model

Table 27. Existing IT systems in SPINE cities

Cities	IT systems (platforms, apps, digital twin etc.)
Antwerp	- ACPaaS: Basic architecture used for all Antwerp's applications - NXTMobility Marketplace: Collection of platforms enabling data transfer, collection & integration - Meldingen: Platform to collect feedback and complaints from citizens - Data & Research: Gateway to get access to all data sources available - Stad in Cijfers: Dashboard and database with citywide data from surveys and other sources - M4 (MultiMobile Mobility Manager): Reporting & monitoring tool for shared mobility providers in Antwerp - Shared Live Data API Store: API-store that provides access to real-time data of the city or partners - GEVAS Centrale/MyCity centrale: Platform used for traffic lights management. - Marketplace Digipolis: Marketplace providing access to the various ACPaaS services
Bologna	-U.T.O.P.I.A. (Urban Traffic Optimisation by Integrated Automation): Traffic light control & regulation platform for analysis, planning, control & management of public & private mobility (e.g. optimisation of traffic light phases with sensors embedded in asphalt) - SIRIO: Electronic control of access to historic center/Low Transport Zones via cameras and sensors that are connected to the local police control center - RITA (rete integrata di telecontrollo degli accessi) checking pedestrian, semi-pedestrian zones and reserved (priority) lanes every day, 24/7 by detecting the transit of all vehicles. - SARA/SIRIO/RITA systems: Electronic control of access to priority lanes, pedestrian area and special LTZs - SIT Territorial Information System, includes vectorial cartography of the urban area; street graph; georeferencing of all traffic elements (traffic lights, inductive loops/ SPIRE, PMV, cameras). - STARS (sanzionamento transiti abusivi rosso semaforico): System for detecting and sanctioning of traffic violations involving red traffic lights, managed by the municipal police -SCOUT Sosta: Device installed on board the service vehicles of the local police for facilitating public transport (double-parking, parking at bus stops or fast lanes, etc.) and making the mobility of bicycles and pedestrians safe - Scout Speed: Device installed on board local police service vehicles for dynamic speed control on city roads to prevent dangerous driving behaviour - ARPAE monitoring stations: Monitoring of air quality in 3 stations in Bologna
Tallinn	- Real time traffic cameras: Platform that provides live stream of major intersections of the city - Public transport real time: Platform that monitors public transport in real time -Tallinn is in the implementation phase of a new Mobility as a Service (MaaS) system, which will start by August 2023. This MaaS cannot be listed as a SPINE solution for Tallinn since it is implemented as part of other initiatives of the city. However, data from the MaaS operation might be available for the project.
Las Palmas	No IT systems have been reported
Gdynia	- TRISTAR ITS: Road and Green Areas Management in Gdynia
Sibenik	- Parking application: Ticketing, reservation of parking spaces, overview of free parking spaces - Traffic flow management: Automatic ticketing system for public urban and suburban transport, which can also monitor costs and the use of passenger tickets in vehicles.
Heraklion	Developing an application which presents real time bus location
Valladolid	- Exploitation management system provided by AUVASA for the provision of real time bus information, bus time prediction, travel recording, information to street panels, buses and drivers management, reports, etc. - Traffic Management Central System, to check traffic conditions, manage incidents for traffic congestion, collect demand and usage data through various sensors and metering equipment distributed throughout the city.
Barreiro	-TCB – Mobilidade Coletiva (APP): Bus services which provide the users with real time information about bus arrival at stops nearby of the user current location, timetables, fares, routes and can be used as a journey planner.
Zilina	- INVIPO digital platform: Platform for integration of technologies, systems and services in the cities and on the roads.
Rouen	A MaaS transportation system is being developed. The system will be available at the beginning of 2024 by Cityway.

3.3 Digital media and communication channels

One of the key discussions with the cities considered the different communication channels that they use to interact with the citizens and provide visibility to their activities. In this line, SPINE project will take into consideration those channels to follow them, tag the entities in their communications and provide visibility to the SPINE publications make through those channels. A list of the social media accounts of the SPINE cities is provided in Annex III. This section focuses on the social media accounts of the cities' municipalities and public transport operators, which consist of 31 Facebook accounts, as presented in Table 28.

Table 28. Sample of the examined Facebook accounts.

Holder of social media account	Facebook account	Short names	City	Type[1]
Slim naar Antwerpen	Slim naar Antwerpen	ANTW_Mun	ANTW	M
De Lijn	De Lijn	ANTW_PuT_DL	ANTW	PT
NMBS	NMBS	ANTW_PuT_NMBS	ANTW	PT
Município Do Barreiro	Município Do Barreiro	BARR_Mun	BARR	M
TCB – Transportes Coletivos do Barreiro	Transportes Colectivos do Barreiro	BARR_PuT_TCB	BARR	PT
Carris Metropolitana	carris metropolitana	BARR_PuT_CM	BARR	PT
CP – Comboios de Portugal	CP - Comboios de Portugal	BARR_PuT_CP	BARR	PT
Fertagus	Fertagus - O Comboio da Ponte	BARR_PuT_Fer	BARR	PT
Comune di Bologna	Comune di Bologna	BOL_Mun	BOL	M
Servizio Ferroviario Metropolitano Bologna SFMBO	Città Metropolitana di Bologna	BOL_PuT_SFMBO	BOL	PT
TPER (Transporto Passeggeri Emilia-Romagna) (TPB-Bologna)	Tper Spa	BOL_PuT_TPER	BOL	PT
MEX – Marconi Express	MEX – Marconi Express	BOL_PuT_MEX	BOL	PT
City of Gdynia	Gdynia	GDYN_Mun	GDYN	M
Mobilna Gdynia	Mobilna Gdynia	GDYN_gen_MG	GDYN	PT
PKA company	Team Gdynia Pka	GDYN_PuT_PKA	GDYN	PT
PKP Szybka Kolej Miejska w Trójmieście	SKM Trójmiasto	GDYN_PuT_PKP	GDYN	PT
Municipality of heraklion	Δήμος Ηρακλείου - Municipality of Heraklion	HERA_Mun	HERA	M
Ayuntamiento de Las Palmas de Gran Canaria.	Ayuntamiento de Las Palmas de Gran Canaria.	PALM_Mun	PALM	M
GLOBAL	Guaguas Global	PALM_PuT_GLOBAL	PALM	PT
Guaguas Municipales	Guaguas Municipales	PALM_PuT_GM	PALM	PT
Métropole Rouen Normandie	Métropole Rouen Normandie	ROU_Mun	ROU	M
Réseau Astuce	Réseau Astuce	ROU_PuT_RA	ROU	PT
City of Sibenik	Grad Šibenik službene stranice	SBNK_Mun	SBNK	M
Gradski parking d.o.o. Šibenik	Gradski Parking Šibenik	SBNK_PuT_GS	SBNK	PT
City of Tallinn	City of Tallinn	TALL_Mun	TALL	M
Tallinna Linnatransport	Tallinna Linnatransport	TALL_PuT_TL	TALL	PT
Tallinn European Green Capital	Tallinn - Euroopa roheline pealinn 2023	TALL_gen_TEGC	TALL	N/A
Ayuntamiento de Valladolid	Ayuntamiento de Valladolid	VALL_Mun	VALL	M
AUVASA	Auvasa	VALL_PuT_AUVASA	VALL	PT

City of Zilina	Mesto Zilina	ZILI_Mun	ZILI	M
DPMZ	Dopravný podnik mesta Žiliny	ZILI_PuT_DPMZ	ZILI	PT
[1]M=Municipality, PT=Public transport operators				

The analysis of the above social media accounts is presented in the following section.

3.4 Existing data in SPINE cities

3.4.1 Collection of secondary data

As part of WP1, T1.1 collects all necessary, city-specific data from available secondary sources as well as conducting social-media data mining. The list of secondary data from the SPINE cities is included in Annex IV in a tabular format. It should be emphasized that the identification of the existing data sources is a continuous process which will be updated throughout the project based on the developments and the needs of the SPINE measures' implementation and modelling activities.

3.4.2 Social media data mining

This section presents the analysis conducted on the social media accounts of Table 28. The analysis was based on metrics related to followers (number, reactions, comments), total number of posts and average number of posts per month to understand the level of citizens' engagement. All public transport operators and authorities in each city were examined and a data-driven approach was followed to select the agencies and their social media activity.

The study collected information based on all posts that are publicly available via the official Facebook accounts of municipalities and public transport operators presented in Table 28. To determine the popularity and intensity of social media activity metrics such as the number of followers and reactions and number of posts were collected.

Table 29 summarises popularity metrics for 31 analysed accounts related to their social media presence from January 2022 to June 2023. It includes data on followers, total post reactions, total comments, and average reactions per post for each account in the SPINE cities.

- The social media account "CP – Comboios de Portugal" in Barreiro has the highest follower count at 259,000.
- Conversely, "PKA company" in Gdynia has the lowest number of followers with 1,100.
- "City of Gdynia" in Gdynia stands out with 157,084 total post reactions, indicating active public interest in municipal affairs and transportation services.
- "CP – Comboios de Portugal" in Barreiro has the most total comments with 18,932, showcasing strong interaction and communication with its followers.
- "Comune di Bologna" in Bologna boasts the highest average reactions per post at 230.97, suggesting excellent engagement with its audience.
- "Slim naar Antwerpen" in Antwerp has the lowest average reactions per post at 7.78, indicating potential for improved content and communication strategies.

These metrics offer valuable insights into the effectiveness of social media platforms in conveying information, promoting services, and engaging with the public within the SPINE cities.

Table 29. Popularity of Facebook accounts in SPINE cities

Holder of social media account	City	No. of followers	No. of post reactions	No. of comments	Average reactions /post
Slim naar Antwerpen	ANTW	10000	1462	337	7.78
De Lijn	ANTW	119000	36372	14012	98.04
NMBS	ANTW	59000	26889	9482	127.44
Município Do Barreiro	BARR	32000	26180	2372	58.05
TCB – Transportes Coletivos do Barreiro	BARR	13000	9527	1618	28.19
Carris Metropolitana	BARR	5800	2345	1672	45.10

CP – Comboios de Portugal	BARR	259000	101411	18932	228.92
Fertagus	BARR	32000	25632	4659	102.53
Comune di Bologna	BOL	155000	116178	7635	230.97
Servizio Ferroviario Metropolitano Bologna SFMBO	BOL	33000	14316	730	29.95
TPER (Transporto Passeggeri Emilia-Romagna) (TPB- Bologna)	BOL	10000	5880	1192	22.53
MEX – Marconi Express	BOL	9000	732	323	17.02
City of Gdynia	GDYN	172000	157084	4467	212.00
Mobilna Gdynia	GDYN	6500	726	350	13.96
PKA company	GDYN	1000	3863	896	27.79
PKP Szybka Kolej Miejska w Trójmieście	GDYN	21000	10254	1998	82.69
Municipality of Heraklion	HERA	27000	13083	1192	29.01
Ayuntamiento de Las Palmas de Gran Canaria.	PALM	43000	12993	1236	28.43
GLOBAL	PALM	12000	15729	3290	98.31
Guaguas Municipales	PALM	19000	15178	2604	56.63
Métropole Rouen Normandie	ROU	38000	23084	3438	26.81
Réseau Astuce	ROU	19000	6006	2323	28.07
City of Sibenik	SBNK	9000	14318	617	15.40
Gradski parking d.o.o. Šibenik	SBNK	2000	500	218	10.00
City of Tallinn	TALL	3200	5402	197	14.10
Tallinna Linnatransport	TALL	9300	28826	1529	145.59
Tallinn European Green Capital	TALL	2200	3029	73	9.23
Ayuntamiento de Valladolid	VALL	58000	10727	2494	29.47
AUVASA	VALL	1100	238	54	8.81
City of Zilina	ZILI	23000	52283	2046	111.00
DPMZ	ZILI	2100	2205	285	23.46
	Max	**259000**	**157084**	**18932**	**230.97**
	Min	**1000**	**238**	**54**	**7.78**

Table 30 includes the metrics of the 31 analyzed accounts that are related to the activity and their commitment. The table includes the total no. of posts, the average posts per day and the longest period without post. The social media account with the highest number of total posts is "City of Sibenik" in Sibenik with a total of 930 posts. This indicates a highly active and engaged account, consistently sharing content and updates with its audience. The regular posting frequency demonstrates a commitment to keeping the community informed and involved in municipal affairs and transportation services. The lowest number of total posts was recorded in the account of "AUVASA" in Valladolid, with only 27 posts. This suggests that the account may benefit from increasing its activity and content sharing to better engage with its audience and enhance its visibility.

In terms of average posts per day, "City of Zilina" in Zilina stands out with the highest average of 1.91 posts per day. This reflects a dynamic and proactive approach to social media, with frequent updates and interactions with followers. The "AUVASA" account has also the lowest value of average posts per day (0.0566/day). This further emphasises the potential for increased activity and communication to keep the audience engaged and informed about transportation services and activities in Valladolid.

In terms of average posts per day, the shortest period without a post is observed for "City of Zilina," with only 4 days without posting. This indicates a consistent and proactive approach to maintaining communication with the audience, contributing to a more engaged online community. The longest period without a post is observed for the "Ayuntamiento de Las Palmas de Gran Canaria" account in Las Palmas, which went 462 days without posting. This extended period of inactivity could have

implications for engagement and keeping the audience informed, indicating a potential opportunity for improvement in maintaining consistent communication with the followers.

Table 30. Activity and commitment of Facebook accounts

Holder of social media account	City	Total no. of posts	Average posts per day	Longest period without post
Slim naar Antwerpen	ANTW	188	0.34	14
De Lijn	ANTW	371	1.02	7
NMBS	ANTW	211	0.38	11
Município Do Barreiro	BARR	451	0.80	338
TCB – Transportes Coletivos do Barreiro	BARR	338	0.61	8
Carris Metropolitana	BARR	52	0.12	71
CP – Comboios de Portugal	BARR	443	0.81	5
Fertagus	BARR	250	0.45	10
Comune di Bologna	BOL	503	0.96	8
Servizio Ferroviario Metropolitano Bologna SFMBO	BOL	478	0.85	186
TPER (Transporto Passeggeri Emilia-Romagna) (TPB- Bologna)	BOL	261	0.47	27
MEX – Marconi Express	BOL	43	0.10	65
City of Gdynia	GDYN	741	1.31	386
Mobilna Gdynia	GDYN	52	0.10	85
PKA company	GDYN	139	0.28	29
PKP Szybka Kolej Miejska w Trójmieście	GDYN	124	0.22	38
Municipality of heraklion	HERA	451	0.80	318
Ayuntamiento de Las Palmas de Gran Canaria.	PALM	457	0.81	462
GLOBAL	PALM	160	0.29	25
Guaguas Municipales	PALM	268	0.48	15
Métropole Rouen Normandie	ROU	861	1.53	30
Réseau Astuce	ROU	214	0.38	27
City of Sibenik	SBNK	930	1.65	4
Gradski parking d.o.o. Šibenik	SBNK	50	0.10	95
City of Tallinn	TALL	383	0.68	6
Tallinna Linnatransport	TALL	198	0.36	12
Tallinn European Green Capital	TALL	328	0.66	36
Ayuntamiento de Valladolid	VALL	364	0.65	308
AUVASA	VALL	27	0.06	63
City of Zilina	ZILI	471	1.91	4
DPMZ	ZILI	94	0.17	28
	Max	**930**	**1.91**	**462**
	Min	**27**	**0.06**	**4**

The findings highlight the importance of regular and consistent communication on social media to engage with the audience effectively. Social media accounts that maintain a dynamic and proactive approach in sharing content and updates tend to have higher engagement and visibility among their followers. On the other hand, accounts with lower activity may have an opportunity to improve their online presence and enhance their audience's experience through more regular and informative posts.

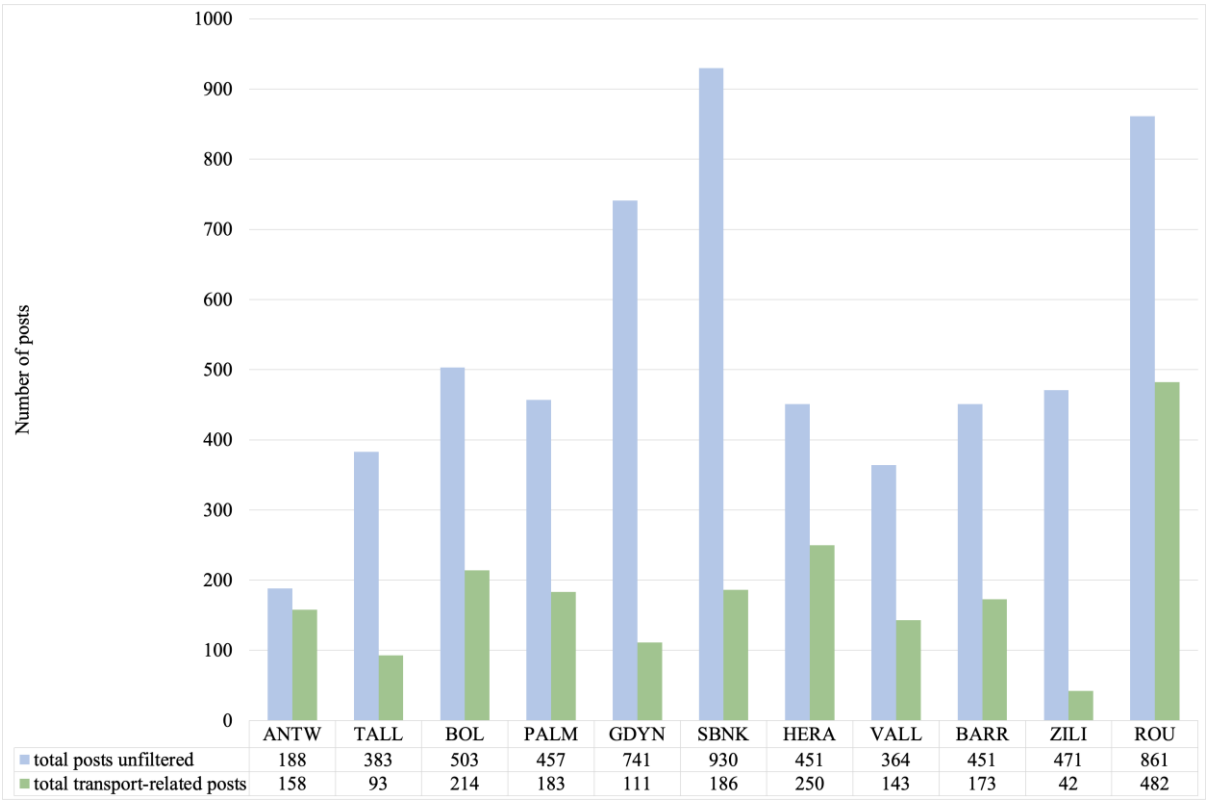
Additionally, an analysis of the content shared (from January 1, 2022 until the middle of July, 2023) on the Facebook accounts was followed (sentiment analysis). Facebook features such as uploaded

posts, user-composed comments under each post, as well as available posts and comment reactions were filtered based on transport-related keywords to analyse only the transport-related content of the respective social media accounts.

The extracted Facebook content underwent a two-step process using a Python-based middleware. First, using the Deep-translator library, texts of posts and comments were translated into English. Second, the data was cleansed by removing irrelevant elements such as blank texts or unextracted image comments. Post-translation, each post information was enhanced with the translated post and comment text in English. An advanced iterative process (coded in Python) was developed, as follows. This process scanned each post for each account. Then, for each post in the database, the script went through the transport-related keywords and applied keyword matching. If a keyword was detected within the content of the post, the post and all related fields were retailed. Otherwise, if no keyword was found, that post was skipped and the procedure proceeded to the next account until all posts to be processed.

Figure 3 shows the number of shared contents on Facebook's accounts of municipalities in the 11 SPINE cities. The blue color shows the total number of posts during the examined period, while the green color the number of posts with transport-related content after the filtering. Rouen leads the group with a substantial 861 total posts, of which 482 were filtered as transport related. This suggests a strong emphasis on the communication of transport-related issues for the municipality. On the contrary, Zilina, despite sharing a total of 471 posts, had the lowest transport-related posts at just 42. Antwerp has an impressively high percentage of transport content, with 158 out of 188 total posts being related to transport. This suggests that transport is a central theme of communication for the Antwerp municipality on Facebook. On the lower side, Tallinn, with 383 total posts, had just 93 related to transport. Similarly, Gdynia had 111 transport posts out of a significant 741 total posts, which might imply a diverse set of topics being communicated by the city.

These findings reveal significant variations on the emphasis placed by SPINE cities on transport-related communication on their official Facebook channels. Some cities prioritize transport-related information, reflecting its importance to their residents or the city's initiatives, while others maintain a diverse range of topics in their communications.



	ANTW	TALL	BOL	PALM	GDYN	SBNK	HERA	VALL	BARR	ZILI	ROU
total posts unfiltered	188	383	503	457	741	930	451	364	451	471	861
total transport-related posts	158	93	214	183	111	186	250	143	173	42	482

Figure 3. Total posts vs. transport-related posts shared on Facebook accounts of the 11 SPINE municipalities

Upon reviewing the filtered data, users' reactions to the Facebook transport-related content were analysed. As indicated in Figure 4 the SPINE cities elicit diverse reactions from their audience. Barreiro, for instance, shows a significant number of 'likes' for its public transport Facebook page labeled as 'BARR_PuT_CP' with 83,421 likes, which is the highest in the dataset. On the other hand, Valladolid's 'VALL_PuT_AUVASA' account recorded the lowest engagement with just 76 likes. These numbers highlight differences in the effectiveness of the organisations' social media

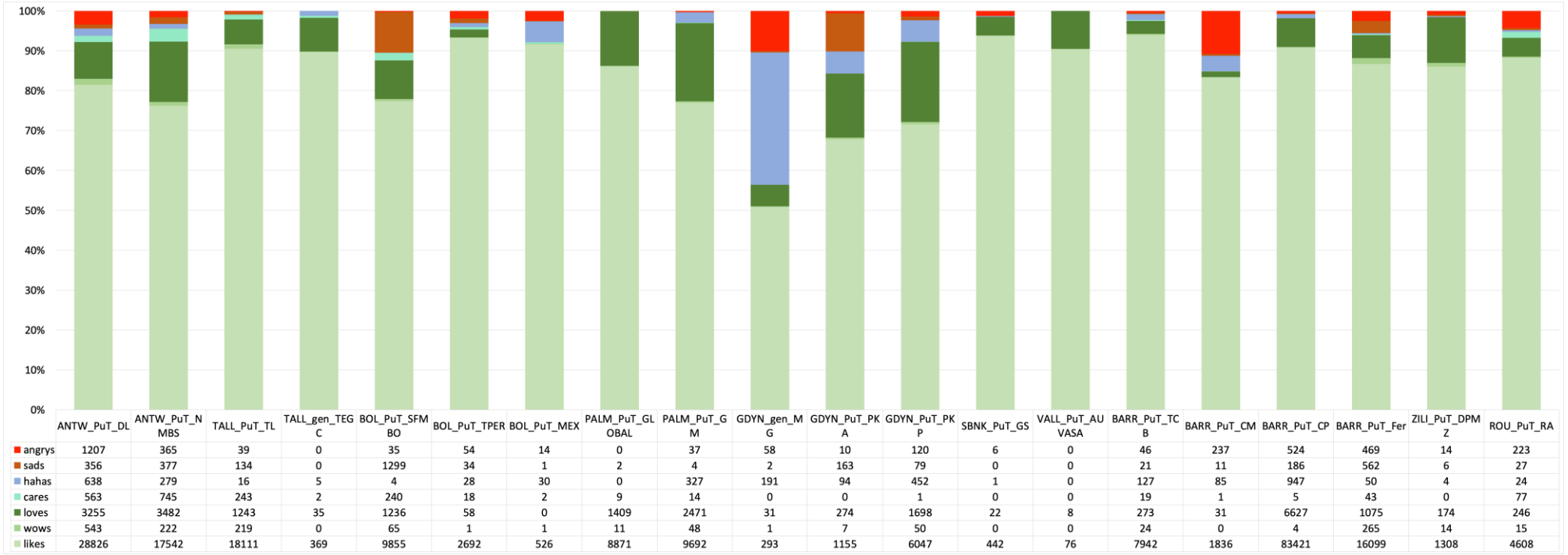
strategies or perhaps the sentiments of the local population towards the respective transport systems.

Taking 'sads' and 'angrys' as indicators of dissatisfaction, Bologna's municipal account registers 3,052 and 416 respectively, indicating potential transport-related concerns in the city. In contrast, Sibenik, with its main municipal account, registers low numbers in these categories. This suggests fewer concerns/complaints and it should not be attributed to low engagement, as the audience's reaction metrics do not display low levels.

Notably, Heraklion lacks a Facebook account for public transport. This observation is noteworthy because social media platforms, especially Facebook, serve as key communication channels in the modern age. The absence suggests potential untapped opportunities for gathering feedback, addressing concerns, and promoting public transport initiatives within the city.

In the same city, we can observe significant variations in user engagement across different Facebook accounts. Taking Antwerp as an example, while 'ANTW_Mun' has 1,078 likes, 'ANTW_PuT_DL' records a significantly higher count of 28,826 likes. This divergence indicates that various departments or facets of the city's transportation system may resonate differently with the public.

In essence, the findings offer rich insights into public sentiment towards transport across cities, with clear indicators of where improvements might be necessary. The variability across different Facebook accounts within the same city also underscores the importance of holistic and coordinated social media strategies to effectively communicate and engage with the public.



	ANTW_PuT_DL	ANTW_PuT_NMBS	TALL_PuT_TL	TALL_gen_TEGC	BOL_PuT_SFMBO	BOL_PuT_TPER	BOL_PuT_MEX	PALM_PuT_GLOBAL	PALM_PuT_GM	GDYN_gen_MG	GDYN_PuT_PKA	GDYN_PuT_PKP	SBNK_PuT_GS	VALL_PuT_AUVASA	BARR_PuT_TCB	BARR_PuT_CM	BARR_PuT_CP	BARR_PuT_Fer	ZILI_PuT_DPMZ	ROU_PuT_RA
angrys	1207	365	39	0	35	54	14	0	37	58	10	120	6	0	46	237	524	469	14	223
sads	356	377	134	0	1299	34	1	2	4	2	163	79	0	0	21	11	186	562	6	27
hahas	638	279	16	5	4	28	30	0	327	191	94	452	1	0	127	85	947	50	4	24
cares	563	745	243	2	240	18	2	9	14	0	0	1	0	0	19	1	5	43	0	77
loves	3255	3482	1243	35	1236	58	0	1409	2471	31	274	1698	22	8	273	31	6627	1075	174	246
wows	543	222	219	0	65	1	1	11	48	1	7	50	0	0	24	0	4	265	14	15
likes	28826	17542	18111	369	9855	2692	526	8871	9692	293	1155	6047	442	76	7942	1836	83421	16099	1308	4608

Figure 4. Percentage and number of user reactions to transport-related content

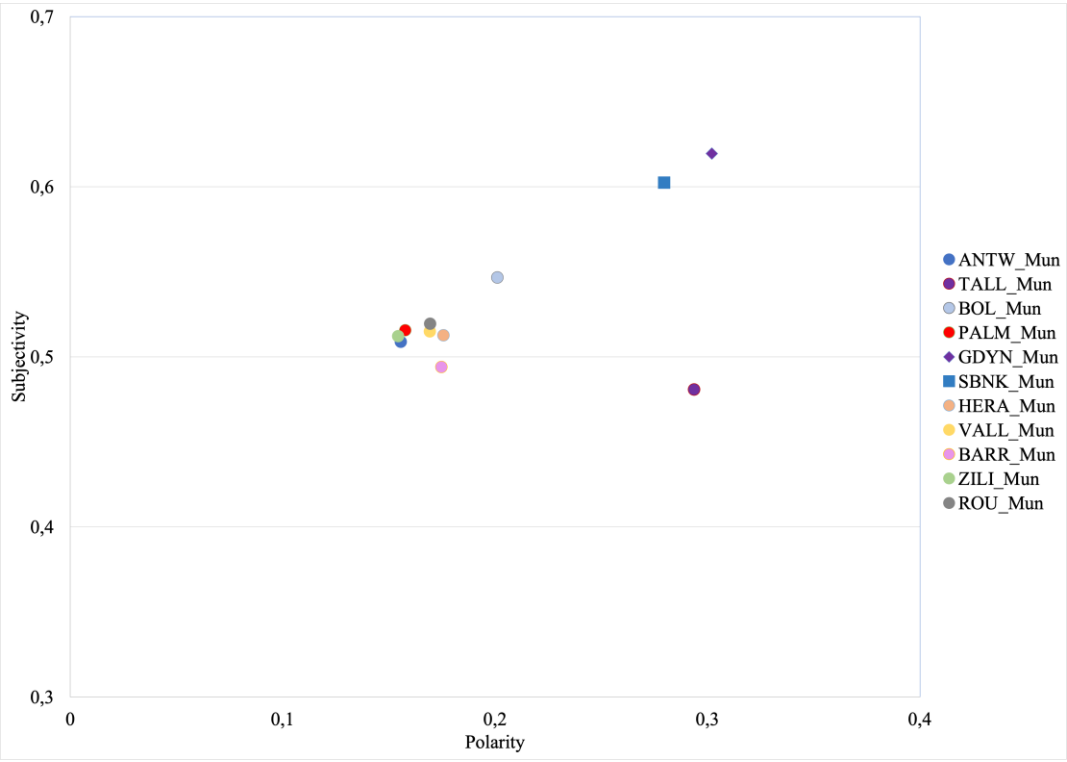
Utilizing the SpaCy ecosystem, which employs machine learning linguistic models, the 'spacytextblob' pipeline (https://spacytextblob.netlify.app/) for sentiment analysis of the text was applied. This pipeline leverages the linguistic model loaded into SpaCy to identify specific words or word patterns, thereby extracting emotional information about polarity and subjectivity. The explanation of the metrics is given below:

- Average polarity per organisation: metric that describes the average emotional polarity of all comments across all posts on an organisation's timeline. Polarity ranges from -1 to 1. If this value is greater than zero, then the average sentiment is positive. On the other hand, if the value is less than zero, the average emotions are negative.
- Average subjectivity per organisation: this metric shows the subjectiveness of all comments across all posts on an organisation's timeline on average. The greater this value is, the more subjective the comment text is (i.e., subjectivity > 0).
- Average polarity per post: this metric indicates the average emotional polarity of all comments under each post.
- Average subjectivity per post: this metric indicates the subjectiveness of all comments under each post on average.

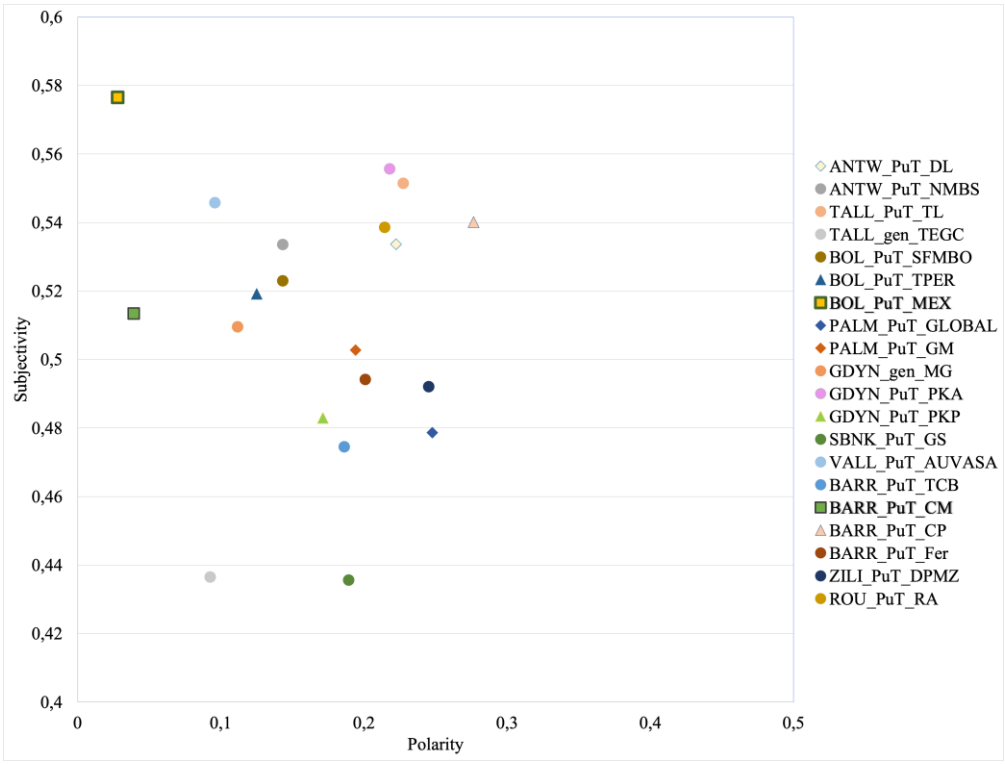
Once the above metrics were defined based on the comments under each organisations' posts, the sentimentally evaluated data were visualized.

Figure 5 presents the average sentiment analysis of the examined Facebook accounts in relation to the comments under each organisation's transport-related posts. Specifically, Figure 5a includes the municipalities' Facebook accounts, while Figure 5b refers to public transport Facebook accounts. It is worth noting that all organisations have positive emotional polarity, while in most of these cases, the comments written by Facebook users are quite subjective, which is quite normal as users are writing their personal experiences or reviews.

Figure 5a shows that in the accounts of Gdynia, Tallinn and Sibenik municipalities the posts' comments are more positive and less neutral compared to comments of the rest municipalities. Regarding the public-transport Facebook accounts (Figure 5b.), in the Metropolitan Rails in Barreiro (Carris Metropolitana with the short name BARR_PuT_CM) and Marconi Express in Bologna (MEX – Marconi Express with the short name BOL_PuT_MEX) Facebook users' comments could be characterised as more sentimentally neutral as can be noticed on the left side of the sparse diagram reaching almost zero on the polarity axis.



(a)



(b)

Figure 5. Average sentiment analysis for (a) municipalities' and (b) public transport Facebook accounts

The following figures represent the average emotional arrangement of Facebook users' comments under each post of the analysed organisations. Indicative graphs are included in this section, while the respective graphs for all the analyzed Facebook accounts can be found in Annex V. Figure 6 illustrates the average emotional analysis of comments written by users for each post on the public Facebook pages related to the city of Rouen. Regarding the account of the Municipality of Rouen (Figure 6a), most of those posts include comments, which were written with positive feelings (polarity greater than zero). However, several post comments can betray the 'not so happy' state of the authors during their composition. The Réseau Astuce account, the account of the PT operator in the city of Rouen, shows a positive reaction to the shared post. Only in few posts, the followers expressed negativity.

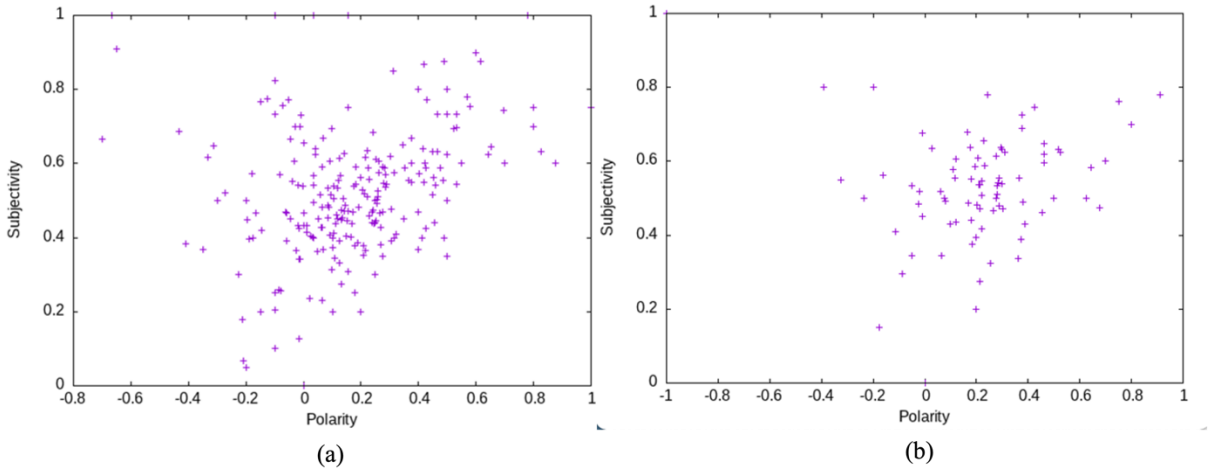


Figure 6. Average comment sentiment analysis per post for Rouen Facebook accounts (a) Métropole Rouen Normandie (ROU_Mun) (b) Réseau Astuce (ROU_PuT_RA)

Figure 7 shows the average sentiment analysis of comments written by users under each post on the public Facebook pages related to the city of Bologna. Figure 7a refers to the Facebook account of Bologna's municipality. Most of those posts include comments, which were written with positive feelings (polarity greater than zero). However, this is not the case for Transporto Passeggeri Emilia-

Romagna, the account of public company that oversees public transportation in the Metropolitan City of Bologna. Several post comments show the followers' neutral (around zero) or negative (less than zero) state for the shared content.

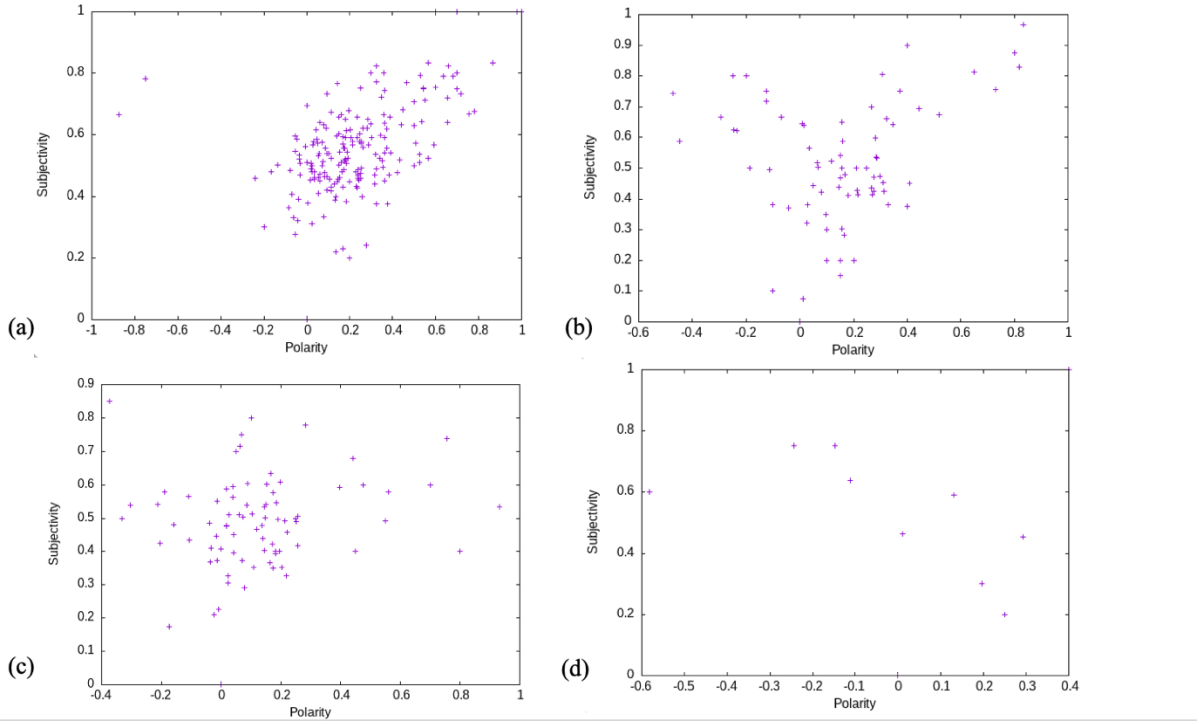


Figure 7. Average comment sentiment analysis per post for Bologna Facebook accounts (a) Comune di Bologna (BOL_Mun) (b) Servizio Ferroviario Metropolitano Bologna SFMBO (BOL_PuT_SFMBO) (c) TPER (Transporto Passeggeri Emilia-Romagna) (TPB- Bologna) BOL_PuT_TPER (d) MEX – Marconi Express (BOL_PuT_MEX)

3.5 Experience of SPINE cities in co-creation activities

This section presents the SPINE cities' previous experience working with co-creation. As we can see in Table 31, almost all SPINE cities have been engaged in co-creation activities in the past including participants across different groups (MSPs, public bodies, private companies, end users) and demographics (citizens/locals, tourists).

Table 31. Previous experience of SPINE cities in co-creation

City	Number of co-creation activities/projects	Number of participants	Type of participants
Antwerp	13 co-creation activities (since 2019) *these projects were carried out in cities like Antwerp, Dublin, and Manchester*	Over 800 participants	MSPs, public players, end users
Bologna	3 co-creation projects (since 2016)	Up to 6000 participants	Citizens of different locations of the municipality, the metropolitan city, institutional MSPs
Tallinn	1 co-creation activity (since 2019)	15 participants	Citizens, private companies, different municipalities
Las Palmas	2 co-creation project (since 2019)	Over 80 participants	Participants covering different demographics including citizens of different locations of the municipality
Gdynia	5 co-creation projects (since 2012)	Over 10000 participants	Citizens of each location, delivery companies, entrepreneurs, and commuters, which has covered the main city centers
Šibenik	5 co-creation project activities (since 2015)	Over 200 participants	Citizens and tourists

Heraklion	4 projects that included co-creation activities such as co-creation workshops, citizen engagement activities, involvement of community of practices, and citylab activities (since 2014)		Citizens and commuters of the city
Valladolid	3 co-creation activities such as workshops, LL, and learning community (since 2018)	At least 5 participants in each learning cycle	Citizens in the identified cities as well as local companies
Barreiro	*Barreiro LL has not been engaged in any co-creation activities in the past.*		
Zilina	2 co-creation activities such as working groups and workshops (since 2018)	40 participants	Politicians, stakeholders, private partners, and targeted field experts respective to each co-creation activity
Rouen	1 co-creation project (since 2022)	20 participants	Mobility providers and service providers, public players, and several end users

4 Initial basket of SPINE solutions

4.1 Description and mapping of SPINE solutions

A key focus of WP1 involves the identification of the initial basket of SPINE solutions and their mapping to the specific SPINE cities. This basket of solutions will serve as the foundation for WP2 and WP4, as they will be presented during the early stages of the co-creation process with the Living Labs (LLs) and the twinning cities. The GA provided the starting point for each city's solutions, while the questionnaire and the additional interviews and workshops with the cities helped us re-define the solutions to better align with the individual city's objectives, goals, and aspirations for achieving climate neutrality. However, we should emphasise that the final SPINE measures will be further refined in each city through the co-creation and twinning activities (for Lead and twinning cities respectively) carried out as part of WP2 and WP4 respectively.

A primary emphasis was placed on bolstering Public Transport (PT) systems through intelligent integration with new mobility services, ensuring a synergistic approach to sustainable urban mobility tailored to each city's unique requirements. Table 32 presents the initial basket of SPINE solutions and their mapping to the cities, as identified through the questionnaire and the interviews and workshops with the cities. As can be seen, our solutions include both push and pull soft measures.

Table 32. Initial basket of solutions and their mapping to SPINE cities

Measures	Pull/Push	Cities										
		Antwerp	*Bologna*	*Tallin*	*Las Palmas*	*Gdynia*	*Šibenik*	*Heraklion*	*Valladolid*	*Barreiro*	*Zilina*	*Rouen*
MS1: Multimodal hubs	***Pull***	✓	✓	✓	✓	✓	✓		✓			
MS2: Real-time information for passengers	***Pull***	✓									✓	
MS3: Multimodal journey planner app	***Pull***	✓						✓			✓	
MS4: EV charging stations	***Pull***		✓				✓					
MS5: Inclusive mobility services	***Pull***		✓			✓						
MS6: MaaS	***Pull***		✓				✓			✓		✓
MS7: LEZ (Low Emission Zone)	***Pull***		✓		✓							
MS8: Smart City Platform	-		✓	✓				✓			✓	
MS9: Citizen Mobility App / Micro-incentives programme	***Pull***		✓	✓			✓		✓	✓		
MS10: Logistics solutions	***Pull***		✓									
MS11: Cargo-bikes renting service	***Pull***			✓					✓			
MS12: Smart park and Ride management	***Push***			✓		✓			✓	✓	✓	
MS13: Traffic Management / PT prioritization services	***Push***	✓	✓	✓	✓	✓			✓		✓	
MS14: Mobility Management Software feature extension	-				✓							
MS15: On-demand mobility service	***Pull***							✓	✓			
MS16: Bus Passengers Analytics	-									✓		
MS17: Cargo hitching	***Pull***							✓				
MS18: Intersection Camera Recognition/ Dashboard for real-time traffic data	-										✓	
MS19: Environmental Sensors	-			✓								

The following paragraphs present each measure that will be implemented within SPINE. In each measure, its definition is provided, along with a short description of the actions to be held within the considered cities is given. In addition, competing solutions and products that are already available on the market are mentioned where applicable (e.g., MaaS, citizen app, etc.).

4.1.1 MS1 - Multimodal hubs

Multimodal mobility hubs provide a smart point in the transport network that seamlessly integrate different modes of transport. By combining and integrating public or collective transport stations and services, car-sharing parking spaces, bike-sharing docks, EV-charging stations, or public cargo bike-sharing platforms, multimodal hubs can play an important role in the transition towards zero-emission urban mobility.

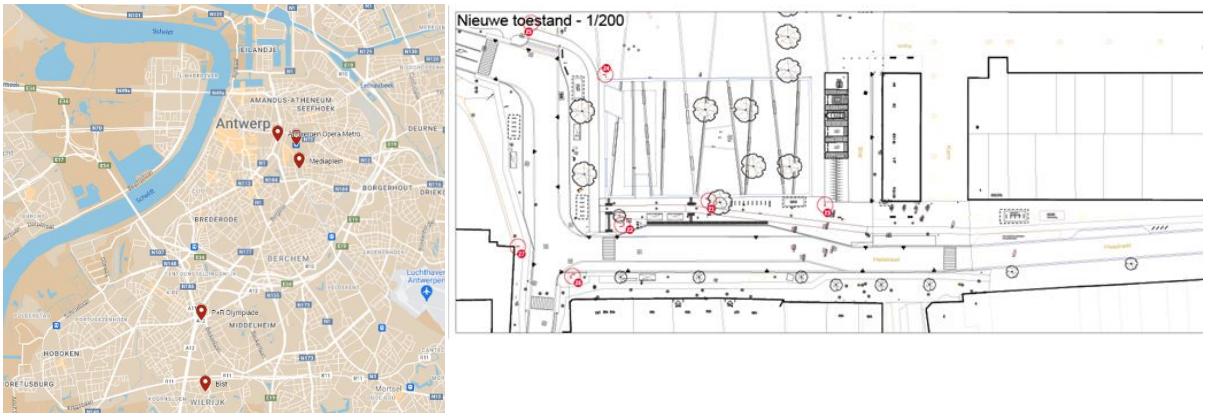
Mobility within multimodal hubs in SPINE project, will demonstrate the seamless integration of PT with multiple mobility services and offer spaces and physical facilities to improve the overall accessibility and traveller experience. The implementation of multimodal hubs in SPINE will include:

1) Accessible real-time information to passengers regarding the availability of mobility services, the location of the respective vehicles (bus, trolleys, etc.), departure times, waiting times, proactively explaining unexpected delays, etc. In most cases, this information will be presented to the passengers through interactive screens installed in the multimodal hubs.

2) Efficient color markings to improve wayfinding (marking around public transport stops, bike-sharing, and hubs).
3) Passenger crowding, where information regarding the number of passengers (or passenger load factor) in each carriage of a train/metro/tram will be provided to the passengers waiting at the next station(s). This information will be given through interactive screens located at designated positions of the platform so that the passengers decide the right place to stand on and avoid over-crowded carriages.

More details on the specification of the multimodal hubs in the SPINE cities are provided below.

MS1 – Antwerp: Currently there are 5 multimodal hubs in the city of Antwerp. The city will further develop and improve the five mobility hubs within the SPINE project. These hubs are key nodes in the mobility network of Antwerp and its functional urban area. The multimodal hubs are: Bist, Operaplein, Olympiade, Mediaplein and Centraal Station, and their locations are presented in Figure 8(a).



(a) (b)

Figure 8: (a) Locations of the multimodal hubs in Antwerp, (b) Plan of interventions in multimodal hub of Bist

Improvements to be held through SPINE project are related to wayfinding, digital signs and improvements in real-time data. For each location, a redesign is done for the surrounding space. Based on this redesign, wayfinding locations are defined based on the existing infrastructure. An example of such a plan can be found in Figure 8(b).

MS1 – Bologna: SPINE will focus on the implementation of collaborative mobility in the following multimodal hubs, located in the urban area of the city (within 5-6 kms from the historical center of the city): 1) Mazzini area, 2) Casteldebole in the western part of the city and/or 3) Corticella in the northern periphery.

The first hub in Mazzini area, has a potential demand of 30,000 pedestrians and 85,000 cyclists. Currently, various mobility services are operating, including train (local and inter-regional/regional and long-distance) with ticketing and information services, bus lines, free-floating bike-sharing and car-sharing and 1 electric vehicle charging station within 250 metres from the train station, bicycle paths and parking space are also available. For the second (Casteldebole) and third (Corticella) multimodal hubs, potential demand is expected to be 5,000 and 10,000 for pedestrians, and 20,000 and 30,000 for cyclists respectively. Currently, various mobility services are provided (such as bus, train, free-floating bike-sharing, car sharing (service area extended in May 2023). In addition, EV charging stations are currently available within 250 metres from the train station, while the tram will become operational in 2027. Casteldebole presents good cycling accessibility with well-connected cycle paths crossing the railway (tunnel).

The aim of the city of Bologna within SPINE project is to integrate offered mobility services and equip multimodal hubs with innovative and inclusive facilities to improve passengers' experience and satisfaction such as (a) on-site interactive screens as well as speakers and braille displays to provide real-time information to passengers regarding arrivals, delays, crowding of buses and train carriages; (b) deployment of efficient color markings; (c) digital signages at the hubs to inform and entertain passengers while waiting.

MS1 – Tallinn: In Tallinn, SPINE will enhance one multimodal hub, with the installation of two-sided screens at the center of the hub to showcase all available mobility services, such as e-scooters, shared cars, and public transportation options. The screens will prominently display QR-Codes to enable users to download the city's MaaS app conveniently. To achieve this, the city will collaborate with private companies since it does not own the land where the hub will be established.

MS1 - Las Palmas: Within SPINE, Las Palmas will improve 3 bus stations ("7 Palmas", "La Ballena" and "Auditorio") to improve user experience and promote multimodality. The station "Auditorio" is a terminal stop while the other two are in the upper city, where accessibility is poorer and thus micromobility (e-bikes) will play a significant role. In the multimodal hubs, multimodality will be promoted with the provision of other mobility services than the bus, including bike-sharing, scooters and taxi in some cases. The implementation of the multimodal hubs will include: 1) implementation of wayfinding (color marking on the floor or bus stops) and signaling to facilitate the modal change or bus change, 2) installation of digital screens (for real time information, integrating the existing solutions for blind people, for information regarding the other transport modes available in the hub, for the publication of air quality parameters, etc.).

MS1 – Gdynia: In SPINE, Gdynia will focus on establishing one multimodal hub within the central district, where PT mobility will be integrated and synchronised with other mobility services (Bike & Ride, Park & Ride). This integration and synchronisation of services aim to optimise urban mobility, allowing bikes and cars to serve as convenient first/last mile options for travellers, while PT covers the main segment of their trips. As part of this measure, digital signages for infotainment and ads will be installed.

MS1 – Sibenik: The aim of the city of Sibenik within the SPINE project is to establish multimodality among land and sea transport. SPINE will enhance the "intermodal point" that has already been developed at the port of Šibenik to transform it into a smart multimodal hub for collaborative and integrated mobility among bus, rail, bike-sharing, and parking services (the stations the above mobility services are located within 500m distance). SPINE interventions will include adaptations to the physical infrastructure (interactive kiosks, and solutions for vulnerable and functionally disabled groups, incorporation of electric vehicles) as well as improvement of the digital infrastructure to enable the synchronisation of the existing mobility services (i.e., real-time passenger information, ticket integration).

MS1 – Valladolid: SPINE's improvements to the multimodal hub will extend mobility services within the city center and Valladolid urban area. These will include: 1) the deployment of a new cargo bike-rental system (see also MS17) designed for parcel delivery services, 2) Study and implementation of integrated ticketing, enabling travellers to use multiple modes of transport with a single ticket, and 3) Enhancement of the planning algorithm utilising comprehensive public transport information for continuous improvement and optimisation.

4.1.2 MS2 - Real-time information for passengers

Real-time passenger information systems for PT provide accurate departure and arrival times, as well as timely updates on service disruptions and potential delays enabling passengers to plan their journeys and use their time efficiently. The ultimate goal of this measure is to increase PT usage by offering customers a better-quality service. Within SPINE, MS2 will be implemented in Antwerp and Zilina, with the aim to increase the PT quality and passengers' comfort during their door-to-door journeys. By creating an improved travel experience, the measure aims to encourage traveller s to adopt sustainable multimodal mobility services, fostering a positive shift in their travel habits while also enhancing their satisfaction with PT usage.

In Antwerp, real-time information (e.g. updated PT information, crowding monitoring, route planners etc.) will be displayed on the digital screens of the multimodal hubs, (see also Section 4.1.1 for MS1) as well as integrated into the mobility apps. As for Zilina, the real-time data will be showcased on digital screens that will be installed in public shopping malls maximising PT visibility and reach among the commuting public. Finally, the real-time data will feed into the Smart City Platform, contributing to the city's broader mobility and urban planning efforts.

4.1.3 MS3 - Multimodal journey planner app

The multimodal journey planner proposed in SPINE project is an integrated, dynamic journey planner which provides the passenger with real-time and scheduled information for several mobility services (PT, sharing modes, micromobility, etc.) incorporating multimodal routing and optimal travel planning. Utilising dynamic vehicle routing for on-demand mobility and real-time traffic information, the journey planner ensures that users can decide for their travel routes, while it creates a seamless and efficient mobility service, optimising the travel process. The planner responds to user requests for a route by presenting a list of available routes, taking into account factors such as the fastest, cheapest, or more suitable options. As indicated in Table 32, this solution will be implemented in Antwerp, Heraklion, and Zilina as described below:

MS3 – Antwerp: Currently a functional route planner with navigational support is available in Antwerp. Within SPINE, the main aim is to integrate real-time data into SPINE's multimodal journey planner app so that travellers have up-to-date and reliable information for scheduling their journeys.

MS3 – Heraklion: The multimodal journey planner will cover the whole city of Heraklion and will integrate buses, a minibus service located within 3 P+R locations, bike stations, taxi stations and a parking system.

MS3 – Zilina: Žilina has several other mobility apps for public transport and bike sharing. The aim of SPINE is to combine the available apps and features in one working solution as a multimodal journey planner, which can be linked and accessed from the existing smart city platform INVIPO. Curated information about PT solutions, rental bikes, or walking possibility will be provided.

Already several multimodal journey planner apps have been developed worldwide, to provide real-time information on routes, PT schedules, and pricing. These include Google maps, MooVit, Transit, and CityMapper. It is worth noting that Google maps and MooVit are already in place in most of SPINE cities, while Transit, and CityMapper are not operating in any of SPINE cities.

4.1.4 MS4 - EV charging stations

EV charging stations are stationary infrastructure that provide electric energy for the recharging of electric vehicles, such as cars, bicycles and scooters. EV stations play an important role in the adoption of cleaner and more sustainable solutions in the cities supporting the reduction of polluting vehicles' usage.

MS4 - Bologna: Currently, the city's EV charging stations within a 250-meter radius of the train stations are limited. At present, the Mazzini hub, the one multimodal hub considered in SPINE, has only one charging station, while at Casteldebole and Corticella hubs (the other hubs of SPINE) EV charging stations will be installed in the next few years. Within SPINE, the city will utilise the public parking spaces surrounding the stations to deploy charging stations for EVs. The stations in Bologna will consider the provision of improved accessibility for users with special mobility needs. They will be equipped with accessibility interventions such as ramps and covered roofs, catering to individuals with unique mobility requirements. Special plugs accessible to wheelchair users will also be incorporated, fostering a user-friendly environment for all EV drivers.

MS4 - Sibenik: Four electrical vehicle charging stations will be installed across different areas of Sibenik city. Charging stations will be suitable for cars, e-bikes, and e-scooters. Each charging station will be equipped with multiple plug-ins, accommodating different e-bike and e-scooter models. Leveraging the experience gained from its public bike-sharing system since 2014, the city of Šibenik will carefully determine the best locations for positioning the charging stations around the town and defining their technical specifications.

4.1.5 MS5 - Inclusive mobility services

Within the framework of SPINE, the implementation of inclusive mobility services aims to elevate the concept of social equality in transportation. By providing transportation alternatives to all citizens, this measure endeavors to bridge the gaps in accessibility and ensure that mobility is equally accessible and available to everyone. This measure is considered in two SPINE cities: Bologna and Gdynia.

In Bologna, this is mainly linked with MS1 (Multimodal hubs) where a number of inclusive interventions will be employed to make mobility services in the city more equal. More specifically, MS 5 in Bologna includes braille and audio communication for visually impaired users, visual instructions and efficient colour marking for hearing impaired users included in digital signages and kiosks, information in different languages, etc.

In Gdynia, the action plan for inclusive mobility services includes the increase of PT usage for Ukrainian refugees. When the war started, the city organised transport for refugees based on coaches and private cars of volunteers. Within SPINE, the city will conduct research to analyse the inclusiveness of public transport services with regards to Ukrainian refugees and support them in their PT trips (e.g. include in the NFC labels targeted information for Ukrainian refugees).

4.1.6 MS6 - Mobility as a Service (MaaS)

MaaS is a relatively new mobility concept that aims to offer a comprehensive and user-centric approach to urban transportation, wherein various modes of transportation are integrated and offered as a seamless and personalised service to travellers. MaaS provides individuals with a single platform or application that allows them to plan, book, and pay for their entire multi-modal journey, which may include options like public transportation, ridesharing, bike-sharing, car-sharing,

scooters, and other mobility services (e.g. on-demand services, parking services). By combining and optimising different transportation options, MaaS seeks to enhance convenience, accessibility, and sustainability, ultimately encouraging a shift towards more efficient and sustainable mobility choices. Within SPINE, MaaS will be offered by utilising and extending existing digital collaborative platforms, to offer information regarding disruptions and environmental footprint of the chosen mode(s), live guidance, ticketing, and bi-directional communication with MaaS users to acquire feedback for their travel experience.
MS6 - Bologna: The MaaS solution is aimed at improving smart mobility in the metropolitan area. An integrated multimodal travel planner will be developed. It will provide insights into mobility demand and the basis for further integration of mobility operators.
MS6 - Sibenik: The concept of MaaS in the city of Sibenik will be introduced through collaboration with stakeholders that would be open to collaboration and are interested in its implementation. Through this MaaS initiative, bundled packages of diverse mobility services, such as ground and maritime PT and bike-sharing, will be made available. Special attention will be given to crafting attractive packages tailored to the needs of tourists, making it easier for them to explore the city and its surroundings.
MS6 - Barreiro: To enhance the appeal of PT, Barreiro aims to develop the MaaS app and empower citizens to plan their trips conveniently, using real-time information. In addition, the city aims to leverage MaaS as a valuable urban planning tool gaining deeper insights into the Origin-Destination (OD) patterns of its citizens' trips. MS6 in Barreiro will develop and update existing journey planner app with multimodal MaaS functionalities and innovative user information, e.g. the new Park & Ride alternative.
MS6 - Rouen: The MaaS app in Rouen will involve the following integrations:

- On-site parking in Rouen: The app will integrate information about available parking spaces for standard vehicles, EVs and spaces for disabled persons. This aims to reduce the reliance on private cars in the city center, encouraging drivers to park their vehicles and opt for PT as a more sustainable solution.
- Low Emission Zone (LEZ): The app will incorporate LEZ information, encouraging users to park their vehicles outside the LEZ and use PT as part of their multimodal trip.
- Carpooling integration: The MaaS app will present carpooling solutions and allow the booking through a deep link, promoting their usage within the area of Rouen.
- Full integration of Transport on Demand: The app will optimise the booking and the utilization of smaller on-demand busses operating in selected areas where PT coverage is limited.

In terms of competition, it is worth noting that MaaS is not already developed in the above cities. However, a number of applications have already been developed in Europe and worldwide. From the first pilot of UbiGo in 2014 in Gothenburg, Sweden and the subsequent launch of Whim in 2016 in Helsinki, Finland (Karlsson et al., 2016; Smith et al., 2018), many MaaS initiatives have been implemented worldwide. In 2016, the MaaS application called "Mobilatsshop" was created by the GVH transport authority and a PT operator (Ustra), in the city of Hannover, while In June 2017, the city of Vienna with WienerLinien created a subsidiary dedicated to MaaS, Upstream Mobility. In 2017 Instant System produced the Ile-de-France Mobilités app (Vianavigo) in the Paris region. Switchh in Hamburg, Tuup in Turku, EMMA in Montpellier and SkedGo in Australia and New Zealand are some of the MaaS schemes currently operating including various urban mobility services such as PT, Bike sharing, Car sharing, Taxi and Rail (Polydoropoulou et. al, 2020).

4.1.7 MS7 - Low Emission Zone (LEZ)

A low-emission zone (LEZ) is a designated geographic area where access to certain vehicles is restricted or discouraged as a deliberate measure to improve air quality within the LEZ's boundaries. By limiting the entry or encouraging the use of low-emission vehicles and active mobility within the LEZ, we aim to mitigate the impact of vehicular emissions on the environment and create a cleaner and healthier atmosphere in the cities.
Within SPINE, this measure will be explored in Bologna (covering the Green Area of the city while also introducing the City 30 km/h concept) and Las Palmas, while in the city of Zilina a feasibility study will be conducted as part of the smart parking management solution (see MS12).

4.1.8 MS8 - Smart City Platform

To ensure that the environments in various European and global cities remain vibrant and livable in the future, city authorities and operators are increasingly turning to integrated technology platforms to efficiently manage both existing and new transport infrastructure. Within SPINE, the Smart City Platform (SCP) aims to assist the city authorities and operators to efficiently manage their operations, assets, and monitor the SPINE-related mobility measures through targeted KPIs. Quantitative KPIs

will indicatively include indicators related to modal split, traffic conditions, user satisfaction and environmental aspects. The SCP serves as a Software as a Service (SaaS) application that can be integrated with a variety of data sources and pull and push information using APIs and data ingestion procedures. A set of different functionalities and dashboards are foreseen including Goal view, Modules view, KPIs & Analytics view. MS8 will be implemented in four SPINE cities, namely Bologna, Tallinn, Heraklion and Zilina.
Concerning MS8's competitive solutions, among the key players in this field are Arcadis IBI Group, IBM, Cisco Systems, Siemens, SAP, Microsoft, and Huawei. The platforms developed by these companies offer various modules such as real-time data analytics, smart parking and lighting, traffic management optimization, electric vehicle (EV) charging infrastructure, smart logistics, fleet management, and predictive maintenance for transit systems.

4.1.9 MS9 - Citizen Mobility App

The Citizen App is a mobile application that empowers citizens to participate in the SPINE project, engage with the co-creation of solutions and "generate" the impact of the proposed measures. As the Community Hub in SPINE, the citizen app will contribute to

- Community Interaction, the app provides a platform for citizens to connect,
- Living Lab Discussion, the app enables citizens to contribute to the LLs with their insights and feedback about the implemented solutions,
- Logging Complaints / Suggestions, the app features a straightforward process for logging complaints or suggestions,
- Impact Assessment, the app is designed to collect both quantitative and qualitative impact data of the solutions implemented.

The app includes the following functions:

- Travel Logger, offering an optional and convenient way for citizens to track their travel and activities,
- Micro-incentives, designed to nudge behavior towards the use of PT,
- Safety Features, such as:
    - Panic Button, which users can press in case of emergencies or distress to alert local authorities,
    - Incident Reporting, to report incidents such as harassment, accidents, or other unsafe conditions,
    - Safety Notifications, where the app sends alerts about potential safety issues in the city, such as areas with high crime rates,
    - Travel Buddy, where users can share their live location with a trusted contact during their journey.

Citizen Mobility App is designed to act as an integrator of existing services and solutions developed in SPINE. Depending on the needs of the SPINE cities different features will be implemented. The SPINE cities that will implement the Citizen App include Bologna, Tallinn, Sibenik, Valladolid, and Barreiro.

Given the multiple capabilities and versions of the SPINE Citizen app, competitive applications in the local context would likely be other all-in-one urban mobility apps that provide similar functionalities. These could include apps that offer real-time public transportation information, ride-sharing options, bicycle rental services, traffic updates, and route planning features. Furthermore, there are often local apps developed by municipalities or other local actors that are tailored specifically to the needs of a city and its citizens. These apps may include a range of functionalities, from reporting potholes and other urban issues, to accessing local government services, to providing information on local events and attractions (e.g. the Dimotis app in Heraklion city where the citizens can be informed from the municipality on several issues, while also providing feedback to the municipality about problems occurring at the city).

4.1.10 MS10 - Logistics solutions

As part of SPINE, this measure focuses on improving freight operations and their efficient transportation in urban environments. In SPINE, this measure will be implemented in Bologna with the aim to support the reduction of CO_2 emissions and the presence of polluting vehicles within the city center adopting sustainable last-mile mobility services in the urban logistic chain. For this purpose, the city will advance the activities implemented as part of the URBANE project and

undertake an analysis to explore innovative cargo hitching solutions for the optimisation of PT in low congestion peak hours.

4.1.11 MS11 - Cargo bike-renting service

This is a SPINE measure aiming to promote a sustainable alternative to small-scale logistics. Through that measure, the cities will provide ecofriendly solutions for delivering packages, especially in areas where other means of transport are difficult to enter (narrow streets) or vehicles are not allowed to operate (LEZ, city center etc.). This measure will be implemented in:

- Tallinn, with the deployment of 15 new cargo-bikes and the use of a shared mobility software for renting, customer service, bike opening and money collection and
- Las Palmas, with the installation of 3 new electric bike stations in important nodes of the bus network, to support a modal change from car to bus and improve accessibility in the hilly parts of the city.
- Valladolid, will define the technical requirements to implement all the services included for the cargo-bike sharing solution. City will implement a customer and business app to assist citizens and ground operation teams to book cargo bikes, unblock them and pay for the services.

4.1.12 MS12: Smart Park and Ride management

The SPINE measure aims to collect the necessary data, conduct relevant analysis and provide real-time information to travellers regarding parking space availability in existing Park and Ride (P+R) facilities or on the road. This will support travellers with informed decision-making, ensuring they can effortlessly find the most efficient P+R location and seamlessly transition to available transit alternatives. This measure will be implemented in five SPINE cities as follows:

MS12 - Tallinn: This measure will focus on the conversion of three existing parking lots (Gonsiori, Pirita and Kalev) into smart P+R facilities within the city of Tallinn. The parking areas will be equipped with digital signages/screens to display all available vehicles (e-scooters, shared cars, PT schedules) and if the car will be left there, usage of PT is free of charge.
MS12 - Gdynia: Throughout this measure, Gdynia aims to understand the necessity of the existing parking spots and decide whether the number of existing parking spaces should be reduced. For this purpose, 150 wireless sensors will be installed in chosen locations of the city center to monitor parking data and create parking services leveraging PT use.
MS12 - Valladolid: The city of Valladolid has one existing parking area and a P+R facility is currently designed. Within the SPINE project, this solution will be implemented for the management of the P+R facilities with the aim of encouraging access to the city center by PT, bicycle or on foot, carrying out occupancy forecasts, reservations, tariffs or preferential management for users of public transport or bicycles.
MS12 - Barreiro: For Barreiro, the aim is to promote the definition of a new P+R solution outside the city center and leverage the use of PT from non-Barreiro residents who cross the city center by car every commuting trip. The city will employ 40 parking sensors to provide information to the visitors coming from the suburban areas of Barreiro to monitor the new P+R data and create parking services leveraging PT use.
MS12 - Zillina: The city of Zilina will deploy sensors in the vicinity of the city center. Real-time information about parking space availability in those areas will be provided to the users. This way, the city will nudge people towards using PT instead of trying to find a parking space in the city center thus promoting PT instead of cars. This will be achieved by demonstrating the extremely limited availability of a parking space in the area and by providing alternative PT connections in conjunction with the multimodal journey planner app.

4.1.13 MS13 - Traffic Management / PT prioritisation services

In SPINE, the implementation of MS13 will be carried out in eight cities as follows: Antwerp, Bologna, Tallinn, Las Palmas, Gdynia, Valladolid, and Zilina. The primary objective is to enhance PT reliability, reduce travel times, and optimise green waves. In these cities, the measure will encompass several key features, including:

- Quality Management of Public Transport Data: Ensuring the accuracy and reliability of PT-related data to facilitate efficient traffic management.
- PT Prioritisation Quality Analysis: Assessing and optimising the prioritisation of PT vehicles within the traffic flow to expedite their movement.
- PT Green Wave Quality Analysis: Evaluating and fine-tuning green wave synchronisation for PT vehicles, enabling smoother and more continuous travel.

- Green Wave towards P+R Areas Quality Analysis: Analyzing and refining green wave coordination towards Park and Ride (P+R) areas, encouraging seamless PT transitions for commuters.

As for the potential competitive solutions of MS13, there are currently no comparable solutions available on the market.

4.1.14 MS14 - Mobility Management Software feature extension

This measure will be implemented in Las Palmas, with the aim to collect up-to-date information about citizens' mobility behavior. In this way, the city will be able to improve bike and scooter sharing schemes management, while improving user satisfaction. Software will be a useful decision-making tool for the implementation of the LEZs in the city.

4.1.15 MS15 - On-demand mobility service

On-demand mobility service entails a service which operates on-demand and caters to passengers' demands by optimising routes based on their specific requirements. Through on-demand mobility, passengers can enjoy greater flexibility, convenience, and accessibility, as these services are tailored to meet their travel needs effectively. This measure will be considered in Valladolid, where it will be supported by modeling, and simulation of an on-demand bike sharing, in integration with the existing infrastructure and data available in the city.

4.1.16 MS16 - Bus Passengers Analytics

The objective of the solution is to collect data about the number of passengers inside public transportation vehicles (including O-D data, which will provide valuable insights for designing new or improving existing PT routes). The solution will be deployed in the city of Barreiro, where real-time occupancy for a sample of 10 TCB buses will be measured through computer vision and AI to enhance the visibility of the city's journey planner and increase user satisfaction.

4.1.17 MS17 - Cargo hitching

Cargo hitching is a concept for collaborative logistics that involves the sharing of cargo space in commercial vehicles. In the context of PT, it refers to the practice of utilising PT vehicles, such as buses or trains, to transport freight or cargo in addition to passengers. In this way, the unused or underutilise d capacity of PT vehicles is used for cargo. This measure will be implemented in Heraklion, where the PT operator will explore the use of PT unused capacity for transporting parcels within the city (e.g. connecting the Port and/or the Airport).

4.1.18 MS18 - Intersection Camera Recognition/ Dashboard for real-time traffic data

This measure aims to collect traffic data in a data space and visualise it in a dashboard. The data is gathered through surveillance cameras installed in road intersections across an area and by employing image processing on the collected data. This measure will be implemented in the city of Zilina, which has already installed 10 cameras in major road intersections around the city. Nowadays, those cameras are used as surveillance cameras for the public to monitor the traffic situation in Žilina in real-time. Moreover, there are traffic counters installed in the city of Žilina. These counters are collecting traffic geofencing data from sensors installed in 6 different locations, detecting the type of incoming/outgoing vehicles and the traffic volume to the city center. Through MS18, the city will collect traffic data in a data space and visualise it in a dashboard. Image processing from surveillance cameras installed in intersections for cooperative traffic and intersection monitoring will be carried out to improve PT service reliability with traffic lights coordination (e.g., green -wave system).

4.1.19 MS19 - Environmental Sensors

This measure concerns the installation of environmental l sensors, in order to monitor and collect environmental information for a city. Within SPINE, these data will be used to quantitatively assess the environmental impact of the project's planned interventions. These sensors are currently being discussed to be implemented in the city of Tallinn. Further locations may be assessed as the project progresses in future. They can be installed either on vehicles (e.g. installed on buses) or positioned at fixed locations across the city. The range of pollutants these sensors are capable of measuring encompasses CO_2, CO, NO_2, $PM_{2.5}$, PM_{10}, VOC, CH_4, H_2S, and SO_2. The valuable results gleaned from these sensors will be displayed on the Smart City Platform, offering stakeholders and decision-makers a comprehensive overview of the city's environmental conditions.

5 SPINE Prototype business and governance models

5.1 Background: Business models and governance

The business model concept is often denoted as the logic behind an organisation's working (private or public organisations) towards its objectives. It defines the organisation's purpose(s) and represents how the organisation is trying to achieve these purposes. Another definition often used is that the business model describes how the organisation creates, delivers and captures value. This value can be economic value, which is usually the focal point of commercial organisations, but it can also include broader societal and environmental goals. The SPINE project takes the viewpoint of the local authority, and the business models define which different (authority's) goals (i.e. value) the SPINE solutions contribute to and the mechanisms behind their implementation.

There are different design tools to support defining the business model. In this case, we used the Business Model Canvas developed by Osterwalder and Pigneur, which put forwards nine pillars, i.e. value proposition, key activities, key resources, key partners, customer segments, customer relationships, channels, costs and revenues. It is a widely used design tool, which is applicable in various contexts. Osterwalder and Pigneur developed it with a particular focus on single private companies, to depict how they create economic value. However, the design tool has also been applied to outline non-economic value propositions from the perspective of a public or non-profit organisation. Within this task, the business models of SPINE's solutions from the lead cities (i.e. Antwerp, Tallinn, Las Palmas and Bologna) are developed using the BMC. The nine pillars are described as follows:

- Value proposition: This pillar describes the benefits offered or particular objectives intended for. Which value is created for specific customer segments? Which specific needs are fulfilled?
- Key activities: To achieve the organisation's objectives, certain activities must be carried out.
- Key resources: To carry out these activities, the organisation will require certain assets, which can be physical, intellectual or human.
- Key partners: This building block specifies the external partners required to carry out the activities or give access to key resources.
- Customer segment: The benefits defined in the first building block, are aimed towards specific user groups.
- Customer relationship: This pillar describes the intensity and form of the relationship between the organisation and its customer segments.
- Channels: This building block describes the channels, which could be physical or digital, that are used to reach the customers and make them aware of the initiatives. This can be broad campaigns or targeted interventions.
- Costs: The cost structure depicts the different fixed and variable costs associated with performing the key activities and access to the key resources.
- Revenues: The revenue pillar describes the different streams through which the organisation generates money.

The further description of these pillars allows to specify how public authorities are considering their governance models. Likewise, it supports on understanding the process of managing their stakeholders and how authorities try to ensure a continuation of their initiatives. When considering the integration between public transport and shared mobility, certain concepts have already been regarded from a business model perspective. First, there is the digital integration part, which is often named as MaaS (see Kraus et al., 2022; Polydoropoulou et al., 2020 for business model developments of MaaS). Second, there is physical integration, which is currently being enabled by the implementation of mobility hubs (see Coenegrachts et al., 2021, for business model developments of shared mobility hubs). In SPINE, lead cities are trying to support and reinforce public transport, partly through such digital and physical integration with shared mobility, but also by implementing other solutions.

In this regard, there is a broad network of stakeholders involved. The governance of such (new) mobility solutions has already been studied in previous European projects (e.g. MobiMix, Gecko).

In the next section, the main outcomes of the interviews with the lead cities are presented in four BMCs, one for each city. Following each of the BMCs, there is an introduction with the relevant content for each of the nine pillars where the characteristics of the city's mechanism to obtain the value proposition are specified.

5.2 Description of the Business Model Canvases in SPINE

BM Antwerp

<table>
<tr>
<td>Key Partners</td>
<td>Key Activities</td>
<td rowspan="3">Value Propositions</td>
<td>Customer Relationships</td>
<td rowspan="3">Customer Segments</td>
</tr>
<tr>
<td rowspan="2">
Public authorities
- Neighbourhood community centre

Private partners
- Companies located in Antwerp
- NGOs in transport

Mobility service providers
- Public transport operator
- Carsharing provider
- Shared bike provider
- Shared e-scooter/step provider
- Software development partner
- Ticketing system provider
- P+R integration partner
- Journey planner developer and provider

Infrastructure providers
- Physical infrastructure provider, i.e., signage, parking

Data provider
- Floating data vehicle provider
- Public transport and shared mobility data provider
</td>
<td>
Development and improvement of multimodal hubs
- Redesign and install hubs signage
- Determine requirements for operation of the improved hubs
- Strategic design to improve modal split
Improving real time information for passenger
- Incentivise new sustainable mobility initiatives
- Actively supporting mobility providers (networking, rollout, communication)
Upscaling the multimodal journey planner app
- Support citizen communication strategy
- Capture mobility data
- Interconnect the network of mobility hubs with help of governmental agencies
- Increase accessibility of the hubs (digital via route planner, physical via signage)
- Create a communication strategy for citizens to perceive the new and existing hubs in the cities as a single network
</td>
<td>
- Personal engagement with citizens through neighbourhood centres
- General engagement with citizens through journey planner campaigns
- General engagement with visitors through media campaigns
- General engagement with citizens to inform them about the improvement of mobility hubs
- Collaboration with mobility providers through the marketplace
- Co-design of mobility strategies with employers through the marketplace
</td>
<td rowspan="2">
- All citizens in Antwerp
- Citizens interested in hubs and using Smart Ways to Antwerp
- Employers
- Shared mobility providers
- Short-term visitors
</td>
</tr>
<tr>
<td>
Key Resources

Physical infrastructure
- Signage for wayfinding (static or dynamic)
- Parking spots, e.g., shared car, personal car and bike
- Measuring equipment, e.g., cameras, crowdscanning
Digital infrastructure
- System for inventory of parking space and parking guidance
- Passenger crowding system
- Map guidance system
Data resources
- Passenger traffic data (real-time and historic)
- GIS data of transport network
- Vehicle information (public transport, shared mobility)
- Integrated ticketing
- Live data to feed parking guidance system
- Data layers with information about shared mobility available to use for third parties
</td>
<td>
Channels

Physical channels
- Corporate events
- Marketing material, e.g., logos, colours, in advertising boards

Digital channels
- Public channels: website, social media
- Newsletter
- Mainstream media: Radio/TV
- Mobile applications
</td>
</tr>
<tr>
<td colspan="3">Cost Structure</td>
<td colspan="2">Revenue Streams</td>
</tr>
<tr>
<td colspan="3">
Fixed costs
- Communication channels
- Mantainance of routeplanner and mobility map
Governance
- Subsidizing new mobility initiatives i.e., credit for shared mobility when buying green modes
Physical
- Data gathering infrastructure
</td>
<td colspan="2">
Structural revenues
- Mobility consultancy

Ad-hoc revenues
- EU funding
- Governmental funding e.g., city of Antwerp, Flanders region
- Consortia, e.g., collaboration with universities
</td>
</tr>
</table>

Antwerp's main key activities include the improvement of 5 **multimodal hubs**, **updating their real-time information system** and **upscaling their multimodal journey planner**. Currently, the 5 multimodal hubs are high-traffic nodes in the city where shared mobility (bike-sharing), infrastructure (parking for car and bikes) and public transport is already available.

Improving mobility hubs first entails redesigning the physical space to (re)locate the signage and organise parking spaces and circulation paths for pedestrians. Some new signage incorporates displays with real-time information about public transport arrivals. To show the information about the transport available in the hubs, the city of Antwerp further integrates the traffic data from shared mobility and public transport into a single system. This integration assists citizens in choosing the most efficient and sustainable mode and promotes the efficiency of public transportation.

Similarly, Antwerp already has a real-time information system for passengers and a multimodal journey planner app in place. With the upgrades of their real-time data for passengers, the city of Antwerp will gather relevant data from public transport in neighbouring cities or countries, e.g., train schedules, that can complement their existing information system. The idea behind these improvements is to facilitate multimodal trips for passengers and strengthen the city's relationship with mobility providers in their ecosystem.

The upgraded real-time passenger transport system feeds Antwerp's multimodal journey planner resulting in improved quality of the data available in the application. Moreover, the multimodal planner captures and displays information about the mobility hubs, e.g., parking spaces and availability of shared mobility, supporting digital integration to make all transport services accessible. Given that the mobility hubs are also displayed in both desktop and a mobile app, citizens can access a more comprehensive array of transport modes, making it easier to plan for their journey and, thus, facilitating a modal shift.

The physical infrastructure in the key resources includes the new signage in the hubs, i.e., digital displays for wayfinding, parking spots for shared mobility and private vehicles, and measurement equipment, e.g., crowd scanning sensors and cameras. The measurement equipment captures real-time traffic and passenger data for public and shared mobility operators. Other data resources include historical data, GIS data from the transport network, and parking guidance.

The two key digital infrastructures are upgraded map guidance and a parking inventory system. They both improve the quality of the information provided in their passenger information system and multimodal journey planner.

Antwerp previously established connections with several key partners from which they will continue maturing their relationships to deliver the value proposition. For example, public and private transport providers will continue providing positioning and availability data to feed the multimodal planner and information systems. Similarly, floating vehicle data is essential to build a comprehensive picture of traffic delays, accidents and the best routes for car drivers. Nonetheless, improvement in the digital infrastructure of the real-time information system involves merging new and existing data into the system. Thus, software developers and providers might enter the ecosystem of actors in the city.

In addition, to display arrivals and connections at the hubs, Antwerp must establish relations with digital signage providers. And since the mobility hubs are now included in the journey planner, P+R integration partners ensure the availability of parking spots is displayed in their journey planner. Moreover, private partners such as companies in Antwerp and public authorities like the neighbourhood centres provide a platform to contact workers and citizens regarding new transport modes and network improvements.

The customer segments for the three key activities are all citizens of Antwerp, employers, short-term visitors and shared mobility providers. The citizens are subdivided into users interested in the hubs, e.g., private drivers interested in the P+R, and users interested in shared mobility, e.g., users booking from mobility hubs. The short-term visitors are people from neighbouring cities or countries downloading the journey planner to navigate the city. Employers use Antwerp's mobility marketplace to offer sustainable means of transport to their employees by creating a customised offer for those who commute without a car. The mobility marketplace is a series of partnerships established by the city of Antwerp with shared mobility providers to directly offer their services to employers in the region. Finally, shared mobility providers market their services through the journey planner and information system, thus, the upscaling of the multimodal journey planner is attractive for them.

The physical channels to build customer relationships include corporate events where the city of Antwerp provides employers with a portfolio of mobility services to promote modal shifts for commuting trips. In these events, the city grants customised services. Additionally, there are more traditional marketing materials, such as logos and colour palettes (to associate mobility initiatives with the city), besides billboards in public spaces. The digital channels are social media, newsletters, radio and TV campaigns. The radio campaigns are broadcasted at a regional level. The social media campaigns engage with users through the channels of the city. To reach short-term visitors living abroad, the city also uses mainstream channels.

The cost structures to execute the activities are the fixed costs which are the maintenance of the current communication channels to promote their activities, e.g., mainstream communication, social media and billboards, and the maintenance of the digital infrastructure needed to keep the journey planner functioning. Antwerp also provides credit to citizens when buying sustainable mobility modes, i.e., bikes or e-bikes for commuting. The cost of these credits comes from maintaining their governance structure. The city also incurs costs for infrastructure (physical costs) to gather data, i.e., cameras.

Finally, some of the revenue streams come from the mobility packages for commuters they propose to employers. Employers pay a small amount to the city to get access to their mobility marketplace. It is worth mentioning that the revenue Antwerp receives for its mobility consultancy services is to hold networking events between employers and mobility providers. Also, Antwerp receives funds from the government (Flanders), EU-level and consortia with universities.

BM Bologna

Key Partners

Public authorities
- Regional education authority
- School boards

Mobility service providers
- Public transport operator
- Carsharing provider
- Shared bike provider
- Shared moped provider

Software development partner
- Smart application developer and provider
- Citizen platform developer and provider
- LEZ application provider
- Data integration partner

Logistics providers
- Logistics manager
- Last-mile logistics coordinator
- Supply-chain relationship manager

Communication experts

Infrastructure providers
- Provider of measurement equipment (environmental sensors, cameras)
- EV infrastructure provider
- Physical infrastructure provider (ramps, roof, special plugs)
- Locker providers

Public space designer

Key Activities

Implementation of mobility hubs
- Installation of EV charging infrastructure
- Monitors traffic density in areas around the hub
- Offers on-site real time information
- Offers physical infrastructure for impaired groups to access transport services

Implementation congestion charging
- Review the current access regulation scheme
- Reduce driving speed from 50km/h to 30km/h
- Identify charging schemes based on EURO class

Deployment of cargo hitching
- Draw feasibility plan for deployment cargo hitching service for logistics
  - Create a tender for cargo hitching providers
  - Creation of 3 last-mile (logistic) hubs
  - Build a SWOT analysis for the logistics management after SPINE
  - Create a responsibility scheme for the providers

Development of a MaaS app
- Incorporate shared mobility options into a single interface
- Provides with a multimodal travel planner for citizens

Development of a Citizen app
- Provides information on (impact of) travel behaviour to users
- Enables monitoring measurements, e.g., CO_2 consumption per trip
- Classifies information about impact of travel behaviour based on CO_2 reduction per school

Development of Smart Mobility app
- Integrate data sources (open, dynamic, static)
- Provides support for decision-making based on actual data

Key Resources

Physical infrastructure
- Measuring equipment, e.g., passenger counters, (environmental) sensors, bus ID, cameras
- Equipment, e.g., speakers, ramp, roof and special plugs for citizens with disabilities, lockers for logistics, cargo hitching vehicles
- EV charging stations
- Parking spaces, e.g., private cars, bikes, car-sharing

Digital infrastructure
- Citizen app
- MaaS app
- Smart Mobility app
- WiFi sniffer app
- APIs to automatically integrate different data flows

Data resources
- Real time data (Traffic flows, PT schedules/delays, availability of mobility services)
- Data on citizens' travel mode and trip distance
- CO_2 emissions per modal choice and distance
- Data about users profile
- Data from user satisfaction survey

Value Propositions

- Combine existing and new mobility measures to improve the quality and competitiveness of public transport
- Co-create with actors inclusive, resilient and sustainable mobility solutions
- Integrate other mobility services in public transport by using AI/data-driven simulation tools to capture ecosystem dynamics and trigger behaviour change.

Customer Relationships

- Engagement with citizens (school parents) through citizen app
- Offer general information to citizens through MaaS app, mobility hubs and congestion charging
- Collaboration for logistics solutions with logistics partners
- Direct relationship with public transport for the Smart city app

Channels

Physical channels:
- Flyers for students to bring to their parents in schools

Digital channels:
- Public channels: social media from the city and shared mobility providers
- Exclusive channels: social media available from external projects (associated to the Key Activities)
- Tenders

Customer Segments

- Parents of primary schools participating in the Citizen app
- Citizens from impaired groups and different language background
- Logistics providers
- Public transport provider
- Citizens interested in shared mobility
- Private car drivers

Cost Structure

Fixed costs:
- Software development and maintenance
- Data management

Governance
- Tendering and procurement process

Physical
- Maintenance of the hub infrastructure
- Adaptations to hub infrastructure (electricity, displays, internet)

Variables
- Change of management

Revenue Streams

Structural revenues
- LEZ revenues: circulation of private vehicles and fines
- Increased number of public transport ticket sales

Bologna's key activities include the implementation of two **mobility hubs**, **a congestion charging scheme**, **logistics solutions**, **a MaaS app**, **a Citizen app** and a **Smart Mobility app**. Within the mobility hubs, there are two other key activities: the **installation of 6 Electric Vehicles (EV) charging stations** and **physical infrastructure for impaired groups** to access transportation, for example, speakers, ramps and roofs.

Bologna considers the (re)design of the mobility hubs' public space to ensure the system is more inclusive. The mobility hubs are intended to increase the use of shared mobility to all citizens by offering in-place real-time information about the availability of public transport and shared mobility. In addition, mobility hubs create a location for all shared mobility to be readily available for citizens. With EV charging and infrastructure for impaired groups, the mobility hubs strengthen the transport network and complement the public transport offer.

The congestion charging solution has two different components: on the one hand, it revisits the current access vehicle regulations in the City to evaluate the feasibility of a charging scheme based on the emission standards listed on the EURO class. On the other hand, the solution aims at decreasing the driving speed from 50km/h to 30km/h in a limited area.

Similar to the mobility hubs, the cargo-hitching activities aimed at improving the transport network by decreasing the number of logistics vehicles in circulation during rush hours. To achieve this, the city will tender for cargo hitching providers, provide three lockers for storage goods and acquire several vehicles for last-mile delivery. Additionally, the feasibility plan of the cargo-hitching solution considers a responsibility scheme for the providers. The city owns the equipment of the cargo-hitching solution, and their role is limited to administration. The operation and management of the lockers will be carried out by the logistics operators outside of the scope of the SPINE project.

Both the MaaS app and Citizen app are intended to nudge citizens towards more sustainable modes of travel, yet, they have different target groups. The MaaS app incorporates all shared mobility available in the city and offers a journey planner in a single interface that is available to everyone. The Citizen app is aimed at primary school parents. It provides them with information about the impact of their modal choice for school trips, monitors and classifies trip data based on CO_2 consumption.

Lastly, the Smart Mobility app provides public transport authorities with a dashboard that integrates open, dynamic and static data from public transport and shared mobility providers. As the interface uses different data sources to show, i.e., traffic flows, modal share, CO_2 emissions and ridership levels, policy makers decrease the uncertainty on their decision-making regarding public transport system.

The physical infrastructure part of the key resources necessary to carry out the key activities includes passenger counters, digital bus ID, cameras and sensors to measure the conditions inside of the public transport, identify key issues with crowding and accessibility equipment, monitor the speed and access to restricted areas from car drivers. To reinforce electric mobility and thus make sustainable choices, EV charging stations are part of the physical infrastructure included in the hubs. Also, equipment for impaired groups, such as ramps, speakers and roofs, are necessary to ensure access to the transport modes.

The digital infrastructure includes four different applications: A citizen app, a MaaS app, a Smart City app and a WiFi sniffer app. The Citizen app is where parents from the primary schools participating in the micro-incentive programme can find a direct communication channel with the city. They also obtain information about the programme and their CO_2 consumption per modal choice. In the MaaS app, which could be connected to the Citizen app, citizens can check public transport schedules and shared mobility availability. They can likewise plan their journey using the multimodal application. Public transport operators and other governmental stakeholders monitor traffic flows and CO_2 emissions using the Smart City app. In all cases, to integrate the data flow from public and shared transport providers, the digital infrastructure also includes an Application Programming Interface (API) to enable the exchange of information between providers and facilitate the creation of a single interface to visualise the KPIs chosen by the city.

The data resources comprise real-time information from the public transport operator and shared mobility providers to feed the dashboard in the Smart City and the journey planner in the MaaS.

Additionally, gathering information about travel destinations and modes is essential to estimate CO_2 emissions from shared and personal mobility. Thus, data resources also include user profiles generated by the Citizen app, which incorporate modal choice and travel times. Furthermore, user satisfaction data will be available through an ex-ante and post-implementation survey.

Each key partners are associated with one or more of the solutions. In total, 7 categories of partners are working to deliver the solutions: the public authorities, such as the regional education authorities, which directly communicate to school boards about the reward scheme accessible in the Citizen platform app. The school boards manage the project internally and communicate with teachers and parents in more detail. The mobility service providers include shared cars, mopeds and bike providers, besides the public

transport operator. The software development partners need to collaborate with the mobility service providers to process, analyse and present the data for the Smart City app, Citizen app, and Low Emission Zone (LEZ) (for the delivery of the new congestion charging scheme). The city creates tenders for providers, manages the system and owns the vehicle for the logistics solutions. At the same time, it is the logistics providers who coordinate and operate the cargo hitching initiative.

The communication experts deliver the strategies and materials to engage with parents in the Citizen app; the infrastructure providers supply the physical structures and technology needed for the adaptation of the mobility hubs and logistics solutions; and the public space designers will create the layout of the mobility hubs to facilitate the access of physically impaired groups.

There are three different customer segments for the solutions:

1. The citizens interested in shared mobility benefit from the multimodal planner offered in the MaaS app and the mobility hubs. Likewise, citizens with impaired mobility increase access to public transport and shared mobility. Also, parents of children in primary schools are the target segment of the Citizen app.
2. The deployment of cargo hitching targets the logistics providers.
3. The public transport providers can take informed decisions and improve the efficiency of their network using the dashboard offered by the Smart City app.

Customer relationships vary depending on the activity. For the parents, there is a collaborative relationship where the city can directly address their inquiries through the Citizen app platform. The feature allows direct feedback and a better understanding of the perception of the micro-incentive programme. Another direct collaboration takes place with the logistics partners, which are contacted through external projects to coordinate and operate the cargo-hitching deployment. However, the relationship is mediated by tenders. Similarly, there is direct collaboration between the public transport operator and the city to create a dashboard (for the Smart City app) with the KPIs needed to improve their services. However, the relationship with citizens using the MaaS app and the mobility hubs is rather unilateral, with information provided through different channels. Still, no direct collaboration yet exists to co-design the activity or receive feedback. Moreover, since the congestion charging is in the early stages, the pricing mechanism has yet to be decided, and the relationship with the drivers affected by the speed reduction is limited to communicating the changes instead of co-designing the activity. The channels to share the activities are limited to social media channels belonging to the shared mobility and public transport operators, partners (outside of SPINE) working in complementary solutions, online tenders and flyers for the children of the primary schools to bring to their parents.

The city considers two structural revenue streams. The first is from fines in the zones with decreased speeds, in addition to taxes from the circulation of private vehicles (once the congestion charging is operational). A second revenue stream is expected from higher ticket sales resulting from improved serviceability of the public transport network brought by the Smart City app, the mobility hubs and the MaaS app.

Finally, the cost structures include all fixed costs directly result from the operation and maintenance of the digital architecture of the apps, i.e., data management, software development and maintenance. The variable costs are related to the possibility of migrating the current information to other systems compatible with the new applications. On the governance side, the tendering and procurement process constitute extra workloads for the city employees. The adaptation of the space of the mobility hubs requires extending the electric grid to locate the EV charging station, adapting the electricity plugs and positioning the rest of the physical infrastructure needed, i.e., ramps, roofs, and boards. The maintenance of the displays, internet and physical infrastructure also adds to the cost structures of the city. Moreover, a switch in the priorities of political agenda might alter the initial priorities given to the key activities. Change of management entails changes on planning, implementation or operation of the solution procedures. Hence, the city considers that given the possibility of changes in governance the deployment of some of the solutions might require to get adapted to new priorities, incurring in extra costs.

BM – Tallinn

<table>
<tr>
<th>Key Partners</th>
<th>Key Activities</th>
<th>Value Propositions</th>
<th>Customer Relationships</th>
<th>Customer Segments</th>
</tr>
<tr>
<td rowspan="2">
Mobility service providers:
- Public transport operator
- Shared cargo bike service provider
- Carsharing providers
- Ride hailing provider
- Shared micromobility providers
- P+R operator
Real estate partner:
- Shopping mall owner
Software development partner:
- Application/platform developer
- Traffic management (traffic lights) partner
- Ticketing system partner
- Data integration partner
</td>
<td>
Development of SMART city platform:
- Integration of data sources
- Enable monitoring and measurement of different KPIs (e.g. delays in PT, congestion levels)
- Enables impact assessment of various interventions
- Provides support for decision-making based on actual data
Development of Citizen app:
- Collects data on travel behaviour of user
- Provides information on (impact of) travel behaviour to the user
- Inform users about other travel options through integration with MaaS app
- Enhance safety feeling (on PT) by providing a safety button
- Provides (financial) incentives for more sustainable travel behaviour
Implementation of mobility hubs:
- Integration of mobility services
- At P+Rs and main PT station
- Provide information on available mobility services, physically and digitally
Development of Smart Traffic management system:
- Gives public transport prioritisation at different road segments, by smart management of traffic lights
</td>
<td rowspan="2">
- Combine existing and new mobility measures to improve the quality and competitiveness of public transport
- Co-create with ecosystem actors inclusive, resilient and sustainable mobility solutions
- Create an integrated approach to public transport with other mobility services using AI/data-driven simulation tools to capture ecosystem dynamics and trigger behaviour change
</td>
<td>
- Active engagement with citizens through incentivization
- Active collaboration with public transport operator to determine optimal use of smart traffic management system
</td>
<td rowspan="2">
- Commuters/visitors from outskirts using car
- Citizens without cars
- Overall citizens
- Public transport operator
</td>
</tr>
<tr>
<td>
Key Resources
Physical infrastructure
- Wayfinding
- Sensors
- Parking infrastructure
- Displays for real time information (on availability of mobility services and PT schedules)
Digital infrastructure
- Smart traffic management system (traffic lights)
- Smart parking management system
- Mobility as a Service platform
- APIs to automatically integrate different data flows
Data
- Real time data (Traffic flows, Public transport schedules/delays, availability of mobility services, availability of parking places)
- Data on citizens' travel mode
- Data on citizens' trip distance
- Traffic lights configuration
</td>
<td>
Channels
Physical channels:
- Advertisement on PT vehicles
- Advertisement on displays (at mobility hubs/P+Rs)
- Advertisement on shared mobility vehicles (cargo bicycles)
Digital channels:
- Public channels: City's & PT's social media, Broadcast TV and radio
- Citizen app – Safety button
</td>
</tr>
<tr>
<th colspan="3">Cost Structure</th>
<th colspan="2">Revenue Streams</th>
</tr>
<tr>
<td colspan="3">
Fixed costs:
Digital
- Software development and maintenance
- Data management
Governance
- Tendering and procurement process
Physical
- Maintenance of physical infrastructure
- Adaptations to physical infrastructure (electricity, displays, internet, traffic lights)
</td>
<td colspan="2">
Structural revenues
- Users
- Pay per use of P+Rs, no fee when public transport is used afterwards
- Free public transport for citizens
Ad-hoc revenues
EU funding
- For software development
</td>
</tr>
</table>

Tallinn's key activities to achieve the value propositions, are the development of a citizens application, a smart city platform, a smart traffic management system and the implementation of mobility hubs. The citizens application and the mobility hubs are directly aimed towards citizens and travellers, while the Smart traffic management system and the smart city platform are indirectly engaging with user's travel behaviour by improving the quality of public transport and being able to measure the effectiveness of these measures.

The citizens application will nudge users towards public transport or shared mobility services by providing information on the environmental impact of their current travel behaviour and giving (financial) incentives for changing their travel behaviour towards more sustainable modes (such as public transport). Furthermore, the MaaS application integrated in this citizens application gives users the possibility to find and book various mobility services, enabling multimodal transport.

The development of mobility hubs will provide travellers alternative mobility services at P+Rs and the main rail station. This will provide better information on which shared mobility and public transport services are available and where they can find them. This enables an easier transfer to/from public transport from/towards one of the alternative mobility services.

The smart city platform integrates different data so that the city can accurately monitor the performance of the traffic system and assess the effectiveness of different solutions. This supports the city to make decisions based on data and make interventions that actually improve the competitiveness of public transport.

Lastly, the smart traffic management system increases the speed of public transport by managing the traffic lights in a way that public transport is prioritise d when approaching the traffic lights. This way, public transport has a time-advantage compared to private cars, so citizens are more willing to opt for public transport.

The key resources required to proceed with the key activities are divided in three components: physical, digital and data requirements. The physical resources are the wayfinding (which indicate the location of shared mobility services and public transport), sensors (which are used to measure the environmental conditions of certain road segments/neighbourhoods in Tallinn), parking infrastructure (for private cars and shared mobility services at the mobility hubs) and the information displays (which provide real-time information about the availability and time schedule of shared mobility services and public transport).

The digital infrastructure includes the smart traffic management system, a smart parking management system (which provides information on the available parking spots at the mobility hubs and dynamically redirects travellers to the most appropriate P+R), a MaaS platform (which is integrated into the citizen application and offers users the possibility to find and book all mobility services) and application programming interfaces (APIs) that connect the different data sources to the smart city platform.

Different data sources, -sets and -flows are necessary to enable the functioning of the SPINE solutions. In this regard there has to be real time information on the availability and location of shared mobility services (at the mobility hubs and in the citizen app), the availability of parking spots (at the mobility hubs and in the citizen app), the time schedule and possible delays of the public transport (at the mobility hubs and in the citizens app), the traffic flows and congestion levels (as input for the smart city platform), the environmental conditions (as input for the smart city platform), the individual's travel behaviour (indicated in the citizen app) and the configuration of the traffic lights (to enable prioritisation for public transport). This data comes from the shared mobility service providers, public transport operator, parking operator, google, sensors and the citizen app.

In order to establish all the key activities, certain key partners have to be involved. In this case, partners can be categorised as mobility service providers, IT partners and real estate partners. Firstly, the public transport authority is important for providing services and information to the mobility hubs, for providing real-time data as input to the smart city platform and smart traffic management system, for testing the smart prioritisation program and to become integrated into the MaaS platform of the citizen application. Secondly, the shared mobility service providers, such as providers of (cargo) bike-, car- and scooter-sharing and ride-hailing, have to ensure availability of their services at the mobility hubs, while also providing real time data to the smart city platform, the displays at the hubs and the MaaS platform. Another mobility service provider is the P+R operator, which has to provide information on the availability of parking spots at the P+Rs and support the integration of the ticketing of the P+R with the public transport ticketing. For the further development of mobility hubs, the city is looking at real estate owners such as shopping mall proprietors, who can provide space for the further development of the hub network at busy locations such as shopping malls. Considering the development of the citizen application, the smart city platform and the smart traffic management

system, IT partners will be involved. This include partners involved in the actual development of the application and platform, partners who will adapt the traffic lights and partners who are responsible for the data integration and processing of the different data streams on the citizen application and smart city platform. Furthermore, the integration between the ticketing system of public transport and the P+R will be done by an external partner.

The customer segments that are targeted by the key activities depend on the type of solution, but also the locational context in which the solution is implemented. The mobility hubs located at the P+Rs are typically focused on attracting commuters/visitors living in the outskirts and suburbs and entering the city by car, so that they switch at the P+Rs to another travel option. The mobility hub at the central station is more focused towards users of public transport, to inform them better about the mobility services they can use to bridge the first-last-mile to/from the station. The citizen application is targeting the overall population. Further, the smart traffic management system and the smart city platform can be useful for the public transport operator, as it supports interventions (e.g. prioritisation) that improve the efficiency of public transport and monitor the impact of it.

The city has established certain customer relationships with these two types of customers. When considering its citizens application, it actively engages with the overall population by informing them about the impact of their current travel behaviour and incentivising them towards more sustainable travel modes. This is different from the customer relationships at the mobility hubs, where the city only generally informs the users. The relationship with the public transport operator goes deeper, as the city will, based on the insights from the smart city platform and traffic management system, collaborate intensely with the public transport operator to adapt/design existing and new interventions.

The channels through which the different customer segments are informed, can be classified in digital and physical channels. There will be advertisements on public transport vehicles, shared mobility vehicles and the displays at the mobility hubs, to inform about the new mobility hubs and services available there and the citizen application. The digital channels include the main public broadcasting channels, such as television and radio, but also the social media of the city and the public transport operator. These physical and digital channels are mainly used to raise awareness about the mobility hubs and citizen application towards the citizens. Furthermore, the citizen application provides a direct feedback channel that can be used by users to indicate whether they feel unsafe in particular public transport stations.

Lastly, we consider the costs and revenues associated with the implementation of the key activities. On the cost side, the city faces fixed costs in terms of its software development and maintenance, its data management, its processing of the tendering and procurement procedures, the maintenance of the physical infrastructure (such as the P+Rs) and the adaptations made to physical infrastructure to implement the mobility hubs (such as information displays, electricity, internet) and public transport prioritisation (adapting/replacing the traffic lights). The revenues can be split between structural revenues and ad-hoc revenues. The structural revenues only come from user fees of the park and rides, keeping in mind that citizens, who can freely travel with public transport, also are exempt from this parking fee when they use public transport from the P+R. The ad-hoc revenues that are particularly used for the development of the smart city platform, citizen application and the smart traffic management system, come from European funding (projects such as SPINE).

BM Las Palmas

Key Partners

Mobility service providers:
- Bike sharing operator
- Public transport operator

Software development:
- Traffic management system partner

Key Activities

Implementation of mobility hubs:
- Integration of mobility services
- Redesign of public space
- Parking infrastructure for shared mobility services

Improvement of mobility management system
- Management of shared mobility services (OD information)
- Supports integration with public transport
- Public transport prioritisation

Key Resources

Physical infrastructure:
- Bike sharing stations
- Bus shelters
- Wayfinding
- Parking infrastructure
- Displays for real time information (on PT schedule)

Digital infrastructure:
- APIs for data integration of shared mobility services and public transport in mobility management system
- Traffic management system (extension)

Data
- Real time data (Availability of bikesharing, Public transport schedules/delays)
- Traffic lights configuration
- Trip data of shared mobility services

Value Propositions

- Combine existing and new mobility measures to improve the quality and competitiveness of public transport
- Co-create with ecosystem actors inclusive, resilient and sustainable mobility solutions
- Create an integrated approach to public transport with other mobility services using AI/data-driven simulation tools to capture ecosystem dynamics and trigger behaviour change.

Customer Relationships

- Active collaboration with public transport operator to determine optimal use of smart traffic management system
- Unilateral informing of citizens

Channels

Digital channels:
- Social media of bike sharing operator
- Social media of public transport authority

Physical channels:
- Advertisement on public transport vehicles
- Advertisement at mobility hubs

Customer Segments

- Citizens and visitors
- Public transport operator

Cost Structure

Digital
- Software development and maintenance
- Data management

Governance
- Tendering and procurement process

Physical
- Adaptations to public space to install mobility hubs (bike stations, electricity, internet)

Revenue Streams

Structural revenues:
- Advertisement on billboards at mobility hubs

Ad hoc revenues:
- European funding

Las Palmas' key activities are the implementation of **mobility hubs** and the improvement of their current **mobility management system**. The mobility hubs will support the integration between public transport and bike sharing, so that citizens can bridge the first-and-last mile gap. It provides better information of and wayfinding to bike sharing and public transport. The mobility management system will monitor whether the bike sharing system complements public transport and it will also support public transport through prioritisation interventions.

The key resources required to proceed with the key activities are divided in the three components: digital, physical and data requirements. The physical resources are the bike sharing stations, the signage (for wayfinding), the information displays (which provide real-time public transport information) and shelters to improve the waiting experience of public transport users.

The digital infrastructure includes application programming interfaces (APIs) that connect the different data sources (i.e. from the bike sharing and public transport) to the mobility management system. Furthermore, there is the traffic management system which allows the prioritisation of public transport.

Different data sources and sets are necessary to enable the functioning of the SPINE solutions. In this regard there has to be real time information on the availability and location of bike sharing (at the mobility hubs), the time schedule and possible delays of the public transport (at the mobility hubs) and the configuration of the traffic lights (to enable prioritisation for public transport). Furthermore, there is the historical trip data of the bike sharing service that allows the city to assess the complementarity of the bike sharing system with public transport. This data comes from the bike sharing provider and public transport operator.

In order to establish all the key activities, certain key partners have to be involved. In this case, partners can be categorised as mobility service providers and IT partners. Firstly, the public transport authority is important for providing services and real-time information on time schedule to the mobility hubs and for testing the prioritisation program. Secondly, the bike sharing provider has to ensure availability of their services at the mobility hubs, while also providing historical trip data to the mobility management platform. Considering the further extension of the mobility management platform, a traffic management system partner will be involved, to adapt the digital coordination of the traffic lights.

The customer segments are not well defined. There are no tailored efforts to attract specific users of the mobility hubs, which are located at main public transport stations, such as commuters. It can be that also visitors of the city make use of the bike sharing system instead of taking public transport. The mobility management system can be useful for the public transport operator, as it supports interventions (e.g. prioritisation at traffic lights) that improve the efficiency of public transport and it monitors the complementarity of the bike sharing system with public transport.

The city will establish certain customer relationships with these two types of customers segments. Citizens and visitors are only informed about the possibility of using public transport and bike sharing at mobility hubs, so no active engagement/dialogue is happening. The relationship with the public transport operator is more engaging, as the city will discuss with the public transport operator how the bike sharing service is being used in relation to public transport and how the prioritisation intervention could be improved.

The channels through which the different customer segments are informed, can be divided in digital and physical channels. There will be advertisements on public transport vehicles and the displays at the mobility hubs, to inform about the new mobility hubs and services. The digital channels include campaigns through the social media and website of the public transport operator and bike sharing operator. These physical and digital channels are mainly used to raise awareness about the mobility hubs towards the citizens.

Lastly, we consider the costs and revenues associated with the implementation of the key activities. On the cost side, the city faces fixed costs in terms of its software development and maintenance, its data management, its processing of the tendering and procurement procedures, the maintenance of the physical infrastructure (such as the mobility hubs) and the adaptations made to physical infrastructure to implement the mobility hubs (such as bike sharing stations, information displays, electricity, internet and bus sheltering) and public transport prioritisation (adapting/replacing the traffic lights). The revenues can be split between structural revenues and ad-hoc revenues. The structural revenues only come from advertisement fees of billboards located at mobility hub locations. The ad-hoc revenues come from European funding (projects such as SPINE) and will be used for all key activities.

5.3 Discussion

5.3.1 Stakeholder relationships, opportunities for governmental partners, opportunities for private partners

We note a distinct difference in strategy among the four pilots. The city of Antwerp, with the most advanced mobility policies, focuses their strategy on developing deeper their current journey planner. Given the maturity of their mobility department and mobility solutions, the city seems to have more power to execute its intentions, steer and attract partners (i.e., shared mobility operators) to cooperate with the city in comparison with other cities. In contrast, Tallinn and Bologna rely more on external partners. The former depends on the private market to secure the land necessary to set up their mobility hubs alongside with creating new partnerships with software developers to merge all the data coming from shared mobility and public transport providers. The latter is building a complex ecosystem of actors (within the SPINE project) ranging from logistics providers, communication experts and public space designers to deliver several of their solutions. In addition, they also collaborate closely with external EU projects (i.e., URBANE) to attract logistics partners. In Las Palmas, the government is remarkably absent in the living lab, allocating the representation and management of the solutions to Cinesi. We do expect that these different levels of control will influence the success of the living labs, and will draw conclusions on the management of mobility solutions in such different policy settings.

Likewise, there is a clear difference in customer segments among the four living labs. On one hand, Tallinn and Las Palmas only target individuals. The stakeholders of these two cities were also quite general when describing their customer segments, limiting them to, for example, "overall citizens", "visitors" or "commuters. On the other, Antwerp and Bologna provide solutions for individuals and businesses. The stakeholders considered how their solutions would bring value to the transport and logistics providers, both public and private. In particular, placing transport providers at the centre of the SPINE narrative facilitates their expansion and operations in the city. This is, for example, due to the development of more advanced applications (i.e., journey planner or Smart Mobility app) that uses data to support their vehicle deployment in areas with low public transport serviceability. Furthermore, the cities were able to narrow down their pool of individuals in the customer segments by including solutions to serve impaired groups and employers. This dual approach of Antwerp and Bologna offers the opportunity for more sustainable transport solutions.

However, it is worth noting that there is space for improvements in the communication channels and customer relationships. Sustainable solutions are supported by co-design methods which benefit the public and private partners. In customer relationships, bilateral relations between cities, businesses and population improves the acceptance of a solution. These relations are mediated by direct cooperation between the partners and enabled by channels of communication that allow bilateral feedback. Hence, it would be beneficial for solutions such as the Citizen app for individuals in Bologna and Tallinn to consider channels with direct feedback included in them. Additionally, focal groups can help understanding the use cases of such solutions.

Better categorisation of customer segments would help to select not only the best strategy to create a relationship with the customer but also the partners that should enter the ecosystem. For example, Bologna identified clear customer segments, which resulted in clear partnerships. It also provides clear user journeys for the app development, which increases the chance of success. For this reason, the other living labs could also benefit from a better categorisation of the potential customers, in doing so, they can define what is the best way to engage with them (see Table 33).

Table 33. Ways to engage with the ecosystem

	Unilateral	Bilateral
Citizens, commuters, visitors	Bologna: informing - Citizen app Antwerp: informing – Social media and mainstream channels Las Palmas: informing – Social media and mainstream channels	Tallinn: interaction - Citizen app
Transport providers: public and private		Antwerp: interaction - Marketplace of mobility Bologna: interaction - transport authority as partner
Logistics providers		Bologna: interaction - tendering for logistics

In the communication channels, we found that all cities rely heavily on digital channels, i.e., social media from public or private operators. Although social media can offer a relatively low-cost platform to (often unilaterally) inform customers about the solution, it has clear biases in the

population that is reached through it e.g., young, digitally literate. This channel might not be sufficient to reach the citizens that are embedded in routines (e.g., commuters) or are not interested in digital devices. This approach through social media presents a contradiction when cities mention their customer target "overall all citizens", since only a proportion of citizens would actually be well informed. Instead, cities would benefit from opening more bilateral channels using focus groups that facilitate co-creation exercises. A particularly well-known unpopular measure is congestion charging, which the city of Bologna will design during the SPINE project. We encourage stakeholders to think simultaneously about communication activities as they design the charging scheme.

5.3.2 Implementation challenges

We foresee two types of implementation challenges. First, getting actors on board to create an ecosystem of private partners requires the lead cities to guarantee subsidies in cases when there is not enough revenue to keep the solutions operational. For example, when the pool of citizens using alternative mobility services, i.e., MaaS, Citizen apps, and shared mobility, is not large enough to ensure short-term profitability. In these cases, the city should intervene to generate with the mobility provider a joint scheme to reach a baseline revenue target. The purpose of this baseline is to find out the most cost-effective way to use subsidies to keep providing citizens with the benefits of the solution. Offering subsidies requires to establish an accountability system for operators to detail their impact in the transport system of the city. Besides subsidies, cities might need to endorse new mobility solutions with joint advertising campaigns with public transport operators.

Moreover, more prominent mobility ecosystems also require complex mediation of relationships between actors. In the case of Bologna, for example, the city is implementing more than six solutions that demand engaging with actors of different natures. Aligning the goals of all project partners poses a risk that should be considered.

Secondly, all activities depend on an elaborate range of mobility data. This is inherent to one of the value propositions of the SPINE project, yet generates a risk, as many solutions, such as MaaS or signage, are only helpful with real-time data. One example of mitigating such risk is the shared mobility contracts in Antwerp that stipulate data provision in return for a permit for operation. All living labs require third-party real-time data. Yet some cities (Las Palmas) will also use historic data for prediction. - As such, the city of Bologna leverages its own Citizen App to gain information on mobility profiles, demonstrating the value of the bilateral set-up of this tool.

Furthermore, all cities envision solutions that directly put public transport efficiency at the centre, indicating a willingness to shift from traditional car-dominant streets towards more collective use of the space. For this reason, Tallinn proposes a Smart City app and a Smart Traffic management system. Both of them are complementary solutions. The Smart City app enables traffic monitoring systems using different vehicle data sources, while the smart traffic management uses the results of the analysis of streams of data to build dynamic traffic lights systems to give an advantage to public transport. Similarly, the mobility management system of Las Palmas would offer public transport prioritisation, besides the assessment of the (possible) demand for shared bikes using public transport passenger flows. Bologna also builds a Smart Mobility app that integrates dynamic and static data from shared mobility providers to support the public transport system. In the case of Antwerp, the city foresees further improvement in their multimodal journey app to capture and add more mobility data, hoping to increase its uptake. Antwerp's application is also used internally by the public transport authority to check flows and update the schedule of their transport. In all cases, the ability to capture and analyse different sources of data result in a bottleneck for the execution of the solutions.

5.3.3 Business requirements

Overall, cities fall short when defining their revenue streams and cost structures in the short run. On the revenue side, they rely primarily on ad-hoc, e.g., EU funding and governmental (national or regional) funding, as opposed to finding more structural revenues to maintain the digital and physical infrastructure required to keep the solutions running. The cities thus need to explore other revenue streams. Given the nature of some activities, i.e., MaaS app and journey planners, they will however encounter resistance from their customer segments if they opt for entry fees or paid subscriptions. If the solution is supported by local authorities, one potential avenue for additional funding are adaptive policies. An adaptive policy for mobility could entail that, given a threshold of economic performance, the city will secure additional funding (for the solution) from structural revenues such as fuel or car taxing. However, reaching a consensus from governmental bodies to allocate (often scarce) financial resources to new mobility might be challenging for some cities. . In any case, it is

critical to maintain these applications running smoothly, so citizens do not experience friction when choosing an alternative transport mode.

In addition to the short-term issues, the lack of clear revenue streams also jeopardises the medium- and long-term sustainability. Providers could refuse to enter the ecosystem if they perceive a high degree of financial uncertainty. For example, a city could opt to densify the electric grid system to facilitate the installation of EV charging from providers – this action assumes the market would overlook the provision of the EV infrastructure itself, but without a clear business case, providers would be hesitant to cover the costs of the EV infrastructure provision. A robust revenue and costs framework with clear responsibilities and aids to the providers helps to consolidate the trust of private companies in the government. We consider that, without such a framework, the activities could turn into a band-aid solution to briefly support public transport instead of strengthening the network in the long run.

Only two of the living labs are considering incentives to promote their solutions. Tallinn offers citizens free public transportation when using the P+R, while Bologna offers parents from the primary school an incentive to use more alternative modes of transport. Tallinn did not mention whether ad-hoc or structural revenues fund these incentives, Bologna considers the SPINE budget enough to execute the scheme behind their Citizen app. Indeed, economic incentives can encourage the customer segments to try alternative modes of transportation; however, they might need a more radical stimulus (i.e., taxing system, circulation plans, mobility policies) for a long-term modal shift.

6 SPINE Impact assessment and twinning framework

6.1 SPINE Impact assessment approach

In this chapter, we aim to present the SPINE impact assessment framework which will be used to assess the activities carried out during the SPINE demonstrations and evaluate the success of the SPINE measures in terms of various domains (e.g., PT ridership, modal split, user satisfaction, environment, etc.). It includes an inventory of indicators to be measured and monitored during the lifetime of the project, while also providing guidelines to the SPINE cities on how to collect and share data and information for the measurements, prepare the set of indicators to be measured/monitored during the project implementation as well as identify potential barriers and drivers during the implementation of the SPINE measures. Given the nature of the framework, it should be regarded as a live document that is continuously updated based on the developments of the project. The KPIs that are defined here will feed D1.3 "SPINE Consolidated Impact Assessment Report" where the impact assessment measurements against the baseline and the evaluation of the success of the interventions/measures are consolidated.

To develop the SPINE impact assessment framework, the CIVITAS impact and process evaluation framework (Engels, De Watcher, & Breemersch, 2020) was initially reviewed, while it was further enhanced and adapted to address the needs of the SPINE project (related to the measures that will be implemented in the cities). In accordance with the CIVITAS framework, we envision two complementary activities as follows:

- The **impact evaluation process,** which includes the evaluation of a wide range of technical, social, economic and other impacts of the mobility-related measures being implemented by the cities through the definition, measurement and monitoring of specific Key Performance Indicators (KPIs). The assessment of the identified indicators is undertaken before (baseline value) and after (final value) the measures' implementation to identify their impact within selected impact categories.
- The **process evaluation activity**, which involves the evaluation of the processes of planning, implementation and operation of the measures, aims to understand why the measures have succeeded or not, including the roles of information, communication and participation. The process evaluation activity is taking place during the operational stage of the project. At this step, potential barriers and drivers of the implementation of each measure are identified. Furthermore, the level of effect of activities in terms of facilitating the implementation, increasing the envisaged impact and avoiding or reducing undesirable impacts are investigated.

In order to achieve a consistent evaluation of the work progress, CIVITAS framework outlines two key roles in the evaluation process of the project. Collaboration of these provide a feasible, efficient and well-structured evaluation approach. Considering the above, the establishment of these roles is considered as a crucial aspect within SPINE, and we define them as follows:

- **Project Evaluation Manager (PEM):** The PEM is responsible for the synthesis of the indicators and supports cities in the process of evaluation in an efficient and consistent way. In SPINE, the PEM is the UAEGEAN and their role will be to scientifically support the evaluation process and draw conclusions based on SPINE's targets.
- **Local Evaluation Manager (LEM):** The LEM is a local stakeholder in each city and is responsible for the whole evaluation process (impact evaluation process and process evaluation activity) within that specific city. LEM collaborates with local partners to coordinate actions for the city. In SPINE, the LEM will be a representative of city partner, who can have a more targeted overview of the progress of the implementations in the city.

The collaboration of PEM and LEM is very important for the progress of the SPINE project. It is crucial to assign those roles from the start of the project in order to achieve the ultimate results.

6.1.1 Impact evaluation process

The impact evaluation process in SPINE includes the definition of the indicators to be measured and monitored for each city to evaluate the impact of SPINE measures on different domains. The assessment of impact within SPINE relies on 'before-and-after' comparisons and should be consistently conducted across all cities. This approach facilitates the sharing of experiences and mutual learning between cities. In general, the approach that we will follow in the impact evaluation process in SPINE is described below:

- Define a set of indicators that describe accordingly the city's characteristics and goals;
- Collect baseline values for these indicators (before the implementation of the proposed measures) and set target values;
- Implement the measures in SPINE cities;
- Estimate the final values of the indicators (after the implementation of the proposed measures);
- Compare baseline and final values of the indicators in each city and formulate the conclusions of the solutions implemented.

6.1.1.1 Define the indicators at city level

Nevertheless, it is important to recognise that in real-world scenarios, a multitude of factors can influence the assessment of the SPINE measures' impact and the trajectory of a specific key performance indicator within the city. For instance, while the implementation of a SPINE measure can impact one facet of a KPI, simultaneously, other city-related factors may also exert an influence on the same KPI.

In SPINE, nine impact categories presented in Table 34 are considered. As indicated in the table all these categories are linked with the different impact categories identified by the CIVITAS framework.

Table 34. SPINE categories of indicators aligned with CIVITAS

CIVITAS framework	Society - People	Governance - People	Transport system	Economy	Energy	Environment
SPINE framework	User Satisfaction	Other	Congestion	Other	Other	Greenhouse Gas Emissions
	Access to Mobility Services		Modal Share			Air Pollution
	-		Accidents and Injuries			Noise Pollution

The next step was to define the specific indicators (referred also as KPIs-Key Performance Indicators) included in the above nine categories. It should be noted that SPINE has two main indicators that should be measured, monitored and achieved in all SPINE cities:

- Increase of the public transport share in the modal split by 30% compared to the baseline.
- Increase of user satisfaction with public transport by 25% compared to the baseline.

However, more indicators were formulated in order to account for environmental, transport, social and other impacts. For this purpose, the list of indicators identified from the CIVITAS framework was further strengthened and enriched by reviewing and incorporating the findings from the following projects and initiatives:

- REPLICATE project (REnaissance of PLaces with Innovative Citizenship And Technologies): is a European research and development project that aims to deploy energy efficiency, mobility and ICT solutions in city districts (Tecnalia, 2017).
- RESPONSE project: aims to establish a strategic vision for Smart Cities Energy Transition: Climate-neutral cities by 2050. RESPONSE aims to turn energy sustainability into a do-able vision by solving the energy trilemma (security, equity/affordability, environmental sustainability) at building, block and district levels in smart cities. (Martinopoulos , Nikolopoulos , & Angelakoglou, 2021).
- Sharing CITIES LH: The Sharing Cities 'lighthouse' programme is a proving ground for a better, common approach to making smart cities a reality. By fostering international collaboration between industry and cities, the project seeks to develop affordable, integrated, commercial-scale smart city solutions with a high market potential. (Zavitsas, et al., 2016).
- MatchUp Lighthouse cities: MAtchUP will design and implement a palette of innovative solutions in the energy, mobility and ICT sectors that will serve as a model of urban transformation for other cities in Europe and beyond. (Mabe , Vallejo , Hernández , Quijano , & de Torre, 2018).
- MySmart Life Lighthouse cities: The mySMARTLife project aims at making the three Lighthouse Cities of Nantes, Hamburg and Helsinki more environmentally friendly by reducing the CO2 emissions of cities and increasing the use of renewable energy sources. (CER, et al., 2019).

- SmartENCity: SmartEnCity's main objective was to develop a highly adaptable and replicable systemic approach towards urban transition into sustainable, smart and resource-efficient cities in Europe (Kamenjuk , et al., 2017).
- MOVE21: MOVE21 aims at transforming European cities and their surroundings into smart zero emissions nodes for mobility and logistics. The project helps participating cities achieve a 30% reduction of transport-related emissions by 2030 via the implementation of 15 transport-related innovations. (Morfoulaki & Konstantinidou, 2021)

The full list of SPINE indicators was created including the following information:

- SPINE category of the KPI, which included the name of the impact category as defined in Table 34
- KPI name
- KPI Definition, including a short description of each indicator
- KPI Unit, i.e. the unit for measuring the indicator
- Supporting data and methods to measure and monitor the KPI

In collaboration with the SPINE cities, this full list was reduced in order to define the list of indicators that should be measured and monitored in each SPINE city. The criteria for including an indicator in the impact evaluation process of a city were:

- Measure-specific, meaning that only KPIs that affect the city's measures are kept;
- Data-specific, considering the data needs to calculate each KPI and the data availability in each city.

For the above procedure, various meetings among the Project Evaluation Manager (UAEGEAN) and the cities' representatives were conducted in order to understand:

- Which of the identified KPIs are currently measured by the cities? What types of data are used?
- Which of the identified KPIs are affected by the SPINE measures in each city?
- Does the city have access to the data needed for the calculation of the KPIs?

The curated list of the SPINE KPIs consists of 68 indicators as presented in Table 35.

Table 35. List of Indicators formulated for SPINE

1. greenhouse gas emissions	**4. modal share**	**5. access to mobility services**	**6. air pollution**	**9. other**
IND6: CO2 emissions	IND1: Average modal split of public transport	IND13: Perception of the level of physical accessibility of a mobility service	IND8: Air pollution	IND14: Stakeholder engagement
IND51: Energy consumption at EV charging stations	IND4: Demand for PT	IND22: Reliability of PT		IND18: Roads with restricted speed zone
	IND5: Number of cars entering the city centre	IND30: Availability of shared bikes	**7. noise pollution**	IND23: Average cycling time
2. congestion	IND10: PT passengers by age	IND31: Availability of bike-sharing stations	IND9: Noise levels	IND24: Number of bike-sharing users
IND7: PT congestion	IND11: PT passengers by gender	IND32: Availability of shared bikes at PT stations		IND25: Distance travelled by bike-sharing
IND15: Car congestion level	IND12: PT vulnerable passengers	IND33: Availability of bike-sharing docks at PT stations	**8. user satisfaction**	IND25a: Number of trips conducted by bike-sharing
IND16: Perceived waiting time at PT stops	IND47: Demand in multimodal hubs	IND34: Availability of bike-sharing docks at PT stations_2	IND2: Citizens' satisfaction with public transport services	IND27: Average time of commuting with scooters
IND17: Average waiting time at PT stops	IND50: Demand of on-demand services	IND35: Cycling lanes	IND3: User satisfaction with the SPINE solutions	IND28: Number of scooter-sharing users

	IND63: Demand for car-pooling	IND36: Availability of shared scooters	IND20: Perceived safety/security in PT	IND28a: Number of trips conducted by scooter-sharing
3. accidents and injuries		IND37: Availability of scooter-sharing stations	IND21: Perceived safety/security in shared mobility services	IND29: Distance travelled by scooter-sharing
IND19: Traffic accidents		IND38: Availability of shared scooters at PT stations	IND26: Cycling conditions	IND42: Occupancy rate of parking spaces
		IND39: Availability of scooter-sharing docks at PT stations	IND49: Perceived quality of the multimodal hub	IND44: Use of space for parking
		IND40:Availability of scooter-sharing docks at PT stations_2	IND64: Crowd level of PT	IND45: Number of multimodal hubs improved
		IND41: Parking availability	IND65: Perceived quality of the PT	IND53: Coverage of LEZ
		IND42: Parking cost		IND53a: Design of LEZ
		IND46: Mobility services at multimodal hubs		IND57: MaaS/multimodal journey planner app trips
		IND48: Number of PT stations with more than one mobility services		IND58: MaaS/multimodal journey planner app registered users
		IND52: EV charging stations		IND59: Citizen app registered users
		IND54: Installation of digital signages/interactive screens etc.		IND60: Green wave
		IND55: PT stops with real-time passenger information		IND61: Goods transported via cargo hitching
		IND56: Mobility integration in the multimodal app		IND62: Cargo hitching usage

The calculation of the KPIs in SPINE will be carried out at city level. The full description of the SPINE KPIs can be found in Annex VI, where guidelines on how to collect the required data for the measurements and prepare the set of indicators were provided to the cities.

After the discussions with the cities, the above list of KPIs was further reduced in order to capture the indicators for each city. It is imperative to emphasize that the initial intent was to maintain uniformity in the definition and units of KPIs across all SPINE cities. Nevertheless, certain challenges, primarily stemming from data limitations and variations in each city's existing measurement practices, necessitated slight modifications to the KPIs, encompassing adjustments in both their definitions and units, to align with the specific requirements of each city. This adjustment was also necessary in order to ensure that the resulting KPIs remain coherent and comparable between baseline and target years. However, whenever feasible, the original KPI list was retained, preserving uniformity, provided that data availability and format permitted such continuity. The list of KPIs that will be measured in each city is presented in Annex VI, as well as in D1.1.

6.1.1.2 Collect baseline value and set target value for each indicator

During the meetings with the cities, it was made clear that the KPIs' measurements should be done both before and after the SPINE measures' implementation. Thus, baseline and target values were defined for each KPI, capturing the value of the KPI before and after SPINE measures respectively.

Setting the baseline year was an important step in SPINE, as the aim was to provide a clear and accurate snapshot of the transportation system before SPINE measures, allowing us to assess the

true impact of our interventions. To determine the most appropriate baseline year, the following considerations were followed:

- Data Availability: One of the primary factors considered was data availability. In SPINE, we chose years for which the cities have comprehensive and reliable data for the relevant indicators (e.g., modal split, PT usage, satisfaction levels). On the other hand, the suggestion was to use data recent enough to reflect the current conditions in the city and the context in which the SPINE interventions will take place (e.g. not recent data may not accurately represent the current mobility challenges and behaviors).
- Policy Timeline: The timing of significant policy changes or transportation projects in the city was considered to select a baseline year (e.g. a period after these changes is considered more appropriate as we can assess the impact of SPINE solutions separately from other initiatives).
- Seasonal Variations: In case the baseline value was derived for a smaller time period (e.g. monthly, weekly, etc.), seasonal variations were considered to choose a baseline period that provides a representative picture of the KPI.
- Data vs budget balance: A significant challenge during this process was to determine the applicable balance between available baseline data and data collection requirements. In cases where the baseline year values were not recent enough, we discussed that along with cities' representatives to find a mutual accepted solution, based on each city's available budget. For example, conducting a survey is a time- and money-consuming procedure that creates barriers in the evaluation process.
- Covid-19 Pandemic: The impact of Covid-19 pandemic, is acknowledged to have had a profound impact on the transportation systems of all cities. On the one hand, in some cases, we opted to use pre-pandemic data (e.g. 2019) as a baseline to represent "normal" conditions in mobility. On the other hand, it is important to acknowledge that Covid-19 has disrupted transportation systems, altering travel patterns, demand for PT, and traffic congestion levels. Thus, these "normal" conditions before 2020 may not fully align with the post-pandemic reality. Based on available data from the cities and their insights into how travel patterns changed, we used the most representative set of available data, for each case.

Overall, the discussions of UAEGEAN with the SPINE cities' representatives were crucial, as the latter provided useful insights into the most appropriate baseline year based on the specific mobility context and recent developments in the city. Table 36 presents the baseline years utilised for the two key indicators of SPINE (IND1 and IND2). Notably, for most of the cities recent data have been used. However, for some cities where baseline data are not recent enough, we will explore the feasibility of gathering fresh data to accurately reflect the KPI status before the introduction of SPINE measures.

Table 36. Baseline years for SPINE indicators IND1 and IND2

	Baseline year for IND1 (PT market share)	Baseline year for IND2 (User satisfaction with PT)
Antwerp	2022	2022
Tallinn	2022	2022
Bologna	2016	2021-2022
Las Palmas	2020	2021
Sibenik	2022	No baseline available
Barreiro	2017	2023
Gdynia	2018	2018
Valladolid	2015	2023
Zilina	2022	2022
Heraklion	2020	No baseline available
Rouen	2016-2017	No baseline available

Concerning the target values, these were determined in collaboration with the cities' representatives to ensure that target values align with the city's goals and priorities, as well as with the SPINE measures to be implemented.

6.1.1.3 Implement SPINE measures

This step corresponds to the activities conducted as part of WP2 and WP4 to implement the SPINE measures. This step is not further discussed in this deliverable.

6.1.1.4 Estimate the final values of the indicators

In SPINE, the final values of the KPIs will be generated from two fundamental data sources:

- Outcomes of the SPINE cities' implementations: This source involves collecting data directly from the cities where SPINE interventions have been implemented. It encompasses real-world observations and measurements of the mobility interventions and their effects. Data may be collected through various methods, including sensors, questionnaire surveys, data collection from existing databases of the city (e.g. municipalities, transport operators) and monitoring systems.
- Transport modelling and simulation outcomes: This involves the use of transport models and simulations to predict how mobility interventions will affect the transportation system. Such tools will be developed as part of WP3 in some SPINE cities.

It is worth noting that the cities' representatives have already identified the methods of collecting the data required for the estimation of the final values of the KPIs.

6.1.1.5 Compare baseline and final values of the indicators in each city

After estimating the final values of each indicator, a comparison with the baseline values should take place to assess the impact of SPINE interventions.

An inherent challenge in assessing the true impact of the SPINE measures lies in the presence of external factors that can influence the considered KPIs. For instance, while the implementation of a SPINE measure can impact one facet of a KPI, simultaneously, other city-related factors may also exert an influence on the same KPI. These factors, ranging from economic shifts to unforeseen events, may confound our ability to attribute changes solely to our interventions. To address this, we will explore employing a comprehensive set of analytical methods and strategies. These might include control group comparisons, regression analysis, and data normalization, enabling us to isolate the effects of our interventions from the broader context.

6.1.2 Process evaluation activity

The process evaluation activity is a critical procedure of the general evaluation and is related to the assessment of how mobility measures and initiatives are planned, implemented, and managed within the project's demonstrations. In SPINE, this evaluation activity focuses on understanding the "process" followed by each city and aims to answer questions related to how well the activities were executed, what challenges were encountered, and what lessons can be learned from the implementation process itself. Below we describe the different steps included in this process.

Before the beginning of the evaluation activity, the following items should be considered by the cities' representatives (e.g. municipalities, transport operators, local supporters) that are involved in the implementation of the SPINE measures:

- Identification of the responsible stakeholders and specification of their role in the implementation of the SPINE measures;
- Description of the required activities and their sequence (operational activities, procurement processes, etc.) for the implementation of SPINE measures;
- Establishment of a timeline with specific milestones for tracking the progress of the measure's implementation;
- Identification of the target groups or people affected by the implementation of the SPINE measures;
- Description of the supporting activities to approach the target groups, disseminate and promote the use of SPINE measures, etc. (how they will benefit, possible inconveniences in testing measures, future benefits etc.).

During the implementation of SPINE measures, the following activities should be considered by the cities' representatives:

- Monitor the implementation process on a regular basis. This monitoring will help cities identify any challenges or obstacles faced during the implementation of mobility measures, which might be related to technical issues, regulatory barriers, or users' acceptance. To achieve a better tracking record of the procedure and ensure transparency, it is important to keep detailed records and documentation of the implementation process, as follows:
  - Recording of communications such as emails, telephone records, notes from face-to-face meetings, that have contributed to the implementation of the measures;
  - Recording of all relevant events in the implementation process with comments on how the process was supported;
  - Recording of other project management information;
  - Keeping track of all the above communications and processes in a unique file.
- Communicate the findings from process evaluation to all relevant partners (local partners, technical partners that are involved in the SPINE measure, etc.), who need to be aware of potential risks or barriers that might not lead to the planned implementation of actions within SPINE. This process also helps in sharing knowledge and experiences.
- Collaborate with all involved partners to identify and report possible mitigation actions, in case a risk has come up.
- Engage stakeholders to discuss the implementation process. These stakeholders could involve:
  - SPINE partners, to collect their feedback regarding the implementation process and their role in implementing the SPINE measures.
  - External stakeholders, mobility experts, experts in related domains, experts with good knowledge of the local administrative and juridical procedures who are not directly involved in the implementation of the measure. Their feedback can be helpful in getting better insights into the implementation process.
- Engage users through questionnaire surveys to further understand some aspects of the implementation process. If a survey is already planned for the impact evaluation process, some questions helpful for the process evaluation can be added. The critical aspect is to assess the influence and the importance of supporting activities to these users. Suggested questions such as 'what did convince you to use the measure' can result in motivated conclusions about the influence of a specific supporting activity.

The above activities could be implemented by all SPINE cities to support the activities conducted as part of WP2 and WP4.

6.2 SPINE Twinning approach

SPINE engages in a series of iterative, coordinated activities which aim to synchronise the efforts and progress of all LLs in the project and achieve horizontal fertilisation of activities, solutions and findings rather than exclusively lead-to-twinning transfer of knowledge. The SPINE twinning framework is based on collaboration and knowledge sharing between the SPINE LLs aiming at creating effective and impactful PT solutions compared to working in isolation. The logic behind the twinning framework is grounded in the understanding that collaboration, shared learning, and mutual support are fundamental drivers of innovation and progress. By connecting the SPINE LLs and facilitating the exchange of knowledge and resources, the twinning framework aims to maximise the potential for impactful PT outcomes and create a collaborative ecosystem that fosters continuous innovation and societal advancement.

The SPINE twinning framework is based on the following principles:

1. Synergy: By joining forces and leveraging each other's strengths, LLs can achieve greater results than they would individually. The collaboration between the SPINE LLs creates a synergy that enables them to tackle larger and more complex challenges, pool resources, and develop innovative solutions.
2. Knowledge Exchange: SPINE facilitates the exchange of best practices, lessons learned, and expertise between the LLs. By sharing their methodologies, processes, and success stories, the LLs can learn from each other, avoid common pitfalls, and enhance their own capabilities. This knowledge transfer strengthens the overall maturity and effectiveness of the SPINE LLs.
3. Collaboration and Co-creation: SPINE promotes collaborative research and development projects among the LLs. By working together, the LLs can bring together multidisciplinary expertise, resources, and perspectives to address complex PT challenges. This collaborative

approach fosters innovation, promotes co-creation with diverse stakeholders, and enables the development of context-specific and inclusive solutions.

4. European Perspective: The SPINE twinning framework encourages cross-border collaboration, enabling the LLs to engage in a European knowledge exchange. This European dimension brings diverse perspectives and cultural influences into the mix, leading to a more comprehensive understanding of complex issues and the development of solutions that can be scaled up and applied in different contexts in Europe.
5. Network Effect: By establishing connections and partnerships, the SPINE LLs create a network that amplifies their collective impact. The network effect allows for broader reach, increased visibility, and access to a wider pool of knowledge and resources. This interconnectedness enhances the overall innovation ecosystem and accelerates the pace of progress of the SPINE solutions.

The 5 principles of the twinning framework are enabled by a set of categories of cross-pollination and twinning activities. The logic of the twinning framework is that lead cities create transferability and replicability between each other horizontally by cross-pollination activities and vertically from lead city to twin cities by twinning activities (see Figure 1). A series of physical and digital meetings are planned where ambassadors from each LL, along with the SPINE Leader's pool will meet and discuss progress, drivers to overcome barriers and successful practices, ensuring close cooperation and an agile adaptation of good practices and key solutions across all LLs.

The common denominator for the cross-pollination and the twinning activities are how findings, activities and methods from the lead and twinning cites can be sustained between the different LLs. For example, the LLs need to consider how the output from field work, or workshops can be useful in another LL, or how customized activities or methods for a lead city can be used as a blueprint or script for action in a twinning city. The LLs need to consider how findings, activities and methods can be sustained in another LL to create a bi-directional flow of exchange of good ideas and key findings. Hence the cross-pollination and the twinning activities are comparable and interchangeable in some cases. Therefore, the cross-pollination and twinning activities will be investigated together by the LLs to establish joint LL approaches.

Based on the SPINE methodology we have categorised the LL activities into actions related to *Emphasising*, *Ideating*, *Prototyping*, and *Testing*. The LLs will collaborate and co-create approaches and LL activities that can be conducted both in parallel and in sequence in the different lead and twinning cities.

The cross-pollination and twinning activities within the SPINE project are classified into three distinct types, each serving a specific purpose:

1. Scaling: These types of activities focus on identifying findings that can be scaled up and transferred between the different LLs involved in the project. It involves recognizing successful practices, approaches, or solutions that have been implemented in one LL and determining their potential for broader application and implementation in other LLs. By scaling these findings, the project aims to maximise their impact and benefits across multiple contexts. This ensures that successful findings are not limited to a single LL but can be expanded and replicated, leading to broader positive outcomes.
2. Replicating: This category focuses on identifying activities or methods that have shown promise and would be beneficial to replicate in different LLs. It involves recognising effective processes, approaches, or methodologies that have been successfully implemented in one LL and determining their potential for application in other LLs. This avoids the need for each LL to reinvent the wheel and provides an opportunity for more efficient and effective implementation of PT solutions.
3. Evolving: This category of activities focuses on utilising the output from lead cities to inform and shape the LL processes in twinning cities. It recognises that different LLs may be at different stages of progress or have unique expertise and insights to offer. The evolving activities involve leveraging the outputs, knowledge, and experiences from lead cities and using them to reframe and enhance the LL processes in the twinning cities. The twinning cities, in turn, may also provide new perspectives, innovative ideas, or alternative approaches that can be shared with the lead cities, fostering a mutually beneficial exchange of knowledge and insights.

By categorising the cross-pollination and twinning activities into scaling, replicating, and evolving, the SPINE project ensures a comprehensive exploration of opportunities for knowledge transfer, adaptation, and improvement. This approach enables the project to maximise the potential for impactful outcomes by leveraging successful findings, sharing best practices, and facilitating a dynamic exchange of ideas and experiences among the participating LLs.

A tentative plan for arranging meetups working with cross-pollination and twinning activities is presented in Table 37. At these meetups, we will focus on collaborating and co-creating approaches to be used in the SPINE LLs in addition to sharing knowledge and insights produced at the different LLs.

Table 37. SPINE cross-pollination and twinning activities

Activity	Description	Month
1	Planning and setting up digital platforms for collaboration	M5
2	Interviews about goals, visions and challenges of SPINE LL	M6
3	Co-Creation and planning of LL activities in lead cities	M10
4	Co-Creation and planning of LL activities in twinning cities	M11
5	Digital meet-up 1: Presentation of LL journeys for both Lead and twinning cities	M12
6	Physical cross-pollination meeting with lead cities	M13
7	Co-Creation and planning of LL activities in lead cities	M15
8	Co-Creation and planning of LL activities in twinning cities	M15
9	Assessment of experiences and learnings in the LLs and in SPINE	M17
10	Physical cross-pollination meeting with twinning cities	M17
11	Digital meet-up 2: Sharing LL experiences between lead and twinning cities	M18
12	Digital cross-pollination meeting with lead cities	M24
13	Digital meet-up 3: Sharing LL experiences between lead and twinning cities	M24
14	Physical cross-pollination meeting with lead cities	M30
15	Assessment of experiences and learnings in the LLs and in SPINE	M29
16	Digital meet-up 4: Sharing LL experiences between lead and twinning cities	M30
17	Digital cross-pollination meeting with lead cities	M36
18	Digital meet-up 5: Sharing LL experiences between lead and twinning cities	M36
19	Assessment of experiences and learnings in the LLs and in SPINE	M42

7 SPINE implementation plan

This chapter aims to present a plan for the different activities taking place in each city. More specifically, we present the:

- The proposed time plan for the SPINE measures that will be implemented in the cities, including the operational processes,
- The co-creation aspects including the set-up of bulletin boards,
- The models that will be developed in each of the selected SPINE cities.

7.1 Timeplan of the SPINE measures' implementation

This section presents the envisioned time plan for each city to implement the identified SPINE measures. It should be noted that as part of WP2 and WP4 more detailed implementation planned are being constructed to identify the timings of the necessary activities for the implementation of SPINE measures.

7.1.1 Antwerp

The measures that will be implemented in Antwerp include:

- MS1: Multimodal hubs
- MS2: Real-time information for passengers
- MS3: Multimodal journey planner app
- MS13: Traffic Management / PT prioritisation services

The implementation plans of the measures are provided below.

Table 38. Implementation plan for the SPINE measures in Antwerp

Measure ID	Operations Processes	Month Start	Month End	Progress monitoring 1
MS1: Multimodal hubs	• Establish data sources/access • Collection of all relevant permissions • Implementation initiation • Integration with existing systems • Initiation of the testing period • Prototype build and test • Roll-out	Jun-23	Dec-25	Dec-23
MS2: Real-time information for passengers	• Creation of use cases • Mapping of the various data owners • Analysis of data sets • Onboarding of improved data sets into NXTMobility/Api-store of the City of Antwerp • Data implementation (production)	Jul-23	Dec-25	Mar-24
MS3: Multimodal journey planner app	• Launch development challenge • Interface redesign • Development of new features • Move to production	Jul-23	Dec-25	Dec-24
MS13: Traffic Management / PT prioritisation services	• Data collection • Data engineering • Implementation • Verification • Analysis • Optimisation of public transport prioritisation and green wave	May-23	Jun-26	Dec-24

7.1.2 Tallinn

The measures that will be implemented in Tallinn include:

- MS1: Multimodal hubs
- MS8: Smart City Platform
- MS9: Citizen Mobility App / Micro-incentives programme
- MS11: Cargo-bikes renting service
- MS12: Smart park and Ride management

- MS13: Traffic Management / PT prioritisation services
- MS19: Environmental Sensors

The implementation plans of the measures are provided below.

Table 39: Implementation plan for the SPINE measures in Tallinn

Measure ID	Operations Processes	Month Start	Month End	Progress monitoring 1 and 2
MS1: Multimodal hub / information screens	• Negotiations of all the stakeholders and private company owning the land • Market consultation to find best available solution • Preparation of tender • Istallation of relevant technical equipment • Implementation of integrations with trasportation operators systems • Initiation of testing period • Monitoring of the usage and influence for PT usage	Jun-23	Dec-25	1: Oct-23 2: Jun-24
MS8: Smart City Platform	• Analyzing and evaluating the proposed measures against the data sources available from the city • Transforming the required data into a standardized format in collaboration with Konnecta • Identifying use cases for configuration and development based on the city's needs • Designing UI interfaces for the identified use cases and obtaining approval from city representatives and the SPINE management team • Configuring and developing the approved designs • Installing the environmental sensors provided by Arcadis IBI (refer to MS19) • City/Konnecta providing test data sources for evaluating goals and KPIs • Integrating the Smart City Platform with the identified data sources • Determining the deployment process and selecting appropriate cloud services for the SCP • Initiating a testing period to ensure the functionality and performance of the application • Monitoring and analyzing the results obtained during the testing phase • Deploying the application with the desired use cases and required dashboards • Ensuring ongoing maintenance and management of the deployed application	Apr-23	Dec-26	1: Dec-24 2: Dec-25
MS9: Citizen Mobility App	• Technical consultation and implementation evaluation • Implementation of the technical integration • Piloting the citizen app inside the MaaS app • Monitoring the usage and influence to the user behavior	Jun-23	Dec-25	1: Dec-23 2: Jun-24
MS11: Cargo-bikes renting service	• Negotiations of all the stakeholders • Installation of relevant technical equipment • Preparation of parking areas for cargo-bikes • Implementation of the service • Initiation of testing period • Monitoring of the usage and influence	May-23	Dec-25	1: Aug-23 2: Dec-24
MS12: Smart park and Ride management	• Negotiations of all the stakeholders and private company owning the land • Market consultation to find best available solution • Preparation of tender • Installation of relevant technical equipment • Implementation of integrations with transportation operators' systems • Initiation of testing period • Monitoring of the usage and influence for PT usage	Jun-23	Jun-26	1: Oct-23 2: Jun-24

MS12: Smart park and Ride management (South-Tallinn)	• Eligibility study to find suitable spot • Negotiations with all stakeholders • Preparation of tender • Implementation of technical equipment and integrating with transportation systems • Initiation of testing period • Monitoring of the usage and influence for PT usage	Jun-23	Dec-25	1: Oct-23 2: Jun-24
MS13: Traffic Management / PT prioritisation services	• Technical consultation and implementation evaluation • If specific locations can be used for PT priority, the implementation of the technical integration will start • Monitoring the influence on the PT journey time	Jun-23	Dec-25	1: Sep-23 2: Jun-24
MS19: Environmental Sensors	• Shipping • Installation Planning • Remote Guidance for deployment • Integration with Smart City Platform • Testing and Calibration • Data Visualization and Analysis • Training and Ongoing Support within SPINE's timeframe	Apr-23	Dec-25	1: Dec-23 2: Jun-24

7.1.3 Bologna

The measures that will be implemented in Bologna include:

- MS1: Multimodal hubs
- MS4: EV charging stations
- MS5: Inclusive mobility services
- MS6: Mobility as a Service (MaaS)
- MS7: LEZ (Low Emission Zone)
- MS8: Smart City Platform
- MS9: Citizen Mobility App / Micro-incentives programme
- MS10: Logistics solutions
- MS13: Traffic Management / PT prioritisation services

The implementation plans of the measures are provided below.

Table 40: Implementation plan for the SPINE measures in Bologna

Measure ID	Operations Processes	Month Start	Month End	Progress monitoring 1 and 2
MS1: Multimodal hubs	• Needs analysis • Involvement of partners and local service providers • Identification of interventions and features • Establish data sources / access • Engagement of stakeholders • Adaptation of features of HUB to needs • Develop awareness and communications approach • Evaluation of bids and awarding of contracts • Collection of all relevant permissions • Installation of physical structures of hub • Integration with existing systems • Communications actions • Initiation of testing period • Collection of results	Apr-23	Dec-25	1: Dec-24 2: Dec-25
MS4: EV charging stations	• Tender procedure and contract award • 6-9 accessible charging stations installed in Multimodal Hubs • Usage data from providers • integration with SPINE technical solutions	Dec-23	Dec-25	1: Aug-24 2: Dec-25

MS5: Inclusive mobility services	• Identify locations • identify accessibility needs in synergy with SUMP guidelines • Identify possible solutions • Planning procurement procedures • Integration with WP3 tools • Implementation	Feb-24	Jun-25	1: Dec-24 2: Dec-25
MS6: MaaS	• Working group activation • MaaS design • Standard definition • Instant System platform customization • Instant System platform testing • Users' targeting • Users' involvement • Before-survey • MaaS implementation running • After-survey	Sep-23	Dec-25	Aug-24
MS7: LEZ (Low Emission Zone) - Green Area/City30	• Setting up vehicle flow monitoring and measuring capacity • Establish Interdepartmental cooperation protocol • Awareness and communications actions • Verify functioning of cameras and data collection • Start data collection • Data collection • Tool integration • Analyse collected data • Environmental charging scheme defined • Implementation and monitoring of the charging scheme • Results analysis	Nov-23	Dec-25	1: Mar-25 2: Dec-25
MS8: Smart City Platform	• Analyzing and evaluating the proposed measures against the data sources available from the city • Transforming the required data into a standardized format in collaboration with Konnecta • Identifying use cases for configuration and development based on the city's needs • Designing UI interfaces for the identified use cases and obtaining approval from city representatives and the SPINE management team • Configuring and developing the approved designs • City/Konnecta providing test data sources for evaluating goals and KPIs • Integrating the Smart City Platform with the identified data sources • Determining the deployment process and selecting appropriate cloud services for the SCP • Initiating a testing period to ensure the functionality and performance of the application • Monitoring and analyzing the results obtained during the testing phase • Deploying the application with the desired use cases and required dashboards • Ensuring ongoing maintenance and management of the deployed application	Apr-23	Dec-26	1: Dec-24 2: Dec-25
MS9: Citizen Mobility App / Micro-incentives programme	• Target group identification (potential target groups: scholars/students, employees, citizens, etc.) • Identification of stakeholders to be involved (School authorities, Mobility managers, local public authorities, etc.) • Micro incentive scheme design • Micro incentive procurement and sponsoring • Micro incentive campaign scheduling • Software (Citizen App) customization • Software testing • Target group recruiting • Micro incentive campaign running with software deployment • Evaluation of results	Sep-23	Dec-25	Sep-24

MS10: Logistics solutions	• Testing of shared logistic solution in the framework of the HE URBANE project • Observation and analysis of main results and lessons learned from the URBANE experience • Elaboration of a possible management scheme for a future feasibility testing of a cargo hitching solution	Feb-24	Dec-25	1: Feb-24 2: Dec-24
MS13: Traffic Management / PT prioritisation services	Selection of corridor/period by COBO; identification and collection of relevant data on traffic flows and traffic lights management; analysis of PT data quality; analysis of PT prioritisation ; analysis green wave along selected trajectories. Monitor smoothing and calming of traffic flows in the city 30 area (MS5).	May-23	Dec-25	Dec-24

7.1.4 Las Palmas

The measures that will be implemented in Las Palmas include:

- MS1: Multimodal hubs
- MS7: LEZ (Low Emission Zone)
- MS11: Cargo-bikes renting service
- MS13: Traffic Management / PT prioritisation services
- MS14: Mobility Management Software feature extension

The implementation plans of the measures are provided below.

Table 41: Implementation plan for the SPINE measures in Las Palmas

Measure ID	Operations Processes	Month Start	Month End	Progress monitoring 1 and 2
MS1: Multimodal hubs	• Drafting the reference document • Tender preparation • Launching and award • Purchase of equipment • Implementation • PT prioritisation (LPGC_MS5 - YUNEX) at 7 Palmas hub corridor • Fieldwork campaign - ex-ante (funded by Guaguas) • Specific communication campaigns • Fieldwork campaign - ex-post	Jun-23	Dec-25	1: Jan-24 2: Jan-25
MS7:Low Emission Zone (LEZ)	• Analysis of citizen participation carried out by the Municipality (outside the SPINE project) • Preparation of the implementation plan • Simulation - Modelling in AIMSUN of the LEZ	Dec-23	Dec-25	1: Dec-24 2: May-25
MS11: E-bike stations	• Drafting the reference document • Tender preparation • Launching and award • Purchase of equipment • Implementation • Fieldwork campaign - ex-ante (funded by Guaguas) • Specific communication campaigns • Fieldwork campaign - ex-post	Oct-23	Dec-25	1: Jan-24 2: Jan-25
MS13: PT prioritisation services	• Corridor selection (Guaguas) • Data collection (LPA can provide data regarding traffic lights and GPS positioning of the buses) • Implementation Quality Management of Data (YUNEX) • Implementation of PT prioritisation Quality Analysis (YUNEX) • Implementation Green Wave Quality Analysis (YUNEX) • Implementation Green Wave Visual Analytics (YUNEX) •Analysis of PT prioritisation (Guaguas)	Jun-23	Dec-25	1: Jan-24 2: Jan-25

MS14: Mobility Management Software feature extension	• Identification of needs by SAGULPA • Tender preparation • Launching and award • Use/Operation • Report on the improvements achieved	Sep-23	Dec-25	1: Jan-24 2: Jan-25

7.1.5 Gdynia

The measures that will be implemented in Gdynia include:

- MS1: Multimodal hubs
- MS5: Inclusive mobility services
- MS12: Smart park and Ride management
- MS13: Traffic Management / PT prioritisation services

The implementation plan of the measures is provided below.

Table 42: Implementation plan for the SPINE measures in Gdynia

Measure ID	Operations Processes	Month Start	Month End	Progress monitoring 1
MS1: Multimodal hubs / Integration of modes & ticketing	• Elaboration of the concept of transformation of multimodal hub Gdynia Central • Conduction of tender procedure for elaboration of the technical project of transformation of multimodal hub Gdynia Central • Elaboration of the technical project of transformation of multimodal hub Gdynia Central • Tender procedure for elaboration of the technical project of transformation of multimodal hub Gdynia Central launched • Technical project of transformation of multimodal hub Gdynia Central elaborated	Oct-23	Jun-25	Sep-24
MS1: Multimodal hubs / Integration of parking guiding system	• Preparation of tender procedure • Installation of Near Field Communication (NFC) labels • Implementation initiation • Integration with existing systems and data • Initiation of testing period • Data capture (if feasible) to identify number of users	Jun-23	Jun-26	Feb-25
MS5: Inclusive mobility services	• Conduction of research among Ukrainian refugees on their perception of PT offer and transport preferences to identify the main barriers to using PT • Elaboration of qualitative research report on the perception and preferences of Ukrainian refugees for enhancement of PT use by Ukrainian refugees in the City of Gdynia • Consultations of possible solutions with the target group for enhancement of PT use by Ukrainian refugees in the City of Gdynia • Elaboration of Action Plan for enhancement of PT use by Ukrainian refugees in the City of Gdynia	Sep-23	Jun-26	Dec-24
MS12: Smart parking management	• Preparation of the tender procedure • Tender conclusion • Installation of sensors • Integration with existing systems (LORA network) • Initiation of the testing period • Evaluation of data from sensors • Parking places for removal selected	Jun-23	Dec-26	Feb-25
MS13: Traffic Management / New lanes/ PT prioritisation services	• Audit of existing bus lanes in Gdynia • Research conducted among bus drivers of the PKA Gdynia (municipal bus operator) • Enlargement of existing bus lanes network • A report on existing bus-lanes network in Gdynia elaborated by YUNEX • A report from the qualitative research of bus drivers in Gdynia elaborated by YUNEX	Sep-23	Jun-25	Jun-24

7.1.6 Sibenik

The measures that will be implemented in Sibenik include:

- MS1: Multimodal hubs
- MS4: EV charging stations
- MS6: Mobility as a Service (MaaS)
- MS9: Citizen Mobility App

The implementation plan of the measures is provided below.

Table 43: Implementation plan for the SPINE measures in Sibenik

Measure ID	Operations Processes	Month Start	Month End	Progress monitoring 1 and 2
MS1: Multimodal hub / information screens	• Design and functionality • Procurement of works and equipment • Construction works • Functional implementation and testing • Public promotion • Evaluation	Jun-23	Nov-24	Jun-25
MS4: Electrical vehicle charging stations	• Marking of the locations • Preparation of public procurement • Public procurement for implementation of Electrical Vehicle Charging Stations (EVCS) • Signing contract with the selected bidder • Implementation of the contract • Implementation of ECVS	Jul-23	Dec-25	1: Aug-24 2: Jun-25
MS6: Mobility as a service	• Concept note detailing the implementation plan, list of stakeholders and blueprint of MaaS service • Appointing local-level stakeholders' group • Initiation of testing period • Collection of results • Re-design of MaaS • Design of open call • Contracting • Implementation of contract • Dissemination of results	Sep-23	Jun-26	1: Mar-24 2: Oct-25
MS9: Citizen Mobility App	• State of the art existing solution • Choosing functionalities of the app • Testing the demo app version • Promotion of the citizen app	Jun-23	Jun-26	1: Oct-24 2: Oct-25

7.1.7 Heraklion

The measures that will be implemented in Heraklion include:

Measure ID	Operations Processes	Month Start	Month End	Progress monitoring 1 and 2
MS1: Multimodal hub / information screens	"• Define locations for the displays • Requirement elicitation • Establish data sources / access • Collection of all relevant permissions • Installation of digital screens • Integration with data source • Initiation of testing period • Test functionality and evaluate impact and benefits"	Nov-23	Jun-26	Dec-24
MS3: Multimodal journey planner app	"• Technical description and system design • Collection of the detailed requirements of the solution • Technical meetings with stakeholders for setup the requirements of the system design • Collection of all relevant data • Testing the demo version of the mobile app and commissioning it in full extent for usage • Implementation initiation • Integration with existing systems • Initiation of the testing period • Collection of the initial results • Application Completion & Dissemination"	Sep-23	May-26	Feb - 24 May-25

MS8: Smart City Platform	• Analyzing and evaluating the proposed measures against the data sources available from the city • Transforming the required data into a standardized format in collaboration with Konnecta • Identifying use cases for configuration and development based on the city's needs • Designing UI interfaces for the identified use cases and obtaining approval from city representatives and the SPINE management team • Configuring and developing the approved designs • City/Konnecta providing test data sources for evaluating goals and KPIs • Integrating the Smart City Platform with the identified data sources • Determining the deployment process and selecting appropriate cloud services for the SCP • Initiating a testing period to ensure the functionality and performance of the application • Monitoring and analyzing the results obtained during the testing phase • Deploying the application with the desired use cases and required dashboards • Ensuring ongoing maintenance and management of the deployed application	Nov-23	Dec-26	Jun-26
MS15: On-demand mobility service	"• Research and purchase of the vehicle • Collect initial data for hyperlocal shared mobility algorithm • Define operational modes • Check integration possibility with existing app or other possibilities • Engagement of stakeholders • Budgetise development and operations of application • Agile development of application • Integration of routing algorithm • Technical and functional testing and improvements • Initiation of testing period • Collection of results • Communication actions"	Jan-24	Jun-26	Jun-25
MS17: Cargo hitching	"• Collection of the detailed requirements of the solution • Collection of necessary data for the hyperlocal shared mobility algorithm • Licenses and decision on physical implementations • Defining details on implementation (pickup points, itineraries etc.) • Budgetise development and operations of application • Agile development of application • Integration of routing algorithm • Technical and functional testing and improvements • Collection of initial results, analysis and adjustment of the solution • Implementation Completion"	Oct-23	Jun-26	Apr-25

7.1.8 Valladolid

The measures that will be implemented in Valladolid include:

- MS1: Multimodal hubs
- MS9: Citizen Mobility App
- MS11: Cargo-bikes renting service
- MS12: Smart park and Ride management
- MS13: Traffic Management / PT prioritisation services

- MS15: On-demand mobility service

The implementation plans of the measures are provided below.

Table 44: Implementation plan for the SPINE measures in Valladolid

Measure ID	Operations Processes	Month Start	Month End	Progress monitoring 1 and 2
MS1: Multimodal hubs	• Define new possible services for the public cargo bikes, ticketing and planning algorithm • Study and implementation of combined ticketing • Definition of the solution and data needs • Improvement of the planning algorithm • Application tested with real data • Improve management services in the city center • Application running for the new public services	Dec-23	Dec-25	1: Jun-24 2: Jun-25
MS6: MaaS	• Develop Journey-Planner • Development of tool for integrating other functionalities into the MaaS platform • Public Transport Real Time Information • Integrate Park & Ride occupancy status and predictions • Information on BUS capacity status	Dec-23	Dec-25	Dec-24
MS9: Citizen Mobility App	• Definition of the update solutions • Identification of problems and barriers in the current App and the updates to implement • Data needs for the digital update solution • Test the updated App and the new citizens usability • Application optimisation measures	Sep-23	Dec-25	1: Jun-24 2: Jun-25
MS12: Smart parking management	• Parking and period selection • Data collection • Definition of the parking occupancy analysis with respect to temporal, geospatial and weather conditions • Data parking processing • Implementation Quality Management of parking management • Implemented the solution for the existing parking area and could then be extended	Nov-23	Dec-25	1: Jun-24 2: Jun-25
MS13: Traffic management	• Corridor and period selection • Definition of the PT lines and period of the data selection • Data processing, implementation Quality Management of PT Data • Analysis PT Data Quality • Optimisation measures of PT Quality management • Implementation PT Priorization Quality Analysis • Analysis PT Priorization • Optimisation measures of PT Prioritisation • Implementation Green Wave Quality Analysis • Analysis Green Wave • Implementation Green Wave Visual Analytics • Optimisation measures of Green Wave Quality and Visual Analytics	Nov-23	Feb-26	Dec-24
MS15: On-demand mobility service	• Recover current needs • Definition of the solution and needs : Bike operations and simulation, demand prediction of bike-sharing system, PT priorization, Occupancy of bike stations system and demand prediction of delivery services • Identification current problems and data needs • Test solution and set up	Sep-23	Dec-25	1: Jun-24 2: Jun-25

7.1.9 Barreiro

The measures that will be implemented in Barreiro include:

- MS6: Mobility as a Service (MaaS)
- MS9: Citizen Mobility App
- MS12: Smart park and Ride management
- MS16: Bus Passengers Analytics

The implementation plans of the measures are provided below.

Table 45: Implementation plan for the SPINE measures in Barreiro

Measure ID	Operations Processes	Month Start	Month End	Progress monitoring 1
MS6: MaaS	• Develop Journey-Planner • Development of tool for integrating other functionalities into the MaaS platform • Public Transport Real Time Information • Integrate Park & Ride occupancy status and predictions • Information on BUS capacity status	Dec-23	Dec-25	Dec-24
MS9: Citizen Mobility App	• Develop a Citizen App • Identification of mobility problems • Development of a tool for inquiry • Development of a bidirectional communication tool	Nov-23	Nov-25	Nov-24
MS12: Smart park and Ride management	• Preparation of the tender procedure for data collection • Data collection and analysis • New park and ride location proposal • Preparation of the tender procedure for sensor acquisition • Tender conclusion • Installation of sensors • Integration with existing systems • Initiation of testing period • First P+R occupancy predictions • Evaluation of data from sensors	Jul-23	Jun-26	Jul-24
MS16: Bus Passengers Analytics	• Preparation of the tender procedure for equipment acquisition • On board installation of equipment's • Computer Vision Solution data tests • Installed on board hardware and first platform data collection • First occupancy estimation • Accuracy tests • INLECOM Digital Twin platform and dashboard deployed • Integration with existing systems • Quantification of OD matrices • Provide real time predictions of bus occupancy in TCB and estimate OD matrices	Aug-23	Jun-26	Dec-24

7.1.10 Zilina

The measures that will be implemented in Zilina include:

- MS2: Real-time information for passengers
- MS3: Multimodal journey planner app
- MS8: Smart City Platform for transport and mobility planning
- MS12: Smart park management
- MS18: Dashboard for real-time traffic data

The implementation plans of the measures are provided below.

Table 46: Implementation plan for the SPINE measures in Zilina

Measure ID	Operations Processes	Month Start	Month End	Progress monitoring 1
MS2: Real-time information for passengers	• Specification of technical parameters • Negotiations with the management of the location objects • Preparation of the tender procedure	Dec-23	May-26	Oct-25

	• Requirement elicitation • Establish data sources / access • Collection of all relevant permissions • Installation of digital screens • Integration with data source • 5 digital screens installed • Initiation of testing period • Performed functionality testing and impact and benefits evaluation			
MS3: Multimodal journey planner app	• Specification of technical parameters • Negotiations with key partners of MJP • Negotiations with the existing partners	Dec-23	Feb-26	Jul-24
MS8: Smart City Platform for transport and mobility planning	• Analyzing and evaluating the proposed measures against the data sources available from the city • Transforming the required data into a standardized format in collaboration with Konnecta • Identifying use cases for configuration and development based on the city's needs • Designing UI interfaces for the identified use cases and obtaining approval from city representatives and the SPINE management team • Configuring and developing the approved designs • City/Konnecta providing test data sources for evaluating goals and KPIs • Integrating the Smart City Platform with the identified data sources • Determining the deployment process and selecting appropriate cloud services for the SCP • Initiating a testing period to ensure the functionality and performance of the application • Monitoring and analyzing the results obtained during the testing phase • Deploying the application with the desired use cases and required dashboards • Ensuring ongoing maintenance and management of the deployed application	Nov-23	Dec-26	Jun-26
MS12: Smart park management	• Preparation of the tender procedure • Tender conclusion • Collection and analysis of public acceptance of Low Emission Zone (LEZ) implementation • Installation of sensors • Installation of screens • Integration with existing systems • Initiation of first phase testing period • Initiation of second phase testing period • Evaluation of data from sensors • Preparation of the implementation plan for the Low Emission Zone	Dec-23	Jun-26	Dec-24
MS13: Traffic Management / New lanes/ PT prioritisation services	Analyzing and evaluation process in terms of the results, set the necessary steps to the data management	Dec-23	Feb-26	Feb-25
MS18: Intersection Camera Recognition/ Dashboard for real-time traffic data	• Evaluation of the current state of cameras • Preparation of the tender procedure • Tender conclusion • Installation of cameras • Software solution	Dec-23	Jun-26	Jul-24

7.1.11 Rouen

The measures that will be implemented in Rouen include:

- MS6: Maas / Integration of on-site parking
- MS6: Maas / Integration of LEZ
- MS6: MaaS / integration of carpooling
- MS6: MaaS / Integration of ToD

The implementation plans of the measures of all MaaS actions in the city of Rouen, are provided below.

Table 47: Implementation plan for the SPINE measures in Rouen

Measure ID	Operations Processes	Month Start	Month End	Progress monitoring 1
MS6: MaaS / Integration of on-site parking	• Collection of data and APIs • Development • Opening to public (selected test users) • Start collecting data • End of collecting data • Reporting	Jan-24	Mar-26	Dec-24
MS6: MaaS / Integration of LEZ	• Collection of data • Development • Opening to public (selected test users) • Start collecting data • End of collecting data • Reporting	Jan-24	Mar-26	Dec-24
MS6: MaaS / integration of carpooling	• Collection of data • Development • Opening to public (selected test users) • Start collecting data • End of collecting data • Reporting	Jan-24	Mar-26	Dec-24
MS6: MaaS / Integration of ToD	• Collection of data • Development • Opening to public (selected test users) • Start collecting data • End of collecting data • Reporting	Jan-24	Mar-26	Dec-24

7.2 SPINE Bulletin Boards

7.2.1 Definition of the Online Bulletin Board

SPINE's Online Bulletin Board (OBB) is a web-based bulletin that enables users to engage in discussions, share information, and collaborate on various topics and subjects. Within the SPINE Project, the online bulletin board plays a pivotal role in facilitating collaboration and knowledge exchange among stakeholders. By implementing the following strategies, these digital platforms become effective tools for information dissemination, discussion, resource sharing, and feedback collection. The employment of the bulletin boards in the SPINE Project occurs in two distinct phases within WP1 and WP3, as described below:

1. WP1: In the first phase, during WP1, concretely, on Task 1.1, the bulletin boards are set up to be utilised to gather insights, initiate discussions, and foster ideation. and engage stakeholders in conversations related to urban mobility challenges, user needs, and potential solutions.
2. WP3: The second phase takes place during WP3, and specifically as part of T3.5.2. In this phase, the bulletin boards serve as an ongoing platform for collaboration, refinement of ideas, and iterative discussions. Stakeholders actively participate in the design and development of innovative solutions, leveraging the collective intelligence and expertise of the participants. The OBBs facilitate continuous engagement throughout the design and prototyping process, enabling stakeholders to contribute their insights and perspectives.

7.2.2 LL Design Thinking Activities and the Role of Online Bulletin Board

The OBB employed within SPINE boasts a versatile dual setup that serves two distinct yet interconnected purposes. One facet of this setup facilitates dynamic interactions among cities themselves, fostering a collaborative environment during co-creation activities. Here, cities engage in spirited discussions, exchange innovative ideas, and share valuable insights, collectively working towards the development of pioneering urban mobility solutions. Simultaneously, the other configuration of OBBs is tailored specifically for seamless communication between cities and their citizens. Within this framework, cities actively engage with their residents, commuters, and community members. They share pertinent information, updates, and relevant content, creating a

platform that prioritises transparency, inclusivity, and active citizen involvement in the co-creation journey. This dual setup empowers cities to not only collaborate effectively with one another but also to engage and involve their citizens, ensuring a rich and holistic approach to shaping the future of urban mobility.

Table 48. Features of the Co-Creation Activities

	Co-creation Activities	Communication Channel with Citizens
Nature of the Discussions	Discussions are asynchronous, allowing flexible engagement to accommodate diverse schedules and time zones.	Asynchronous discussions provide citizens with flexibility in accessing and participating at their convenience.
	Policymakers can share various media types, enriching discussions and accommodating diverse communication preferences.	Citizens receive and engage with content created by cities, including text-based discussions, images, videos, and other relevant media.
Participants Diversity	Diverse stakeholder representation includes experts, planners, agency representatives, researchers, community leaders, and policymakers.	These bulletin boards welcome a diverse range of participants, including community members, residents, commuters, and citizens from various backgrounds.
Duration Planning	Bulletin board durations align with discussion objectives, allowing for in-depth engagement and iterative collaboration.	Carefully planned durations provide citizens with sufficient time for meaningful engagement, fostering ongoing discussions and valuable input.
Stakeholder Diversity	Active engagement of diverse demographics ensures equitable and sustainable urban mobility solutions.	SPINE prioritises inclusivity within OOBs, seeking input from individuals with varying mobility needs, cultural backgrounds, and socioeconomic statuses. This commitment ensures that mobility solutions address the needs of the entire community, promoting equity and sustainability.

7.2.3 Distribution of Responsibilities

Clarifying consortium partners' roles within the OBBs is crucial. This transparency is essential for achieving the project's objectives, including inclusive citizen engagement, data-driven decision-making, and sustainable urban mobility solutions. Thus, in this section, the responsibilities regarding the OBBs will be outlined.

Table 49. Distribution of responsibilities related to OBBs

Partner	Activity description
CARNET	Task Description
	Setting up the Online Bulletin Boards for user-friendliness and functionality
	Collaborating with local stakeholders for city-specific data collection
MOBY	Developing web-based message board for SPINE Project
	Designing user-friendly bulletin board platform
	Supporting location-based modules for geographic discussions
	Interconnected milestones with digital hub setup

Secondly, once the Online Bulletin Boards has been set up, the deployment of the online bulletin board will be undertaken by the following partners.

HU's creation of the methodology, which includes incorporating the OBB, demonstrates their commitment to facilitating co-creation activities. The OBB serves as a platform for policymakers to engage in meaningful interactions, enhancing the co-creation process and fostering collaboration

among stakeholders. This innovative approach aligns with the project's goal of promoting effective policy making and inclusive citizen involvement in shaping urban mobility solutions.

Lastly, the collaboration of the Living Labs, assisted by the communication partners of SPINE, will be essential to achieve the KPI of 300 people interacting with the OBB assigned in the GA.

7.2.4 Real-Time Plan for City Collaboration

To ensure effective collaboration with each city and maintain consistent engagement on the online bulletin boards, a real-time plan with regular posts every 6 months can be established. This plan outlines the timeline for key activities and interactions on the bulletin boards, allowing stakeholders in each city to actively participate and contribute throughout the project. The following is an example of a real-time plan.

Month of the SPINE project	Activities to take place
M10: Ongoing Activities and Review	• City-specific OBBs are set up and made accessible to stakeholders in each city. • An introductory post is made, welcoming participants and providing an overview of the project, its objectives, and the role of the bulletin boards.
M12: Interactive Discussion and Feedback	• Create an interactive discussion post to explore specific transport user needs and challenges in each city. • Stakeholders are encouraged to share experiences, highlight barriers to policy implementation, and propose potential solutions. • Summarize key discussion points and insights from the past months.
M18: Innovative Solutions and Collaborations	• Post on solution opportunities, inviting stakeholders to discuss innovative ideas for sustainable and inclusive urban mobility. • Participants encouraged to share best practices from other cities or projects. • Explore opportunities for collaboration and synergies between cities.
M24: Design and Prototyping Progress	• Share a review and evaluation post, presenting progress in the project's design and prototyping phase. • Invite participants to provide feedback on proposed solutions. • Gather insights on feasibility and potential impact
M30: Policy Implementation Challenges	• Create a post to discuss policy implementation challenges faced by cities. • Encourage stakeholders to share insights and propose strategies to overcome barriers. • Consider the specific context of each city when discussing challenges.
M36: Project Outcomes and Sustainability	• Post a final update summarizing the outcomes of the project. • Highlight achievements and lessons learned. • Invite stakeholders to reflect on the impact of their contributions and provide input on the sustainability and replicability of developed solutions beyond the project's duration. • Discuss plans for knowledge sharing and dissemination.

By following this real-time plan, stakeholders in each city can engage in meaningful and regular discussions on the bulletin boards, fostering collaboration, knowledge exchange, and the co-creation of sustainable and inclusive urban mobility solutions.

Nonetheless, as during the OBB's setting up process, the Living Labs have manifested concerns regarding the implementation of the OBB, we have identified the following risks and planned a mitigation strategy to aid the Living Labs in the implementation.

Table 50. Risks and mitigation strategy

Risks	Mitigation Strategy
Misinformation Spread	Establish a fact-checking process to verify information shared on the OBB Clearly label verified and official announcements
Lack of Real-Time Interaction	Maintain alternative communication channels (city hotline, social media) for addressing urgent concerns Set response time expectations for urgent inquiries.
Difficulty to get citizens engaged	Offer incentives for participation, such as small rewards, recognition, or certificates of participation. Publicly acknowledge and appreciate valuable contributions. Use multiple communication channels (e.g., social media, email, local newspapers, community organisations) to promote the OBB discussions and reach a broader audience.
Privacy Concerns	Communicate the city's privacy policy and data protection measures clearly Ensure compliance with data protection laws and regulations

Digital Inequality	Offer digital literacy programs and training to citizens unfamiliar with online platforms Use accessible OBB platforms with text-to-speech and screen reader compatibility
Loss of Face-to-Face Engagement	Maintain a balance between online and in-person community engagement Host occasional town hall meetings, workshops, or community events alongside OBB discussions
Legal and Regulatory Compliance	Work closely with legal counsel to ensure compliance with applicable laws and regulations Clearly outline terms of use and user responsibilities on the OBB platform
Security Concerns	Choose a secure OBB platform with encryption and robust data protection features. Implement strong password requirements and educate participants about online security.
Technical Issues	Conduct thorough testing of the OBB platform before the seminar to identify and resolve technical issues. Have a backup communication plan and contact information for technical support.

7.3 Transport models as part of SPINE

As part of SPINE, transport modelling activities are foreseen with the development of traffic simulation, activity-based and behavioral models to assess the impact of SPINE measures on transport and the potential behavioral change of people. The involved partners include AIMSUN, the University of the Aegean (UAEGEAN) and CAMBIAMO (CMO).

With the GA as the starting point and the current discussions among the above scientific partners and the cities, the foreseen models to be developed are presented in the following table along with the lead partners. However, this status may change depending on the cities' data availability.

Table 51. Foreseen transport models in SPINE cities

	Bologna	Tallinn	Las Palmas	Gdynia	Valladolid	Barreiro
Traffic simulation model	AIMSUN	AIMSUN			AIMSUN	
Activity-based model		UAEGEAN	MOBY	UAEGEAN		MOBY
Behavioral model	CMO	UAEGEAN	MOBY	UAEGEAN, CMO		MOBY

8 Conclusions

This deliverable marks a significant milestone in the SPINE project, as it establishes a robust knowledge base framework for the implementation, assessment and transferability of SPINE measures. This framework encompasses a comprehensive range of insights and activities that are vital to the project's overall success. This was achieved by collecting information and providing valuable insights into different aspects of the project, ranging from the current mobility situation in the SPINE cities to the initial basket of SPINE solutions and the impact assessment and twinning framework.

First, the deliverable conducted an extensive evaluation of the maturity level of SPINE cities This evaluation involved an in-depth analysis of various critical aspects, including: i) urban mobility status (indicating the availability of mobility services in SPINE cities and examining their policy initiatives and goals, primarily stemming from SUMPs), ii) presence of digital enablers (including smart platforms, transport models, technological innovation for mobility, etc.), iii) experience in co-creation activities, and iv) current approaches for engaging and communicating with citizens (digital media and communication channels). The analysis revealed a rich diversity among the spectrum of SPINE cities, with some already equipped with advanced digital tools and pioneering mobility solutions, while others are in the early stages of mobility innovation.

Furthermore, the deliverable introduced the initial basket of SPINE solutions, as identified until M9 of the project. These solutions will feed the discussions made as part of WP2 and WP4, with the aim to be finalized before their implementation. Additionally, an impact assessment framework for SPINE was developed, with specific indicators and guidelines to enable cities to collect data, calculate indicators, and evaluate the entire process of SPINE demonstrations effectively.

To accomplish these tasks, dedicated meetings/workshops were held with the 11 SPINE cities to gather pertinent information about their mobility status, tailor solutions to their unique needs and define the impact assessment indicators. Moreover, in-depth interviews were conducted with the 4 Lead cities to prototype business and governance measures essential for the successful execution of SPINE measures.

Overall, D1.2 may serve as a foundational cornerstone of the entire SPINE project, offering a comprehensive understanding of the baseline situation in SPINE cities and providing guidance for aligning future actions throughout the SPINE project.

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Annex I: Questionnaire

SPINE
Smart Public transport Initiatives for climate-Neutral cities in Europe

This questionnaire has been structured as part of SPINE WP1 (SPINE innovation and twinning framework) and aims to collect specific information from SPINE cities regarding:

- the current situation of the city's mobility, urban space and setting,
- the available city-specific mobility data,
- the indicators they are currently used to assess mobility interventions, etc.,
- the city's interest in the implementation of the SPINE measures.

It targets all SPINE cities (lead and twinning) and the input provided by them will be useful for structuring the SPINE Living Labs Inception report (D1.1) and SPINE Framework for Innovative PT solutions (D1.2), while also providing valuable input to other WPs of the project (e.g., WP3).

The questionnaire should be filled in by one representative from each city. If needed, an additional follow-up discussion/interview will be scheduled between the city and WP1 contributors to clarify any pending issues.

Please try to answer the questions as precisely as possible and do not hesitate to contact us if you have any questions.

Contact persons: Ioanna Pagoni (ipagoni@aegean.gr; University of the Aegean)
Sissi Koronaiou (sissi.koronaiou@inlecomsystems.com; INLECOM)

Thank you in advance for your collaboration!

SPINE City name:

Note 1: If you have already decided to focus on the implementation of SPINE solutions in one or more specific area(s) of the city please indicate it below. This(these) area(s) will be referred to in this document as experimentation area(s).

SPINE Experimentation Area(s):

Contact details of the respondent/city's representative
Name:
Position in the organisation:
Email:

City's current situation and SUMP

What mobility services for passengers are available in your city (e.g. PT, taxi, car sharing, bike sharing, on-demand services, e-scooters, etc.)? Please provide the requested information below.

Type of mobility service	Name of the operator	Legal status of the operators	Coverage area (e.g. city centre, etc.)	Available information for the service (e.g. statistics). Provide URL if available	Does this service serve the experimentation area of SPINE?

Additional to the above, please provide the following information for the Public Transport (PT) system in your city.

PT service	Passenger traffic *(indicate the year of data)*	Does this PT service serve the experimentation area of SPINE? If yes, do you have passenger traffic data for this area?	Technologies related to SPINE already in place	Other notes you would like to mention
e.g. bus, tram, metro, trolley			*e.g. digital ticketing, real-time information, etc.*	*e.g. do you have PT demand data for specific areas where SPINE will focus, such as specific stations, corridors, etc.?*

Does your city have a Sustainable Urban Mobility Plan?

☐ Yes, it is already completed. Please provide here the document (if you have not done this already).
☐ Yes, it is under preparation/review.
☐ Not yet. Please indicate the time plan for its preparation, if possible:
☐ Other, please specify: The City as a Mobility Travel Plan

Are there other policy documents related to SPINE (e.g. transport, urban planning, including mobility and land use plans, air quality plan)?

☐ Yes, please provide here the relevant documents.
☐ No.

Please provide us with the following information regarding the measures proposed in your city's SUMP (or in the other policy documents).

Target KPIs	Baseline year for initial measurement of the KPI	Target year for initial measurement of the KPI	Solutions/measures to achieve the KPI	Coverage area

City's digital enablers, data and models

Is there an IT system (e.g. operational platform, digital twin, etc.) currently being used to manage and/or support your city's transport operations?

☐ No

☐ Yes. Please specify the below information:

Name of the system	Provider of the system	Features/functionalities of the system	Is it possible to have or already implemented integration with 3rd parties (mobile apps etc.)? If yes, specify the type of interfacing	URL of the IT system (if available)	Other comments you would like to note

What data related to mobility is available for your city?

If this list is too long for your city, please focus on the data that can be useful for SPINE activities and can be made available to the SPINE partners.

Type of data	Is this data available separately for the experimentation area?	Who owns this data?	Type of data (historical or real-time)	Time period of the data (if historically maintained)	Can they be made available? (only for SPINE, publicly)	URL of the data (if available)

Do you have any model to simulate transportation in the city (or part of the city)?

☐ No

☐ Yes. Please specify the below information. If multiple models are available, please add one row per each transportation model your city has.

Modelling software	Type of model	Coverage of the model	Demand data	Validation of the model	Any further comments or description on the model(s) that you want to add

Which are the current media and communication channels of your authority?

To comply with the project proposal, an online Bulletin Board for each city will be created to facilitate the exchange of information and knowledge between policymakers, citizens, participants of LLs, passengers, operators, and other stakeholders, discussing open topics, customizing, and fine-tuning solutions and reporting problems and barriers to their implementation. Have you developed a similar system already? If so, please provide the link.

Evaluation of transport interventions and KPIs

How do you currently measure/monitor the following indicators?

KPI	Tick if you measure/ monitor it	*For each KPI that you measure/monitor, fill in the below information*			
		Value of KPI (based on the latest data, eg. 2021, 2022; this will be SPINE's baseline)	What data do you use for measuring/monitoring this KPI? Please provide the calculation formula	Related assumptions (e.g. applicable to a specific area of the city or a specific transport mean, a specific target portion of the population, etc.)	Additional Comments (e.g. periodicity of monitoring, etc.)
PT mode share	☐				
User satisfaction	☐				
PT demand	☐				
Transport-related CO_2 emissions	☐				
Traffic delays	☐				
User, non user and previous user needs	☐				
Please add more KPIs you currently measure/monitor for your mobility system	☐				

City's interest in SPINE solutions

The list below indicates the SPINE solution(s) for which you declared your interest during the proposal preparation. Please confirm if you are still interested in these solutions and provide the requested information.

Solution/measure	Experimentation area (In which city-specific area will the solution be implemented?)	Who is the solution/measure implementor (e.g. the city itself, other SPINE partners, other stakeholders outside SPINE consortium) Is this solution entirely funded	Key implementation milestones (start date, any intermediate milestones – e.g. permits, other external dependences , completion date)	Affected KPI(s) and expected output	Assumptions (for the KPIs measurements, indicate any assumptions that will allow reaching the envisioned target values)	Link with specific SUMP guideline / target

		from SPINE or from other funds as well? (e.g. SUMP, other projects)				
					-	

Has your city been engaged in co-creation activities in the past (e.g. establishment of a LL, Community of Practices, Mobility HUBs in another project, co-creation workshops, citizen engagement activities, etc.)?

☐ No

☐ Yes. Please provide any available information in the below table.

Type of the co-creation activitiy (e.g. establishment of LL, co-creation workshops, etc.)	Was it part of another project? Please provide the name of the project.	Start/end year of the co-creation activity	Target participants (e.g. citizens, elderly people, commuters, disabled people, etc.)	Number of participants

Annex II: The Business Model Canvas: A quick introduction for Cities

What is a business model?

- The business model describes the activities of an organisation, i.e., networks, companies, governments, and solutions, aiming at achieving a number of goals and bringing value.
- A business model describes how the organisation is going to create or capture value, whether this is public value creation, e.g., accessibility to public transport, the safety of public space, or more traditional value creation, e.g., revenues, brand reach/recognition.
- Among others, a business model helps to:
    - Put the main objective of the organisation in the spotlight
    - Uncover relationships between private and public actors
    - Reveal the role third parties/partners have in the value creation
    - Shows intangible and tangible assets the organisation possesses
    - Reveal costs and revenue streams

Why collect this information?

The business model gathers information from the organisation's significant aspects that help achieve the desired goal. In the case of the SPINE project, the organisation is the participating city. The value proposition the city brings should align with the vision of SPINE. We summarise the SPINE vision in the following four goals (refer to the proposal document):

1. Combine existing and new mobility measures to improve the quality and competitiveness of public transport;
2. Co-create with ecosystem actors inclusive, resilient and sustainable mobility solutions;
3. Create an integrated approach to public transport with other mobility services using AI/data-driven simulation tools to capture ecosystem dynamics and trigger behaviour change;
4. Create a condensed policy document with knowledge from the co-creation exercises and recommendations for implementing mobility solutions.

With the vision of SPINE in mind, the business model workshop will support cities in accurately indicating elements such as key partners, resources, activities, customer segments and channels they envision necessary to deliver the solutions on SPINE. In addition, cities will gain awareness of possible unclear elements of the solution.

Which canvas are we using?

The workshop will use the Osterwalder Business Model Canvas (BMC). See at the end of this document.

Questions

The following questions are a summary of the questions we will ask during the workshop. **Please read them and prepare a preliminary answer for the activity**:

1. Which are the activities you consider essential to deliver the solutions the city is implementing (within the SPINE project)? Please take each one of the solutions and think about the value they bring
    a. For example, to improve quality and competitiveness of public transport, the city could propose a journey planner
        i. The journey planner is then an activity necessary to reach the goal of improving public transport
        ii. Within the activity journey planner, there are sub-activities that the solution does, which could include guide car users to park and rides
2. Who are the key partners to deliver these solutions? Which are the internal and external partners you need to perform the activities? Are there any partners needed to acquire certain resources?
    a. For example, to deliver the journey planner a company for parking tickets is involved in the park and rides
    b. The team of people the solution needs to be up and running are also considered key partners – these are internal partners
    c. The company providing physical infrastructure to gather data is a resource partner
3. Which are the costumer segments (target groups) the solution primary targets?
    a. For example, a journey planner includes P+R located in the outskirts of the city targets users living in the outskirts and suburban areas (this is your target group), so they do not enter to the centre with their car and use the nearest public transport stop
4. How do you build relationships with these costumers?
    a. How do you first come in contact with them and how do you build relationships? Business costumers might be approached through partnerships with HR groups, while tourist through social media
    b. Take into consideration different target group require more time and different channels for communication!
5. Which are the communication/sales channels currently in place for the SPINE solutions?
    a. Are these channels a direct or indirect? External or internal?
6. What are the resources, i.e., infrastructure, knowledge and digital assets, you consider are key to deliver the SPINE solutions
    a. For example, passenger crowding system in place could be important for citizens to choose public transport, thus, an important resource for a journey planner
    b. Which are the barriers/difficulties you face gathering these resources?
7. How do you plan to gather the necessary funding to maintain and expand the solutions?
    a. Who are the parties financing the solution?
    b. Are you planning to collect any revenue through the solution?
    c. Are the costumers paying for a service? What kind of payment scheme?
8. What are the various types of costs the solution incurs?
    a. Fixed costs and variables costs could include maintaining costs of the platform for journey planner or infrastructure to gather data for traffic flows.

Key Partners	Key Activities	Value Propositions	Customer Relationships	Customer Segments
Who are our Key Partners? Who are our key suppliers? Which Key Resources are we acquiring from partners? Which Key Activities do partners perform? MOTIVATIONS FOR PARTNERSHIPS: Optimisation and economy, Reduction of risk and uncertainty, Acquisition of particular resources and activities	What Key Activities do our Value Propositions require? Our Distribution Channels? Customer Relationships? Revenue streams? CATEGORIES: Management, Problem Solving, Platform/Network provision, **Key Resources** What Key Resources do our Value Propositions require? Our Distribution Channels? Customer Relationships Revenue Streams? TYPES OF RESOURCES: Infrastrcuture, Intellectual (brand patents, copyrights, data), Human, Financial, IT,	What value do we deliver to the user? Which one of our users' problems are we helping to solve? What bundles of products and services are we offering to each User Segment? Which user needs are we satisfying? CHARACTERISTICS: Newness, Performance, Customization, "Getting the Job Done", Design, Brand/Status, Price, Cost Reduction, Risk Reduction, Accessibility, Convenience/Usability	What type of relationship does each of our User Segments expect us to establish and maintain with them? Which ones have we established? How are they integrated with the rest of our business model? How costly are they? **Channels** Through which Channels do our User Segments want to be reached? How are we reaching them now? How are our Channels integrated? Which ones work best? Which ones are most cost-efficient? How are we integrating them with customer routines?	For whom are we creating value? Who are our most important users? Is our customer base a Mass Market, Niche Market, Segmented, Diversified, Multi-sided Platform

Cost Structure	Revenue Streams
What are the most important costs inherent in our business model? Which Key Resources are most expensive? Which Key Activities are most expensive? IS YOUR BUSINESS MORE: Cost Driven (leanest cost structure, low price value proposition, maximum automation, extensive outsourcing), Value Driven (focused on value creation, premium value proposition). SAMPLE CHARACTERISTICS: Fixed Costs (salaries, rents, utilities), Variable costs, Economies of scale, Economies of scope	For what value are our user really willing to pay? For what do they currently pay? How are they currently paying? How would they prefer to pay? How much does each Revenue Stream contribute to overall revenues? TYPES: Asset sale, Usage fee, Subscription Fees, Lending/Renting/Leasing, Licensing, Brokerage fees, Advertising FIXED PRICING: List Price, Product feature dependent, Customer segment dependent, Volume dependent DYNAMIC PRICING: Negotiation (bargaining), Yield Management, Real-time-Market

Annex III: Social media accounts of SPINE cities

The following table presents the different media communication channels of each city.

CITY	City web	Other websites	Facebook	LinkedIn	Twitter	Instagram	YouTube	Other
Antwerp	x		x	x	x	x		
Bologna	x	x	x		x	x	x	x
Tallin	x		x	x	x	x	x	x
Las Palmas	x		x		x		x	x
Gdynia	x	x	x					
Sibenik	x	x	x		x	x	x	
Heraklion	x		x		x			
Valladolid	x	x	x		x	x	x	x
Barreiro	x							x
Zilina	x		x	x		x	x	x
Rouen	x		x	x	x	x	x	

ANTWERP

- Website: www.slimnaarantwerpen.be.
- Facebook: Slim naar Antwerpen (facebook.com)
- Twitter: Slim naar Antwerpen (@SlimnaarA) / Twitter
- LinkedIn: (24) Slim naar Antwerpen: Overview | LinkedIn
- Instagram: Slim naar Antwerpen (@slim_naar_antwerpen)

BOLOGNA

- City website: www.comune.bologna.it
- Webpage of the Mobilty Department: https://www.comune.bologna.it/muoversi
- Webpage of the Europe and International Division: www.comune.bologna.it/relazioniinternazionali
- Facebook: https://www.facebook.com/comunebologna/
- Youtube: https://www.youtube.com/ComuneDiBologna
- Twitter: https://twitter.com/comunebologna
- Instagram: https://www.instagram.com/comunedibologna/
- Newsletter (dealing with metropolitan area)

TALLIN

- City's Webpage: https://www.tallinn.ee/en
- City's Facebook: https://www.facebook.com/CityOfTallinn?locale=et_EE
- City's Facebook on sustainable mobility: https://www.facebook.com/linnatransport?locale=et_EE
- City's Facebook on green Tallin: https://www.facebook.com/greentallinn23?locale=et_EE
- City's twitter: https://twitter.com/Tallinnalinn
- City's LinkedIn: https://www.linkedin.com/company/city-of-tallinn/
- City's LinkedIn on Green Tallin: https://www.linkedin.com/company/greentallinn23/
- Instagram: instagram.com/greentallinn23/
- Youtube: https://www.youtube.com/TallinnLV
- Other: special radio broadcast, TV show, press releases, press conferences.

LAS PALMAS

- Website: https://www.laspalmasgc.es/es/
- Facebook: https://www.facebook.com/AyuntamientoLPGC
- Twitter: https://twitter.com/AyuntamientoLPA
- YouTube: https://www.youtube.com/user/AyuntamientoLPA

- Guaguas Muncipales and Sagulpa APP

GDYNIA

- Official City's website: https://www.gdynia.pl/
- City's website on sustainable mobility: https://www.mobilnagdynia.pl/
- City's Facebook profile on sustainable mobility: https://www.facebook.com/MobilnaGdynia
- City's official Facebook profile: https://www.facebook.com/Gdynia

SIBENIK

- Website: https://www.sibenik.hr/
- Other website: https://www.gradski-parking.hr/
- Facebook: https://www.facebook.com/sibenik.hr
- Twitter: https://twitter.com/GradSibenik
- Instagram: https://www.instagram.com/grad.sibenik/
- YouTube: https://www.youtube.com/user/gradsibenik

HERAKLION

- Website: www.heraklion.gr
- Facebook: https://www.facebook.com/heraklion.gr
- Twitter: https://twitter.com/cityofheraklion

VALLADOLID

- Webpage: https://www.valladolid.es/en
- Other website: http://www.auvasa.es/auv_citaprevia.asp#services,
- Facebook: https://www.facebook.com/AyuntamientodeValladolid
- Youtube: https://www.youtube.com/user/ValladolidAyto
- Twitter: https://twitter.com/AyuntamientoVLL
- Instagram: https://www.instagram.com/AyuntamientoVLL/
- Other: Citizen Attention Office; MOVASA Customer service for bike hiring and safe parking services

Valladolid has specific channels for Citizen participation:

- Participation portal: Portal de Participación | Página principal (valladolid.es).
- There are also several organisations to promote this participation, like the "Consejo social de la ciudad de Valladolid" (Consejo Social de la Ciudad de Valladolid | Portal de Participación)

ZILINA

- City's webpage: https://www.zilina.sk/
- Facebook: https://www.facebook.com/zilinaofficial
- YouTube: https://www.youtube.com/user/sportzilina
- LinkedIn: https://www.linkedin.com/company/mesto-%C5%BEilina/
- Instagram: https://www.instagram.com/mestozilina/
- Other: Print reports, Newsletter

ROUEN

- Website: *https://www.metropole-rouen-normandie.fr/*
- Facebook: https://www.facebook.com/MetropoleRouenNormandie/
- LinkedIn:https://www.linkedin.com/company/metropole-rouen-normandie/?originalSubdomain=fr
- Instagram: https://www.instagram.com/metropole_rouen_normandie/
- Twitter: https://twitter.com/MetropoleRouenN
- YouTube: https://www.youtube.com/@metropole_rouen_normandie

Annex IV: Collection of Secondary data from SPINE cities

Annex V: Sentiment analysis for all Facebook accounts

Antwerp

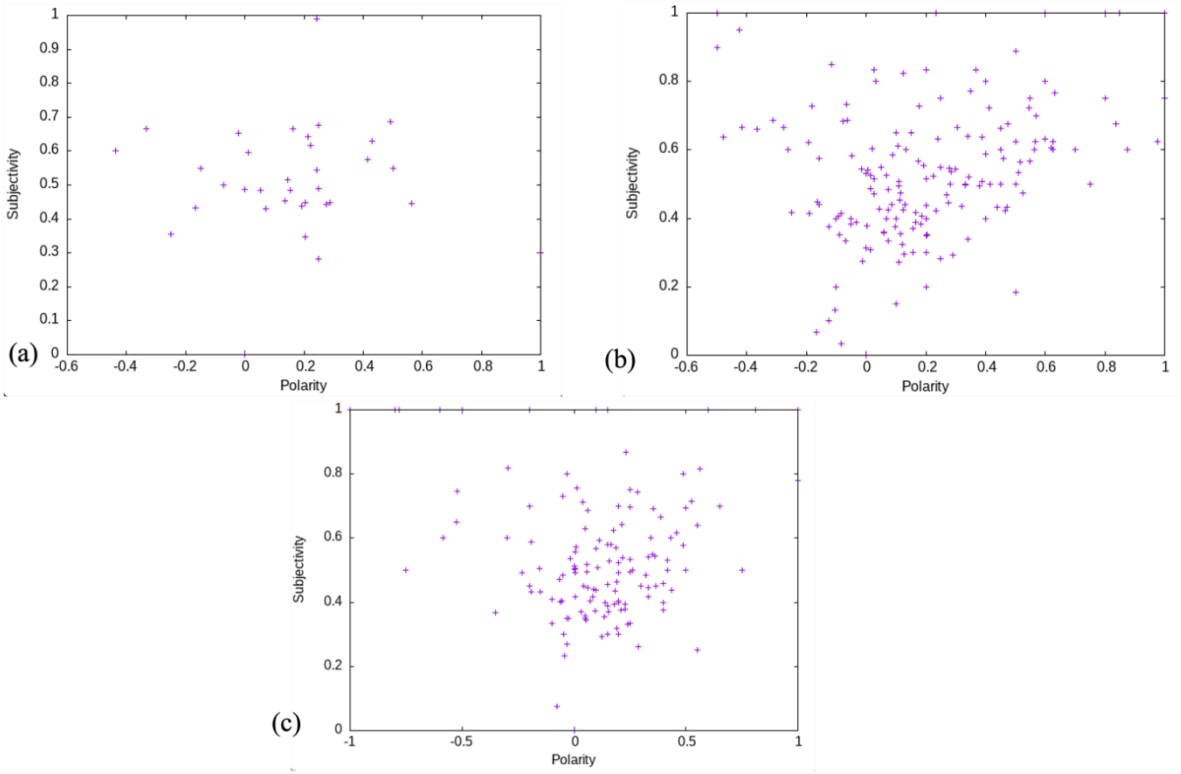


Figure 9. Average comment sentiment analysis per post for Antwerp Facebook accounts (a) Slim naar Antwerpen (ANTW_Mun) (b) De Lijn (ANTW_PuT_DL) (c) NMBS (ANTW_PuT_NMBS)

Tallinn

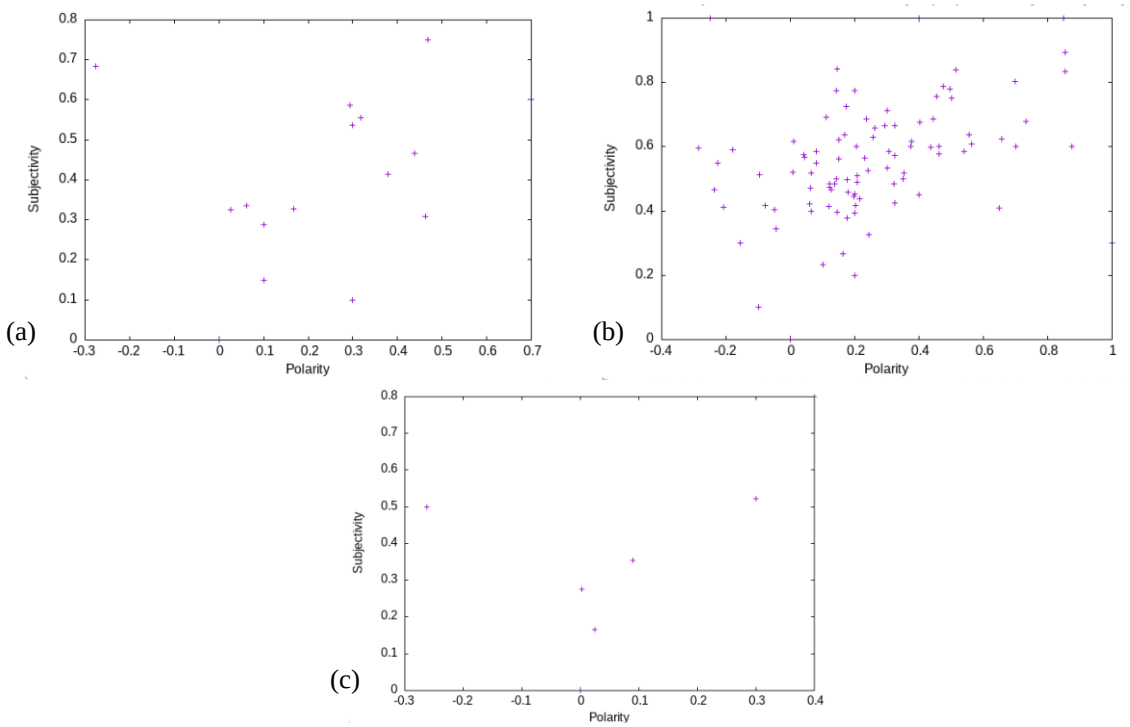


Figure 10. Average comment sentiment analysis per post for Tallinn Facebook accounts (a) City of Tallinn (TALL_Mun) (b) Tallinna Linnatransport (TALL_PuT_TL) (c) Tallinn European Green Capital (TALL_gen_TEGC)

Las Palmas

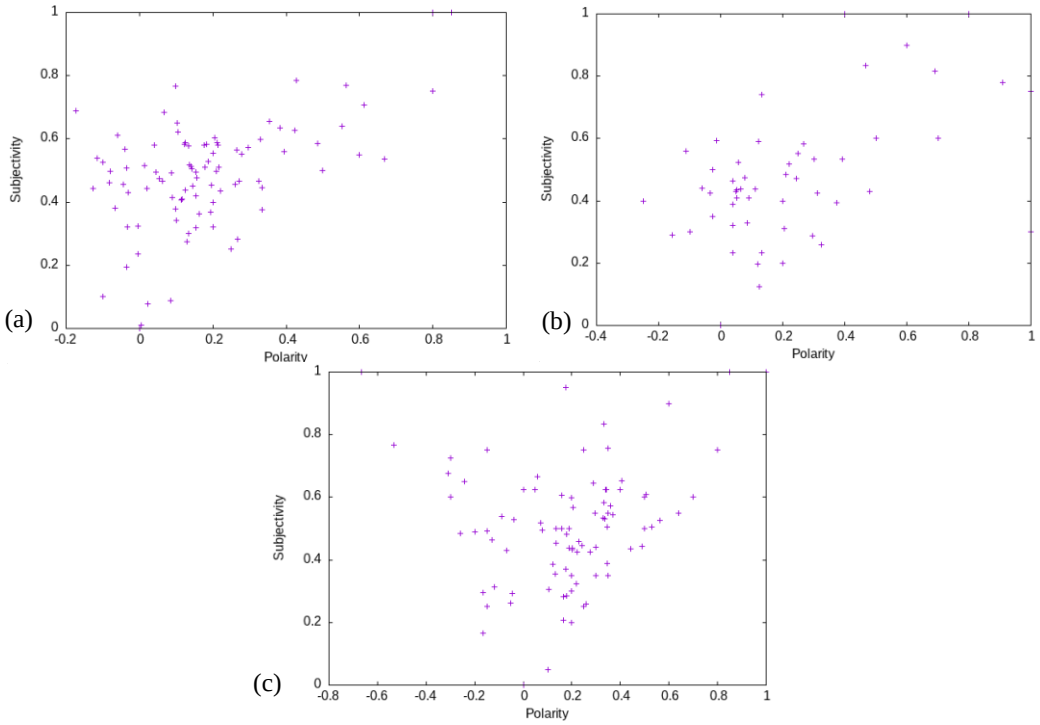


Figure 11. Average comment sentiment analysis per post for Las Palmas accounts (a) Ayuntamiento de Las Palmas de Gran Canaria (LPGC_Mun) (b) GLOBAL (LPGC_PuT_GLOBAL) (c) Guaguas Municipales (LPGC_PuT_GM)

Gdynia

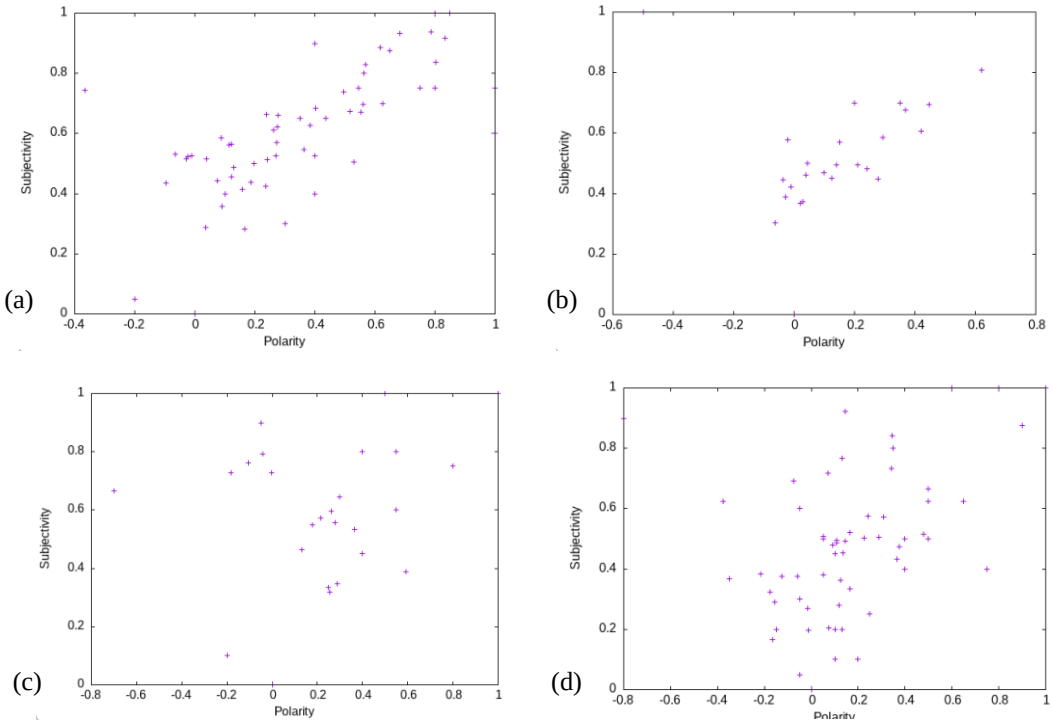


Figure 12. Average comment sentiment analysis per post for Gdynia accounts (a) City of Gdynia (Gdynia_Mun) (b) Mobilna Gdynia (GDYN_gen_MG) (c) PKA company (GDYN_PuT_PKA) (d) PKP Szybka Kolej Miejska w Trójmieście (GDYN_PuT_PKP)

Sibenik

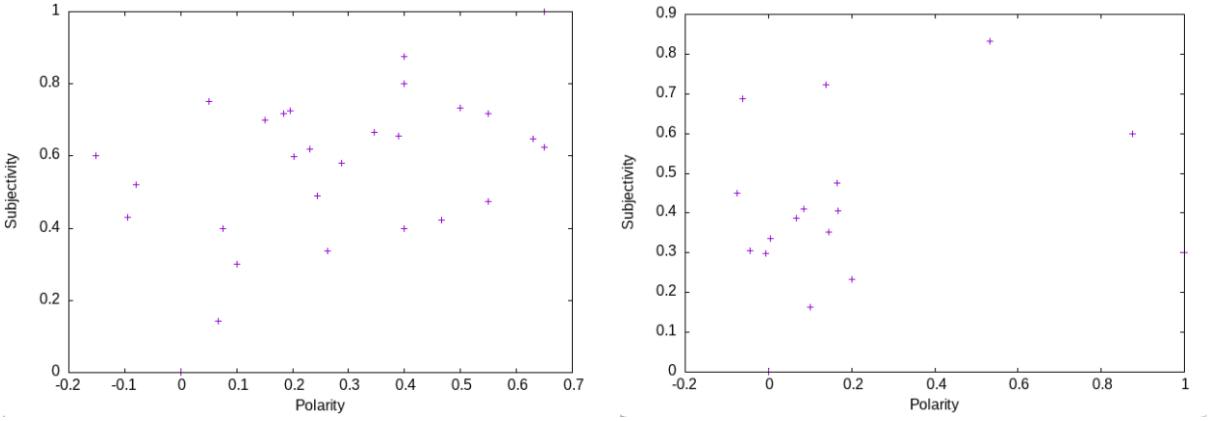


Figure 13. Average comment sentiment analysis per post for Sibenik accounts (a) City of Sibenik (SBNK_Mun) (b) Gradski parking d.o.o. Šibenik (SBNK_PuT_GS)

Heraklion

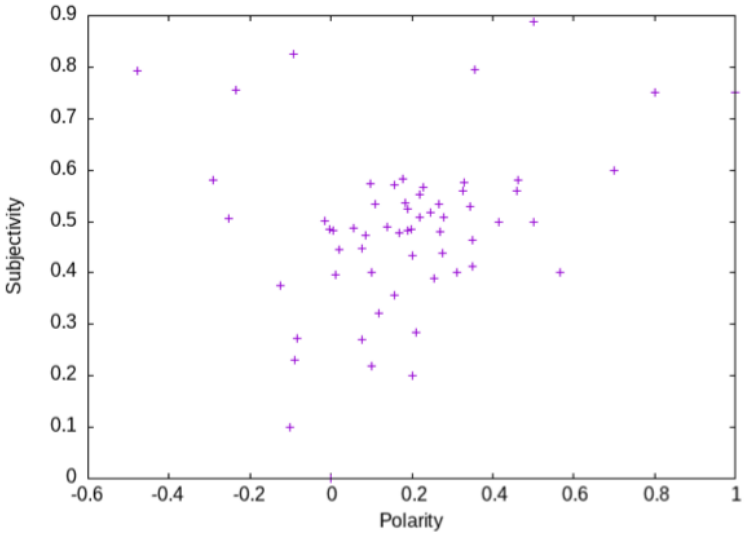
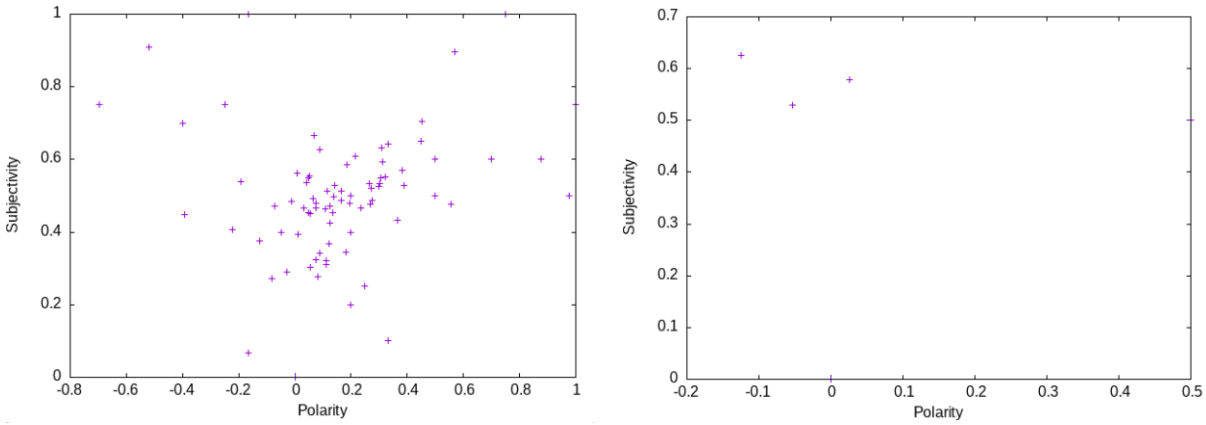


Figure 14. Average comment sentiment analysis per post for Municipality of Heraklion account (HERA_Mun)

Valladolid



(a) (b)

Figure 15. Average comment sentiment analysis per post for Valladolid accounts (a) Ayuntamiento de Valladolid (VALL_Mun) (b) AUVASA (VALL_PuT_AUVASA)

Barreiro

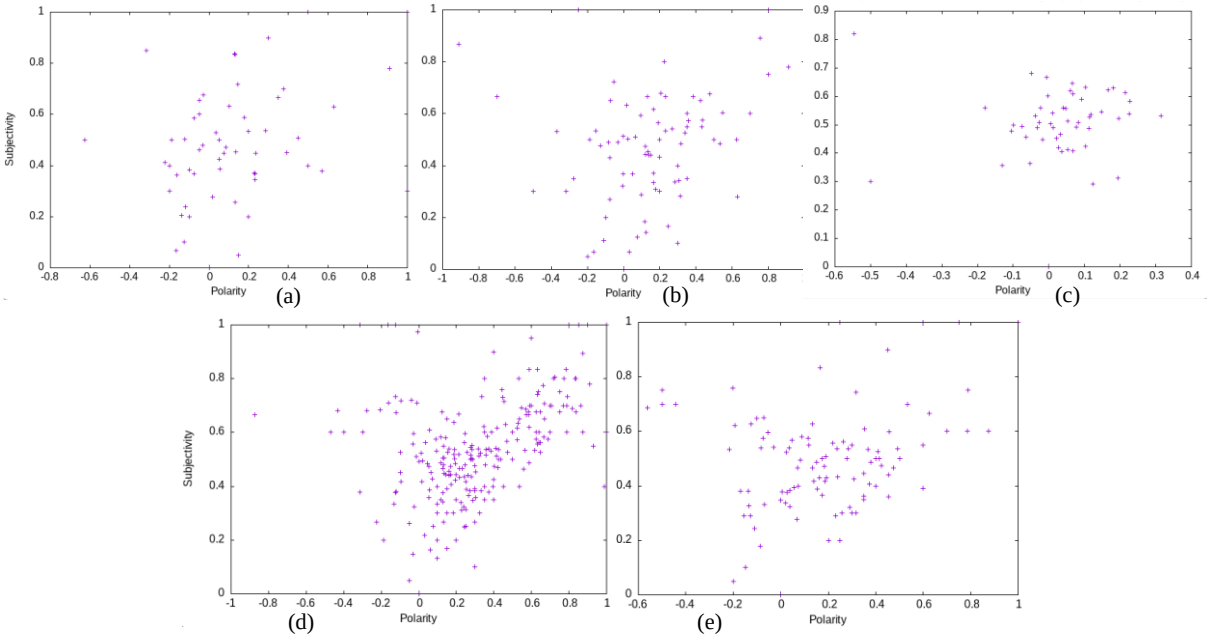


Figure 16. Average comment sentiment analysis per post for Barreiro accounts (a) Município Do Barreiro (BARR_Mun) (b) TCB – Transportes Coletivos do Barreiro (BARR_PuT_TCB) (c) Carris Metropolitana (BARR_PuT_CM) (d) CP – Comboios de Portugal (BARR_PuT_CP) (e) Fertagus (BARR_PuT_Fer)

Zilina

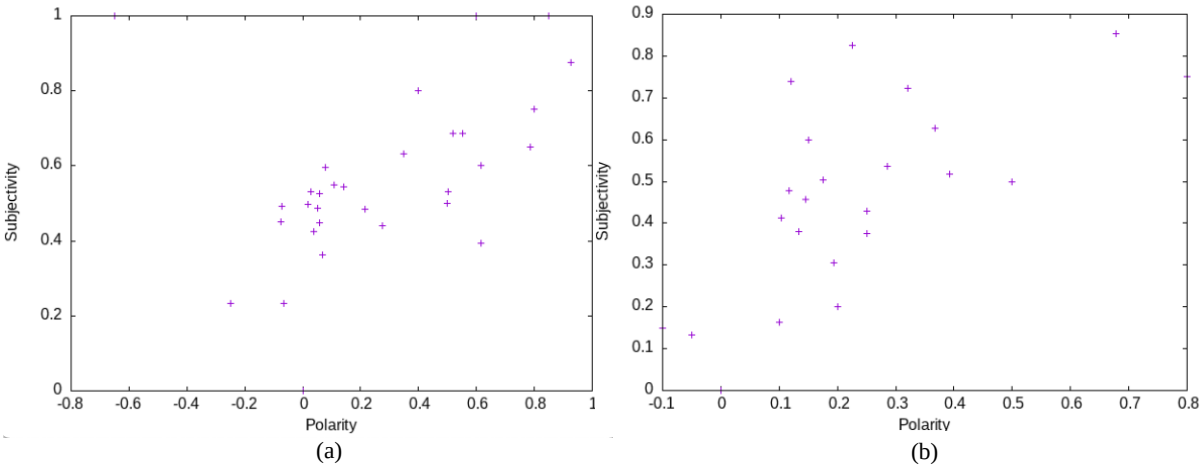


Figure 17. Average comment sentiment analysis per post for Zilina accounts (a) City of Zilina (ZILI_Mun) (b) DPMZ (ZILI_PuT_DPMZ)

Annex VI: List of Indicators used in SPINE for the impact assessment of the implemented measures