REALLOCATE

Evaluation and Impact Framework

Deliverable number: D5.1

Date: 14/02/25

Version: 2

Funded by the European Union's Horizon Europe programme under grant agreement No 101103924. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Commission. Neither the European Union nor the granting authority can be held responsible for them.

REALLOCATE is a project under the CIVITAS Initiative and contributes to the goals of the EU Mission Climate-Neutral and Smart Cities.

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Name of work package	WP5: Proactive continuous assessment
Dissemination level	PUB
Due delivery date:	30/04/2024
Actual delivery date:	05/07/2024 version 1, 14/02/25 revision 2
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Document history				
Version	**Submitted for review by**	**Date**	**Reviewed by**	**Date**
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Executive summary

This deliverable, titled "Evaluation and Impact Framework" (D5.1), presents a comprehensive methodology for evaluating the impacts of the REALLOCATE project's interventions at both micro (project-specific) and macro (city-wide) levels. The primary aim is to establish a robust evaluation framework that ensures interventions lead to sustainable and inclusive urban mobility solutions.

The document begins with an overview of the REALLOCATE project and its objectives, followed by a detailed explanation of the evaluation and impact assessment framework. It outlines methodologies for data collection and analysis, defines and assesses Key Performance Indicators (KPIs), and describes impact assessment tools and strategies. The deliverable concludes with key outcomes and suggestions on how recommendations could be utilised, emphasising stakeholder engagement, data-driven decision-making, and continuous monitoring.

This deliverable is closely linked to several project milestones and tasks, particularly within WP5 and Task 5.1. It provides foundational insights for the mid-term evaluation of interventions (D5.3), distributed dashboards and centralized visualization (D5.2), and recommendations for urban planning. Key related Deliverables include the Data Management Plan (D1.3), SSMLs implementation plans (D2.2), the REALLOCATE Distributed Dashboard (D5.2), and the mid-term evaluation of interventions (D5.3).

Further steps involved refining the evaluation framework and the KPIs, identifying and outlining the data paths for each indicator, selecting appropriate analysis techniques and models, at both macro and micro levels, as well as ensuring scalability and replicability. The results of these efforts will inform policy recommendations and guidelines to support sustainable urban mobility across European cities.

In conclusion, this deliverable lays a solid foundation for ongoing and future evaluations within the REALLOCATE project, ensuring interventions are effective, sustainable, and inclusive.

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List of Abbreviations

Abbreviation	Full Name
AH	Acceptance Hypothesis
AHA	A Human Approach to Future Mobility
AI	Artificial Intelligence
AQI	Air Quality Index
AWI	Aggregated Walkability Index
BA	Barcelona
BRT	Bus Rapid Transit
CBM	Circular Business model
CC	Climate Change
CE	Circular Economy
CO_2	Carbon Dioxide
CPs	Circularity Properties
CSV	Comma-Separated Values
CWIIR	City-Wide Infrastructure Improvement Rate
CWIQ	City-Wide Infrastructure Quality
D	Deliverable
DDMH	Dynamic Data Management Hub
DFR	Design for Recycling
DST	Decision Support Tool
DRT	Demand-Responsive Transport
EFD	Emission Factor Database
EoL	End of Life
EQ	Environmental Quality
EU	European Union
FU	Functional Unit
GDPR	General Data Protection Regulation
GHG	Greenhouse gas emissions
GIS	Geographic Information Systems
GOT	Gothenburg
GPR	Grant Periodic Report
GWP	Global Warming Potential
HD	Heidelberg
HP	Horizontal Partners
IA	Impact Assessment
IIR	Infrastructure Improvement Rate
IND	Indicator
IoT	Internet of Things
IPCC	Intergovernmental Panel on Climate Change
IQ	Infrastructure Quality
IRIS	Impact Reporting and Investment Standards
ISO	International Organization for Standardization
ITF	International Transport Forum
kg CO2e	Kilograms of Carbon Dioxide Equivalent
KPI	Key Performance Indicator
kWh/km	Kilowatt-Hours per Kilometer
LCA	Life Cycle Assessment

Abbreviation	Full Name
LCI	Life Cycle Inventory
LCIA	Life Cycle Impact Assessment
LEM	Local Evaluation Manager
LiDAR	Light Detection and Ranging
LY	Lyon
L/km	Liters per Kilometre
MLP	Multi-Level Perspective
MMV	Micro-Mobility Vehicles
MS	Measure
NLP	Natural Language Processing
NO2	Nitrogen Dioxide
NOx	Nitrogen Oxides
NUMP	National Urban Mobility Plan
PLE	Product Life Extension
PM	Particulate Matter
PSH	Perceived Safety Hypothesis
PT	Public Transport
PwD	People with Disabilities
RFR	Resident Feedback Rate
RNN	Recurrent Neural Network
RPO	Retain Product Ownership
RS	Resident Satisfaction
RSIA	Road Safety Impact Assessment
SDM	System Dynamic Model
SI	Social Inclusiveness
SIA	Social Impact Assessment
SIM	Social Inclusion Monitor
SOPs	Standard Operating Procedures
SQM	Square Meter
SSML	Safe and Sustainable Mobility Lab
SUMI	Sustainable Urban Mobility Indicators
SUMP	Sustainable Urban Mobility Plan
SVHC	Substances of Very High Concern
T	Task
TC	Thematic Cluster
TMP	Tampere
UIA	Urban Innovative Actions
UTR	Utrecht
VR	Virtual Reality
VRU	Vulnerable Road User
WAW	Warsaw
WH	Walkability Hypothesis
WI	Walkability Index
WIR	Walkability Improvement Rate
WP	Work Package
ZG	Zagreb
3D	Three Dimensional

1 Introduction

The REALLOCATE project aims to transform urban mobility by implementing sustainable, inclusive, and data-driven interventions.

In **Chapter 1**, the Introduction outlines the purpose of the deliverable, providing context on the REALLOCATE project's goals and the need for an evaluation framework. It details the organisation of the document, offering a roadmap for the reader.

Chapter 2, Evaluation and Impact Assessment Framework, defines the scope and specific objectives of the framework, emphasising the dual focus on micro and macro-level assessments. It describes the methodologies used for data collection and analysis, highlighting the integration of big data and Artificial Intelligence (AI) techniques.

Chapter 3, Micro Evaluation at Project Level, discusses various thematic clusters as well as the climate targets, social inclusiveness, and safety, and outlines the specific impact assessment areas.

Chapter 4, Macro Evaluation at City Level, provides the evaluations for each participating city, including pilot implementations and their specific outcomes. It describes the procedures followed by the Safe and Sustainable Mobility Labs (SSMLs), from baseline data collection to reporting and communication of findings based on D2.2 but focussing mostly on the indicators and data requirements.

Chapter 5, Data Collection and Analysis, outlines the strategies for collecting baseline and intervention data, and the techniques used for big data and AI integration in analysis.

Chapter 6, Impact Assessment Tools and Strategies, discusses the design of evaluation tools and strategies tailored for specific population groups.

Chapter 7, Utilisation of Indicators for Urban Planning, highlights how the KPIs and collected data can enhance policy-making processes and urban planning strategies.

Chapter 8, Conclusions, summarises the key findings from the impact assessments and provides how actionable recommendations for policymakers and city planners will foster more liveable, resilient, and inclusive urban environments based on the impact assessment estimations.

1.1 Purpose of the Deliverable

The purpose of this deliverable is to present the Evaluation and Impact Assessment Framework for the REALLOCATE project. It aims to define the methodologies, tools, and indicators used to evaluate the project's impacts at both micro and macro levels.

The following diagram (Figure 1) presents the process followed to define the primary dimensions and necessities of the REALLOCATE evaluation and impact framework. It begins with defining the **"Why"** through clear objectives and key performance indicators (KPIs), also mentioned as Measures, emphasizing the use of Sustainable Urban Mobility Indicators (SUMI) and a top-down approach to align with strategic goals (T5.1). Moving to the **"What"**, it delineates the scope of the framework by identifying targeted urban areas and planned interventions, executed in collaboration with horizontal partners (HP). Those are described in D2.2 and the connection of the tools, interventions and HPs is highlighted in Annex A: Data Collection Instruments. The **"Who"** section identifies the key stakeholders, users, and partners involved, including governments, businesses, residents, commuters, and project collaborators. The **"How"** aspect details the implementation tools and methods, combining objective and subjective measures through dashboards (T5.2), analytical tools (T5.5), and both top-down and bottom-up processes. Finally, the **"When"** outlines the timeline and milestones, starting with a 6-month baseline data collection, phased intervention rollouts over 12-24 months, and concluding with a full impact assessment after six months of interventions (T5.3 and T5.4).

This structured flow ensures a comprehensive, participatory, and data-driven approach to achieving the project's strategic objectives. The top-down process is accommodated through the inception report and its separate SSML files. Conversely, the bottom-up process involves the completion of the data collection protocol file (Annex D: Data collection protocol template) by the involved horizontal partners and SSMLs' teams, which includes the collection of data descriptions along with data characteristics from the inception report. Both sources facilitate the mapping of data and indicators by the WP teams. This mapping process ensures that data is available for our indicators and that indicators exist for our data sets. This data validation process ensures compliance with General Data Protection Regulation (GDPR), preventing data redundancy and data loss.

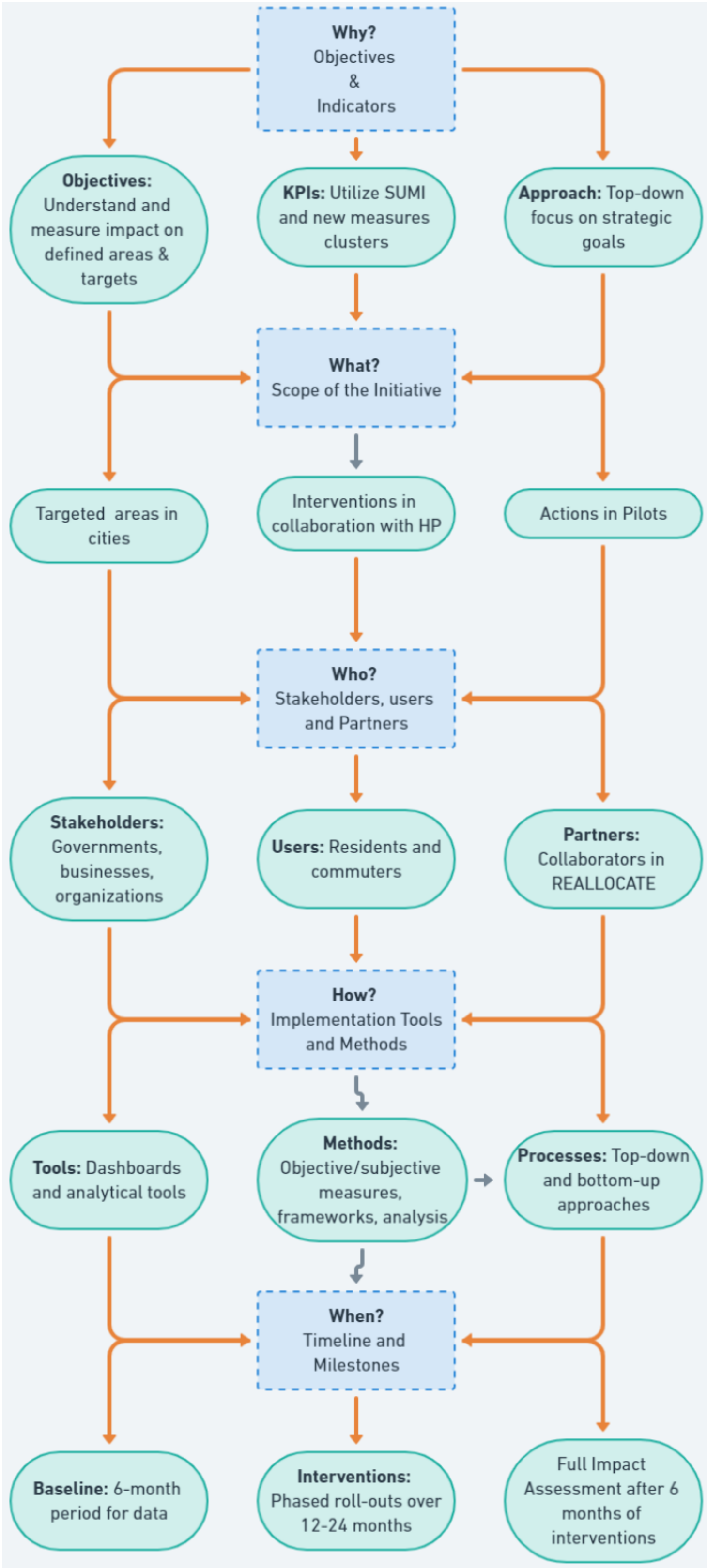


Figure 1. The process for developing the Evaluation and Impact Assessment Framework, detailing the whys, hows, and timelines

1.2 Structure of the Document

This document is organized into several sections, starting with an overview of the REALLOCATE project and its objectives. It then details the evaluation and impact assessment framework, followed by methodologies for data collection and analysis. Subsequent sections cover the definition and assessment of KPIs, impact assessment tools and strategies, and a data-driven urban planning framework. The document concludes with a summary of key findings and suggestions of how recommendations will be documented.

1.3 Overview

1.3.1 Objective

The primary objective of Task 5.1 is to develop an evaluation and impact assessment framework that can effectively measure the impacts of the REALLOCATE project's interventions. This involves defining relevant KPIs, developing data collection and analysis methodologies, and integrating these into a comprehensive framework.

1.3.2 Audience

This deliverable is intended for a wide audience, including project partners, city planners, policy makers, researchers, and the general public. The content is designed to be accessible and informative, providing insights into the project's evaluation and impact assessment processes.

1.3.3 Relationship to Other Work Packages and Tasks

Task 5.1 is closely linked to other work packages within the REALLOCATE project. It relies on data and insights from deployment plans (WP2), pilot implementations and interventions as well as technological innovations (WP3). The outcomes of Task 5.1 will also inform subsequent tasks within WP5 as well as related policy recommendations and urban planning strategies.

2 Evaluation and Impact Framework

The Safe and Sustainable Mobility Labs (SSMLs) represent a progressive approach to urban development, focusing on integrating sustainable solutions through participatory and co-creation processes. Drawing from various sources, including Schliwa and colleagues (2015), Rollin and colleagues (2021), and other scholarly works, this procedure outlines comprehensive steps to ensure thorough evaluation and continuous improvement of urban interventions.

2.1 Scope and Objectives

The evaluation framework aims to assess the impacts of the REALLOCATE project at two levels: **micro (project-specific)** and **macro (pilot site; city-wide)**. The scope includes evaluating the safety, environmental, social, and governance impacts of the interventions. Specific objectives include:

- Measuring changes in urban mobility patterns
- Assessing improvements in road safety and environmental sustainability
- Evaluating social inclusiveness and accessibility
- Analysing governance and policy impacts

In the context of the REALLOCATE project, a **proactive impact assessment framework** refers to a forward-looking and anticipatory approach to evaluating and measuring the effects of the project interventions. Proactive means that the framework is designed not only to assess the impacts after they occur but to anticipate and address potential issues (through interim impact assessment and corrective actions), optimize outcomes, and guide decision-making throughout the project lifecycle. This involves continuous monitoring, iterative feedback loops, and adaptive strategies to ensure that the interventions are effective and aligned with the project's goals. The **evaluation component** of this framework focuses on systematically collecting and analysing data related to the project's KPIs to measure performance and effectiveness. This includes assessing changes in urban mobility patterns, environmental sustainability, road safety, social inclusiveness, and governance. **The impact assessment**, on the other hand, goes deeper into understanding the broader consequences of the interventions, such as their long-term effects on the urban environment, quality of life for residents, and achievement of strategic goals like climate targets and social equity.

By integrating both evaluation and impact assessment, the proactive framework ensures that the project not only tracks immediate progress but also understands and enhances its long-term contributions to urban development.

2.2 Methodology

The diagram (Figure 2) illustrates the structure for developing an evaluation framework for urban mobility projects, covering both micro (project-specific) and macro (pilot site; city-wide) perspectives. At the micro level, the framework begins by setting objectives, followed by identifying relevant indicators such as Sustainable Urban Mobility Indicators (SUMI) and climate targets. These indicators are used to evaluate the project impact areas, leading to the formulation of common indicators. These indicators inform the data types and instruments required for evaluation. On the macro level, the framework aligns city objectives with specific actions, which are then assessed through corresponding indicators. This comprehensive approach ensures effective evaluation of both specific projects and broader urban impacts.

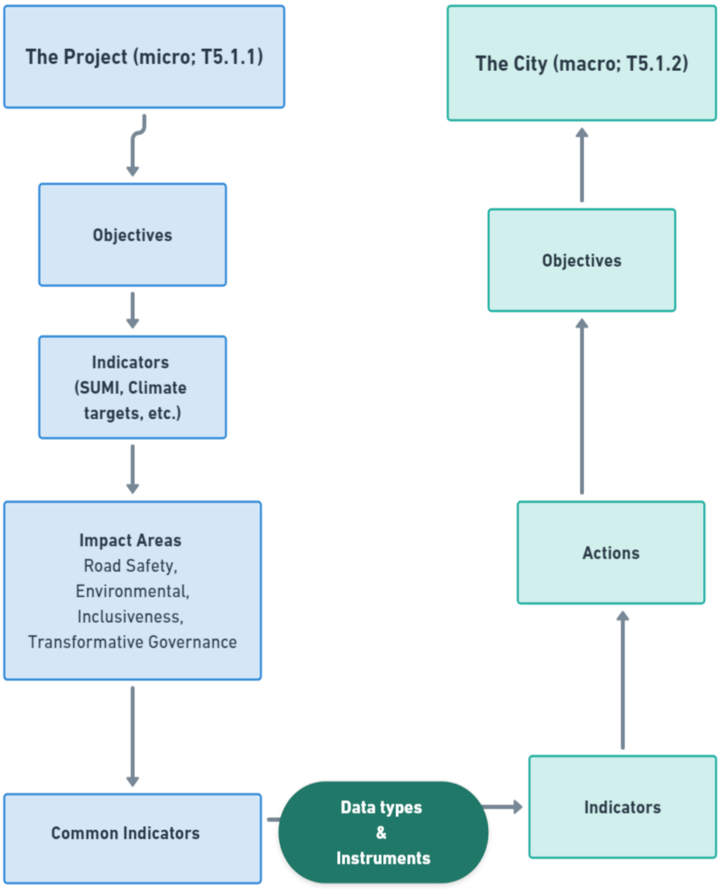


Figure 2. The dimensions of macro- and micro-levels impact assessment

The methodology for the evaluation framework includes several key components. The methodology for the Evaluation and Impact Assessment Framework in the REALLOCATE project is structured around two core components: **the System Dynamic Modelling (SDM) Approach** and **the Data Utilization Strategy**. These components collectively provide a comprehensive approach to evaluating the project's impacts.

The System Dynamic Modelling Approach will help us understand and predict the behaviour of the changes in the SSMLs over time. It involves several steps: conceptualization defines key components and interactions within the system, such as traffic flow, pollution levels, and safety incidents. Formulation uses mathematical equations to represent these relationships. Calibration employs historical data to ensure the model accurately reflects real-world conditions. Simulation conducts scenario analysis to predict the impacts of various interventions, considering both short-term and long-term effects. Sensitivity analysis identifies the most influential variables to prioritize interventions. Finally, validation and refinement compare model predictions against observed data from pilot implementations, adjusting the model to improve accuracy and reliability. SDM will be supportive but not restrictive. Depending on the data collected, additional methods will be applied, with decisions regarding these methods made within Tasks 5.3 and 5.4, respectively.

The Data Utilization Strategy for the REALLOCATE project outlines the processes for collecting, analysing, and using data to monitor KPIs and assess project impacts. Initially, baseline data on traffic volumes, accident rates, air quality, and social inclusion metrics will be gathered to understand current conditions before implementing interventions. During and after these interventions, additional data will be collected to evaluate their impacts. For analysis, the strategy employs both quantitative methods, such as statistical and computational techniques, and qualitative methods, including interviews and focus groups, to identify trends and understand stakeholder perceptions.

Integration of big data and AI will be utilized for advanced analytics and predictive modelling, processing large and complex data sets from various sources like sensors, surveys, and administrative records to create a comprehensive view of the project's impacts.

The strategy includes continuous feedback mechanisms to enable real-time adjustments to interventions, with regular feedback from local communities and stakeholders ensuring that interventions align with their needs and expectations. Data quality assurance is a priority, involving regular validation to maintain accuracy and reliability. Standardised data collection and analysis protocols will ensure consistency across different pilot areas and interventions within the REALLOCATE project.

The following diagram (Figure 3) provides an integrated overview of the framework for REALLOCATE, encompassing the stages of planning, executing, and analysis and reporting. In the planning phase, it highlights the importance of co-creation workshops and SSML deployments to develop KPIs. The implementation of interventions is guided by these KPIs, which are categorized into SUMI (Sustainable Urban Mobility Indicators) and REALLOCATE indicators (see also Table 1).

Moving into the executing phase, the diagram illustrates a timeline starting from the baseline measurement, followed by mid-term and final evaluations. These evaluations are conducted using Dynamic Data Management Hub (DDMH) and Decision Support Tool (DST) systems (T5.2 and T5.5, respectively), ensuring continuous monitoring and assessment of interventions.

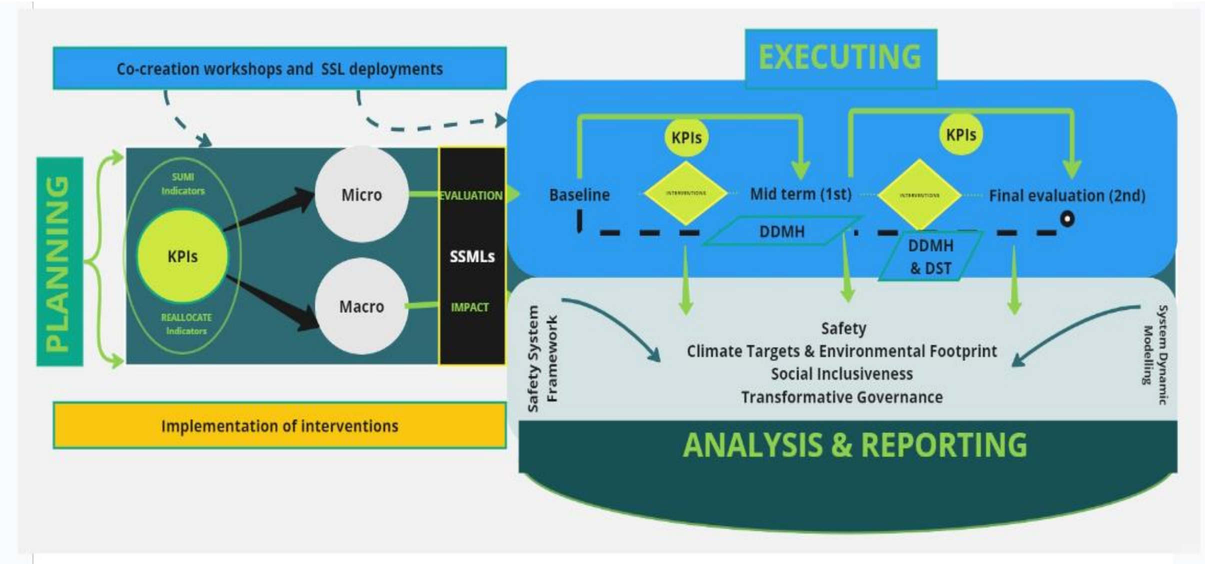


Figure 3. The evaluation and impact assessment framework concept

2.2.1 Key Performance Indicators (KPIs)

The initial step in the impact assessment process is to clearly define the scope and objectives of the SSML interventions. At the project level, this involves identifying specific goals and expected outcomes for the impact area. For instance, if we aim to enhance road safety, objectives may include reducing the number of traffic accidents and near-miss incidents, improving pedestrian safety, and promoting sustainable mobility options like walking and cycling overall in cities. Defining KPIs aligned with these objectives is necessary. KPIs could include metrics such as the reduction in accident rates, increased pedestrian and cyclist counts, and user satisfaction scores.

At the city level, the focus shifts to goals that align with municipal strategies and urban development plans. City-level objectives might include enhancing mobility, reducing greenhouse gas emissions, and improving the quality of public spaces. Identifying intervention, pilot-areas and potentially city-wide KPIs that can encompass multiple pilots and interventions provides a cohesive framework for evaluating the cumulative impact of various SSML actions and, thus, serving the connection with the project level KPIs. **The project-level KPIs are not distinct from those chosen by individual cities; rather, they represent the KPIs that are common across all participating cities.**

In the GA there are 30 KPIs (i.e., Measures) from which 19 are reflecting the previous Sustainable Urban Mobility Indicators (SUMI) and during the lifetime of REALLOCATE we attempt to cluster the indicators in the newly-suggested 7 SUMI categories (Greenhouse gas emissions, Congestion, Accidents and Injuries, Modal Share, Access to Mobility Services, Air Pollution, Noise Pollution, and Other; Table 1), as defined in the inception report. The inception report is a spreadsheet document that includes all the REALLOCATE project measures (i.e., the KPIs) for all cities and pilots, along with the indicators and other relevant information. This is a living document that is periodically updated and shared with the European Commission. Indicators are the specific data points that belong under a certain Measure and are the ones we will collect data for. A Measure can include multiple indicators. The indicators will have data characteristics, such as format, frequency of collection, unit of measurement, etc.

2.2.1.1 Co-development Process

Developing the KPIs for the REALLOCATE project was a collaborative effort involving WP2, SSML partners, stakeholders, and cities. The process ensured the KPIs were relevant and robust for assessing project impacts. It began with two inception reports, followed by monthly meetings with SSML partners to refine the KPIs in line with project objectives and stakeholder needs.

Files were created to identify commonalities across indicators, streamlining KPI development. Meetings with city representatives defined city-specific indicators and provided updates on existing ones, addressing local contexts. The methodical process started with defining deployment plans and selecting horizontal partners, shaping the actions and interventions to solidify the KPIs. This structured approach ensured the KPIs were relevant, coherent, and adaptable to the project's dynamic needs. Below is a detailed overview of the KPI development process:

2.2.1.1.1 Inception Reports

The current process has already involved three inception reports that served as foundational documents.

The inception report was segmented by city and milestone for easier updates and access, compiled into a comprehensive document before each submission. Meetings ensured the pilots' current status was reflected, treating the reports as living documents. However, the process of identifying relevant indicators is dynamic. Cities continue to identify additional indicators, e.g. some in D2.2, which are currently being integrated into the inception reports. These indicators, or their components, may also serve as metrics for broader indicators. Consequently, the inception report reflects the current status of the indicator identification and integration process. Additional columns captured detailed data characteristics such as baseline availability, baseline actions, data source, format, frequency, and unit of measurement. Targets and baseline values for each indicator were, on some level, included but are preliminary, as cities are still defining study protocols and intervention processes, influencing both baseline data and target settings. The clustering of indicators from previous SUMI measures (MS1-MS18) and REALLOCATE (MS19-MS30) measures to new SUMI measures is illustrated in the diagram below (Table 1).

Table 1. Measures and new SUMI categories

MS1	*Affordability of public transport for the poorest group*
MS2	*Accessibility of public transport for mobility-impaired groups*
MS3	*Air pollutant emissions*
MS4	*Noise hindrance*
MS5	*Road deaths*
MS6	*Access to mobility services*
MS7	*Greenhouse gas emissions (GHG)*
MS8	*Congestion and delays*
MS9	*Energy efficiency*
MS10	*Opportunity for active mobility*
MS11	*Multimodal integration*
MS12	*Satisfaction with public transport*
MS13	*Traffic safety active modes*
MS14	*Quality of public spaces*
MS15	*Urban functional diversity*
MS16	*Commuting travel time*
MS17	*Mobility space usage*
MS18	*Security*
MS19	*Increases in pedestrians and cyclists (numbers)*
MS20	*Pedestrian & disabled comfort (reduced risks; walking distance/time; shade, walkable conditions) (% from baseline)*
MS21	*Cycling & e-bike comfort (reduced cycle waiting time, increased bike parking, etc.) (% from baseline)*
MS22	*VRUs/user interactions improvements (AI modelled - reduced near misses, responsive traffic lights, etc.)*
MS23	*Reallocation of public space (sqm/year)*
MS24	*Conversion from impermeable to permeable/vegetated surface (sqm and no. of trees planted)*
MS25	*Uptake/incorporation of Circular Economy principles (% from baseline)*
MS26	*Engagement (no. of people engaged in co-creation/co-management)*
MS27	*Public acceptance of interventions (citizens + stakeholders) (% of persons asked)*
MS28	*Extendibility - Replicability of the intervention (% extendable/ replicable)*
MS29	*Promotion of infection free mobility in Interventions (possibility to keep 1-2m distance)*
MS30	*Achievement of Climate Targets for Transport (% of achievement)*

1. greenhouse gas emissions
2. congestion
3. accidents and injuries
4. modal share
5. access to mobility services
6. air pollution
7. noise pollution
8. other

2.2.1.1.2 Elaboration of Commonalities

To streamline the KPI development process, several files were elaborated to identify commonalities across different indicators. This step involved analysing existing data and indicators from various sources to find overlapping areas and establish a set of common indicators that could be applied consistently across all SSMLs and thematic clusters.

2.2.1.2 Stepwise Approach

The KPI development process was methodical and stepwise, relying also on the definitions provided in the deployment plans and the selection of horizontal partners. Initially, broad categories and potential indicators were identified. This was followed by detailed discussions and refinements based on feedback from partners and stakeholders. Each step built upon the previous one, gradually creating a more concrete set of KPIs.

2.2.1.2.1 Selection of Horizontal Partners and Interventions

The definition of horizontal partners and the specific actions and interventions they would perform were integral to the KPI development process. These selections influenced the focus areas for the KPIs, ensuring that they were tailored to measure the impacts of the specific interventions planned within the project.

2.2.1.2.2 Iterative Updates and Clustering

As we gather more information about the intervention procedure and process, the indicators are becoming increasingly specific and detailed. This process involves step-by-step identification of key points in the data paths, such as the selection of the exact area, the intervention process, instruments to be used, data collection methods, duration, and precise timeline.

The data protocol template (Annex D: Data collection protocol template) serves as the connection document throughout this process, alongside recurrent meetings with cities and horizontal partners. Once we define the data points, we then refine the indicators in the respective SSML file. This file is broken down into an inception report for each city and measure, making it easier for city partners to complete and track the process.

Regular discussions with involved partners ensure that everyone remains updated, even as certain aspects remain dynamic. This approach guarantees that our method is transparent, well-communicated, easy to follow, and applicable. Additionally, it allows for flexibility and adjustments as needed.

Throughout the process, KPIs are subject to iterative updates and potential clustering. Regular feedback from meetings and ongoing project activities prompted periodic reviews and adjustments. This iterative approach allowed the KPIs to remain dynamic and adaptable to new insights and emerging needs. Given the extensive list of KPIs, we have included the related Measures (the terms Measures and KPIs are used interchangeably; see Table 1) and common indicators (i.e., indicators under a major Measure; see Figure 5). These details will be provided upon request, as these files are extensive to be included in this Deliverable.

2.2.2 The layers of assessment

The structured evaluation process in the Impact Assessment (IA) methodology offers significant advantages, particularly in ensuring that interventions are effective and aligned with community needs. Stakeholder engagement is a core component, fostering relevance and acceptance. However, the comprehensive nature of this approach requires substantial time, resources, and technical expertise, potentially facing resistance from stakeholders when adjustments based on IA findings are necessary.

Employing a multi-level perspective allows for capturing direct, indirect, and diffuse impacts, providing a comprehensive understanding of intervention effects. This facilitates targeted improvements at various levels of the pilot. The downside is the complexity and extensive data requirements, which can make it challenging to isolate impacts specific to each layer and integrate multi-level data cohesively. The data utilization strategy for the REALLOCATE project is designed to systematically collect, analyse, and use data to monitor KPIs and assess the impacts of interventions at both micro (project-specific) and macro (pilot-wide) levels. This strategy is structured across four layers: **macro and micro levels, thematic clusters, specific impact areas and types.**

2.2.2.1 Layer 1: Macro & Micro levels

At the micro level, data collection focuses to understand the broader impacts of interventions across multiple sites. The objective is to capture comprehensive data that reflects the cumulative effect of interventions on the project level impact areas. At the macro level, data collection is tailored to each pilot site. In some cases, this method helps us determine if adjacent areas are impacted by the measures introduced, thereby capturing localised effects of the interventions across several municipalities. The goal is to assess how specific interventions influence, for example, mobility and public space reallocation at the local level, providing granular insights that can inform targeted improvements. For both macro and micro levels, baseline data will be collected before interventions begin, followed by regular data collection during and after the implementation phase. For some indicators, real-time data will be gathered using sensors, surveys, and mobile applications to ensure continuous monitoring and timely adjustments.

Quantitative analysis involves using statistical and computational methods to analyse numerical data, identifying trends and measuring changes over time. At the micro level, analysis will provide insights into project-level impacts, while at the micro level, aggregated data will inform city-wide policies. Qualitative analysis involves analysing subjective data from surveys and focus groups to understand perceptions and experiences related to the interventions. At the macro level, resident feedback will inform specific adjustments, while at the macro level, broader qualitative assessments will capture city-wide sentiments. Big data and AI integration involves processing large and complex data sets; at the micro level, AI models will optimise interventions in real-time, while at the macro level, predictive modelling will inform long-term urban planning.

2.2.2.2 Layer 2: Thematic clusters

Thematic clusters group related indicators were created to streamline data collection and analysis. The WP4 thematic clusters are **'Safe & Sustainable Schools', 'Concepts for Space Reallocation'**, **'Data Safety Digital Integration for Accessibility'**, **'Central Areas Traffic Reorganisation'**, and **'Integrated Traffic Reorganisation – Peri-Urban'**.

In the **'Safe & Sustainable Schools'** cluster, data collected includes school zone traffic volumes, pedestrian and cyclist counts, air quality measurements around schools, accident and near-miss incidents, as well as student and parent travel behaviour. For example, predictive analysis based on thematic clustering of the pilots and collected data would result into a System Dynamic Modelling (SDM) simulating the impact of interventions such as safe routes to school, traffic calming measures, and improved pedestrian and cyclist infrastructure on safety and sustainability around schools.

For **'Concepts for Space Reallocation'** cluster of pilots, data collected include usage patterns of reallocated spaces, user satisfaction surveys, traffic diversion data, and public space utilisation. Likewise, the SDM could evaluate the effectiveness of space reallocation concepts, measuring improvements in public space usage, traffic flow changes, and user satisfaction.

In the **'Data Safety Digital Integration for Accessibility'** cluster, data collected includes digital infrastructure usage data, accessibility scores, user feedback on digital tools, and data security incidents. The SDM could assess the impact of digital integration on accessibility, focusing on improvements in data safety, ease of access to digital tools, and user experiences.

For the **'Central Areas Traffic Reorganisation'** cluster, data collected includes traffic volumes, congestion levels, public transport usage, pedestrian and cyclist counts, and air quality in central areas. The SDM could model the effects of traffic reorganisation in central areas, evaluating possible reductions in congestion, improvements in air quality, and shifts to sustainable transport modes.

Finally, In the **'Integrated Traffic Reorganisation – Peri-Urban'** cluster, data collected includes traffic volumes, public transport accessibility, peri-urban mobility patterns, and environmental impact data. The SDM could simulate the impact of integrated traffic reorganisation in peri-urban areas, focusing on enhanced connectivity, reduced environmental impacts, and improved mobility options.

2.2.2.3 Layer 3: Impact assessment areas

The methodology's holistic approach ensures a broad view of social, environmental, and other impacts, aligning with urban development goals. Clear metrics for sustainability and safety are established, but the challenge lies in quantifying some impacts, particularly diffuse ones. This requires diverse data sources and interdisciplinary methods, potentially overlooking immediate short-term impacts. Many Measures correspond to specific impact areas, where detailed data will be collected and analysed. The impact assessment areas are: **Climate Targets, Environmental Footprint, and Circularity; Social Inclusivity and Accessibility; Safe System approach and Road Safety; and Transformative Governance** (further elaborated in section 3.2).

For the **Climate Targets, Environmental Footprint, and Circularity impact area**, data collected includes emission levels (CO_2, NO_x), energy consumption and recycling practices. Baseline data includes current emission levels and current (if any) circularity practices. Post-intervention data measures reductions in emissions and improvements in circularity practices. The SDM could model long-term environmental benefits, providing insights into how interventions contribute to climate targets and circularity (please see section 3.2.1).

In the **Social Inclusivity and Accessibility impact area**, data collected include accessibility scores, satisfaction surveys, and potentially social inclusion metrics. Baseline data captures current accessibility and potentially inclusiveness aspects. Post-intervention data would measure improvements in these areas, focusing on increased access to, for example, Demand-Responsive Transport (DRT) services. The SDM could further evaluate social impacts, ensuring interventions enhance inclusiveness and equity for all population groups in the specific area (please see section 3.2.2).

In the **Transformative Governance impact area**, data collected includes policy implementation records, stakeholder engagement levels, governance structures, and feedback from public consultations. Baseline data includes current governance structures and stakeholder engagement levels. Post-intervention data will evaluate changes in these metrics, focusing on the effectiveness of new governance models. Continuous stakeholder feedback is used to refine governance strategies, ensuring improved engagement and policy compliance (please see section 3.2.3).

For the **Safe System approach and Road Safety impact area**, data collected includes accident and injury records, near-miss incidents, road design features, and speed data. Baseline data includes existing accident rates and safety conditions. Post-intervention data tracks changes in these metrics, focusing on areas with new safety measures. The SDM assesses the effectiveness of interventions in improving road safety, predicting reductions in accidents (and their outcomes) and enhancements in perceived safety ((please see section 3.2.4).

2.2.2.4 Layer 4: Direct, indirect and diffuse impacts

Developing a conceptual framework is essential for categorizing and understanding the different types of impacts. Utilizing a multi-level perspective (MLP), impacts can be classified into three categories: **direct, indirect, and diffuse impacts**.

Direct impacts emerge at the niche level (local individual practices) and are the most tangible outcomes of SSML interventions (see for instance Rollin et al., 2021). These include objectively measurable changes in user behaviour, such as increased use of pedestrian and cycling infrastructure or reduced traffic accidents at specific locations. **Indirect impacts** are follow-up activities at the regime level (dominant practices), influenced by the SSML interventions. These might involve policy changes or new urban planning practices adopted because of successful project outcomes. **Diffuse impacts** occur at the regime and landscape levels (macro-paradigms) and pertain to changes in cultural and normative values within the community. These impacts influence the perception of sustainability issues and the design of urban infrastructures.

2.2.3 Interim and final assessment

The timeline for assessments includes a mid-term assessment conducted halfway through the intervention period, measuring interim progress and identifying necessary adjustments. Data collection for the mid-term assessment involves updated traffic, safety, environmental, and social metrics using surveys, statistical data, and sensors for real-time data for those pilots we will have adequate volume and quality of comparable baseline and intervention data. The analysis will take place between months 24 and 30, with the reporting scheduled for month 30. The SDM could simulate the current state and predict the future (i.e., final) impacts, comparing against baseline and initial targets. The interim report (D5.3) will highlight the progress, challenges, and recommended adjustments (i.e., corrective actions). The final assessment, conducted at the end of the intervention period, will measure overall success and will provide recommendations for future projects. Comprehensive data collection on all impact areas using long-term data from sensors, surveys, and administrative records is conducted for the final assessment. The SDM will provide a final assessment of impacts, evaluating the achievement of climate targets, safety improvements, social inclusiveness, and governance effectiveness. The final report (D5.4) will detail outcomes, successes, areas for improvement, policy recommendations, and future intervention strategies.

The analysis for the interim and final impact assessment is generally covered in D5.1 (in sections 2.2.4 and chapter 5). This framework needs to be flexible to select appropriate and relevant evaluation and statistical techniques based on the data collected. In addition to these techniques, SDM will be used as a tool to identify relationships, connections, and predictions. In summary, this deliverable does not present the analysis plan; instead, the analysis plan will be specifically and concretely addressed in D5.3 and D5.4.

No methodology is panacea; therefore, to ground our work from the beginning, a comparison table for the Impact Assessment (IA) methodology, focusing on various aspects and their respective pros and cons was prepared (Table 2).

Table 2. Impact Assessment (IA) methodology pros and cons

Aspect	Pros	Cons
IA of the Project	- Provides structured evaluation and continuous improvement. - Engages stakeholders, ensuring interventions are relevant and accepted. - Enhances transparency and public trust.	- Time-consuming data collection and analysis. - Requires significant resources and technical expertise. - Potential resistance from stakeholders to changes based on IA findings.
Layers of the Project	- Multi-level perspective captures direct, indirect, and diffuse impacts. - Allows for comprehensive understanding of intervention effects. - Facilitates targeted improvements at different levels.	- Complex and may require extensive data across various levels. - Difficult to isolate impacts specific to each layer. - Integration of multi-level data can be challenging.
Impact Areas	- Holistic view of social, environmental, and economic impacts. - Aligns with broader urban development goals. - Provides clear metrics for sustainability and safety improvements.	- Some impacts, especially diffuse ones, are difficult to quantify. - Requires diverse data sources and interdisciplinary approaches. - May overlook immediate, short-term impacts.
Estimation Methods	- Combines quantitative and qualitative data for robust assessment. - Uses advanced data collection tools for real-time monitoring. - Incorporates stakeholder feedback for comprehensive insights.	- High dependence on technology and data quality. - Qualitative data can be subjective and hard to standardise. - Requires continuous data integration and updating.
System Modelling	- Facilitates simulation and prediction of intervention outcomes. - Supports scenario analysis and risk mitigation. - Enhances decision-making with data-driven insights.	- Requires sophisticated modelling tools and expertise. - Models can be sensitive to initial assumptions and data accuracy. - High computational and resource demands.
Integration with Digital Twins	- Provides real-time data and dynamic simulation capabilities. - Enhances accuracy and reliability of IA through continuous updates. - Facilitates virtual testing and optimisation of interventions.	- High initial setup and maintenance costs. - Requires interoperability between various data systems. - Potential data privacy and security concerns.
Connection with Cascade Cities	- Promotes knowledge sharing and replication of successful interventions. - Builds collaborative networks for broader urban sustainability. - Enhances scalability and transferability of IA findings.	- Diverse urban contexts may limit direct applicability. - Coordination and alignment across cities can be challenging. - Requires standardised frameworks for consistent assessment.

This comprehensive comparison highlights the strengths and limitations of each aspect, ensuring a balanced and informed approach to impact assessment. By understanding these dimensions, we can better navigate the complexities of the involved assessments and the need for adaptability in order to drive meaningful and sustainable improvements.

2.2.4 Data quality assurance

Data quality assurance involves regular validation to ensure data accuracy and reliability, and the standardisation of data collection and analysis protocols (Annex B: Checklist for Ensuring Data Quality and Annex D: Data collection protocol template) across different pilot areas and interventions to maintain consistency. Continuous data collection and monitoring allow for real-time adjustments to interventions. At the macro level, local stakeholders, including residents, businesses, and local authorities, are engaged. At the micro level, aggregated data will be used for project level analyses.

The following method outlines the steps to achieve this. First, we define clear data quality standards and criteria for accuracy, completeness, consistency, and reliability. Then we develop a data quality plan that outlines procedures and responsibilities for data collection, validation, and analysis. For this reason, we created standardised data collection protocols to be used across all pilot sites and ensure all data collectors can use these protocols to maintain consistency. Each pilot needs to apply regular data validation processes to check for errors, inconsistencies, and missing values, using automated validation tools where possible to streamline the process. The dashboard (T5.2; the first version is described in D5.2) will be the data monitoring system to be used to track data, potentially with alerts set up for any anomalies or deviations from expected patterns. It is also important to implement robust data security measures to protect data integrity and confidentiality, ensuring compliance with data privacy regulations and obtaining necessary consents from participants, as it is defined in the relevant Deliverables (D1.1 ’Ethics Requirements’ and D1.3 ‘Data Management Plan’, respectively).

Periodic data quality audits will be conducted to evaluate the overall quality of the data collected, identifying any recurring issues and addressing them promptly. The audits will be conducted at least quarterly, but their frequency depends heavily on the data type and frequency of collection. The feedback from data quality audits and validation processes will be utilised to continuously improve data collection methods, updating protocols and any administered training material as needed to reflect best practices and lessons learned.

2.2.5 Timeline

The Gantt chart (Figure 4) outlines the timeline for the various actions and activities planned under the REALLOCATE project across multiple cities. It spans four years, from May 2023 to April 2027, and details the phases of Baseline, Pilot Execution, Corrective Actions, and Impact Assessment for each participating city. The Gantt chart visually represents the start and end times of these phases, allowing for clear tracking and management of their progress. Further adjustments are anticipated as the conduction processes across pilots and cities are dynamic.

2.2.5.1 Phases

Baseline Duration: For most cities, the baseline phase spans the entire first year from May 2023 to April 2024 and further in the second year of the project. This phase is crucial for gathering initial data to set benchmarks against which the impact of the interventions can be measured.

Pilot Execution Duration: The pilot execution phase generally starts in the second year and can extend into the third year, from May 2024 to April 2026. The duration varies for different cities, but typically this phase lasts about 12 to 24 months. For example, Gothenburg 1 and Gothenburg 2 have pilot execution phases starting at different times, i.e., a year apart.

Corrective Actions Duration: Corrective actions usually start after the pilot execution phase, primarily in the third year (May 2025 - April 2026) and can extend into the fourth year (May 2026 - April 2027). The duration of this phase can range from a few months to over a year, depending on the specific needs and feedback from the pilot execution.

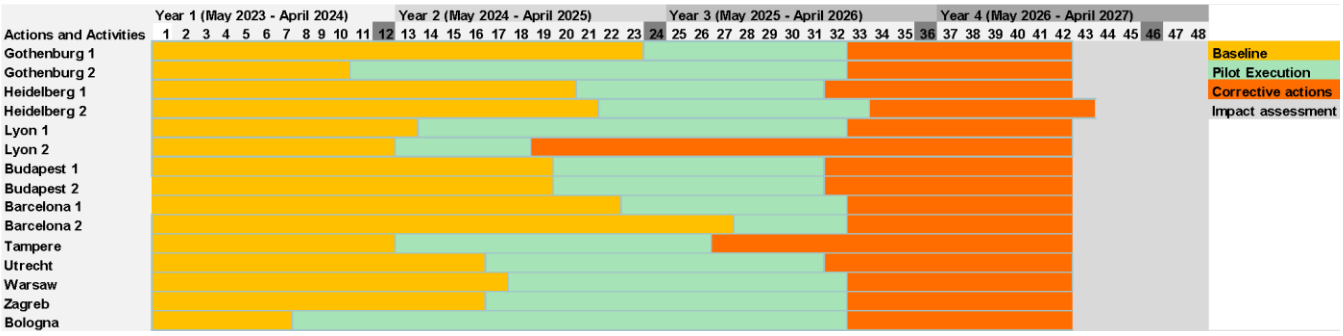


Figure 4. SSML timelines per evaluation phase

2.2.5.2 Baseline condition (Before phase)

The baseline condition at the **macro level** refers to the comprehensive assessment of the entire city's current state before any interventions are implemented. This involves collecting data to capture the overall urban environment, including aspects such as mobility patterns, environmental conditions, social inclusiveness, and governance structures. Establishing this baseline provides a reference point against which the cumulative and wide-scale impacts of the project's interventions can be measured and evaluated over time.

The baseline condition at the **micro level** refers to the assessment of project-level indicators. This involves gathering common and aggregated data to understand the existing conditions in these areas under the same thematic cluster or impact area. Establishing this micro-level baseline allows for precise measurement of the direct impacts of the interventions on targeted aspects of the urban environment within the pilot sites. This detailed baseline serves as a benchmark for evaluating changes and improvements resulting from the project activities.

2.2.5.3 *Intervention condition (After phase)*

The intervention condition at the **macro level** refers to the state of the pilot site action areas during and after the implementation of the specific interventions. This condition involves monitoring and assessing the changes across the urban environment that result from the interventions. It captures the systemic impacts of the actions/ interventions on the area(s) implemented.

The intervention condition at the **micro level** refers to the state of project-level areas during and after the implementation of interventions. This condition involves panoramic monitoring and assessment of changes within these common clusters, capturing the overall impacts of the interventions on generalised aspects.

3 Micro Evaluation at Project Level

The micro evaluation at the project level focuses on assessing the **common indicators** across layers impacts and outcomes of interventions implemented in specific pilot sites within the REALLOCATE project across layers 2 and 3 (i.e., thematic clusters and impact assessment areas, as described in sections 2.2.2.2 and 2.2.2.3, respectively). By concentrating on common indicators across SSMLs for thematic clusters and impact areas, we are facilitating a standardized approach to data collection and analysis to ensure consistency and comparability in understanding the benefits and challenges on a higher level.

Micro indicators distinguish themselves not inherently from macro indicators, but rather through their uniformity across cities and their alignment with specific impact areas and SUMI categories.

3.1 Thematic clusters

Each of these indicators is linked to a Measure (MS) number in the inception report and a new SUMI category. This linkage establishes their connection to the impact area they contribute to at both macro and micro levels, as well as to the relevant interventions. These commonalities provide a basis for prioritizing analysis in the interim impact assessment and ensuring a sufficient data pool for corrective actions, if necessary, at both macro and micro levels. This approach enables proactive assessment and monitoring and will involve deploying centralised data collection systems (i.e., project dashboard) that integrates and aggregates data from various and potentially diverse sources (e.g., we might require to triangulate data even for the same indicator measured across cities that belong in the same thematic cluster).

Figure 5 illustrates the various thematic clusters in the project (layer 2 of the assessment was introduced in section 2.2.2.2). Each cluster addresses a specific aspect of city planning and improvement, outlining the key measures, indicators, and cities involved.

Safe & Sustainable Schools focuses on enhancing school environments through engagement and improved public spaces, with performance indicators such as participation rates and incident reduction. Cities involved include **Utrecht, Bologna, Lyon, and Warsaw**.

Concepts for Space Reallocation aims to optimize the use of public spaces and increase bike parking capacity, assessed by stakeholder feedback. This involves cities like **Barcelona, Budapest, and Heidelberg**.

Data Safety Digital Integration for accessibility emphasizes the secure integration of traffic data and privacy measures, with indicators including data breach incidents and user satisfaction. **Barcelona, Lyon, and Tampere** are the key cities involved.

Central Areas Traffic Reorganization targets the reorganization of traffic in central areas through traffic calming measures and redesigns to reduce the number of traffic accidents and enhance pedestrian safety. The cities engaged are **Gothenburg** and **Zagreb**.

Integrated Traffic Reorganization involves the comprehensive management of traffic and integration of public transport systems, aiming to improve traffic flow and increase public transport usage. **Budapest, Gothenburg**, and **Heidelberg** are part of this cluster.

Several workshops were held to identify the higher-level common indicators that are closely related to the nature of the SSMLs. These indicators were further refined based on the actions and interventions involved. This process served as a starting point for prioritising the definition of data characteristics, including the existing baseline, baseline action description, data source, data format, data volume, data collection frequency, and unit of measurement. An overview of these data characteristics can be found in Figure 5 (overview) and Table 44 (in-depth; Annex C: Common measures, indicators, data characteristics per SSML and Thematic Cluster). The prioritisation at the project level involved defining these data characteristics for the subsequent steps in T5.2 and T5.3, respectively. This approach also ensures GDPR compliance by avoiding the collection of unnecessary and redundant datasets.

All data descriptions are available to partners as online spreadsheets and are the ones that feed the regular inception reports. This approach ensures consistency and enables cities to share best practices and lessons learned from their respective actions and interventions.

At the micro level, we will focus on common indicators, prioritizing their implementation on the dashboard. These indicators, in addition to being grouped within the same thematic clusters, are also categorized under specific impact areas. The indicators within these impact areas will receive further prioritisation within their respective impact assessments (IA). This dual clustering process serves as a filter, determining the relevance and applicability of indicators at the micro level and ensuring that only the most pertinent indicators are utilised.

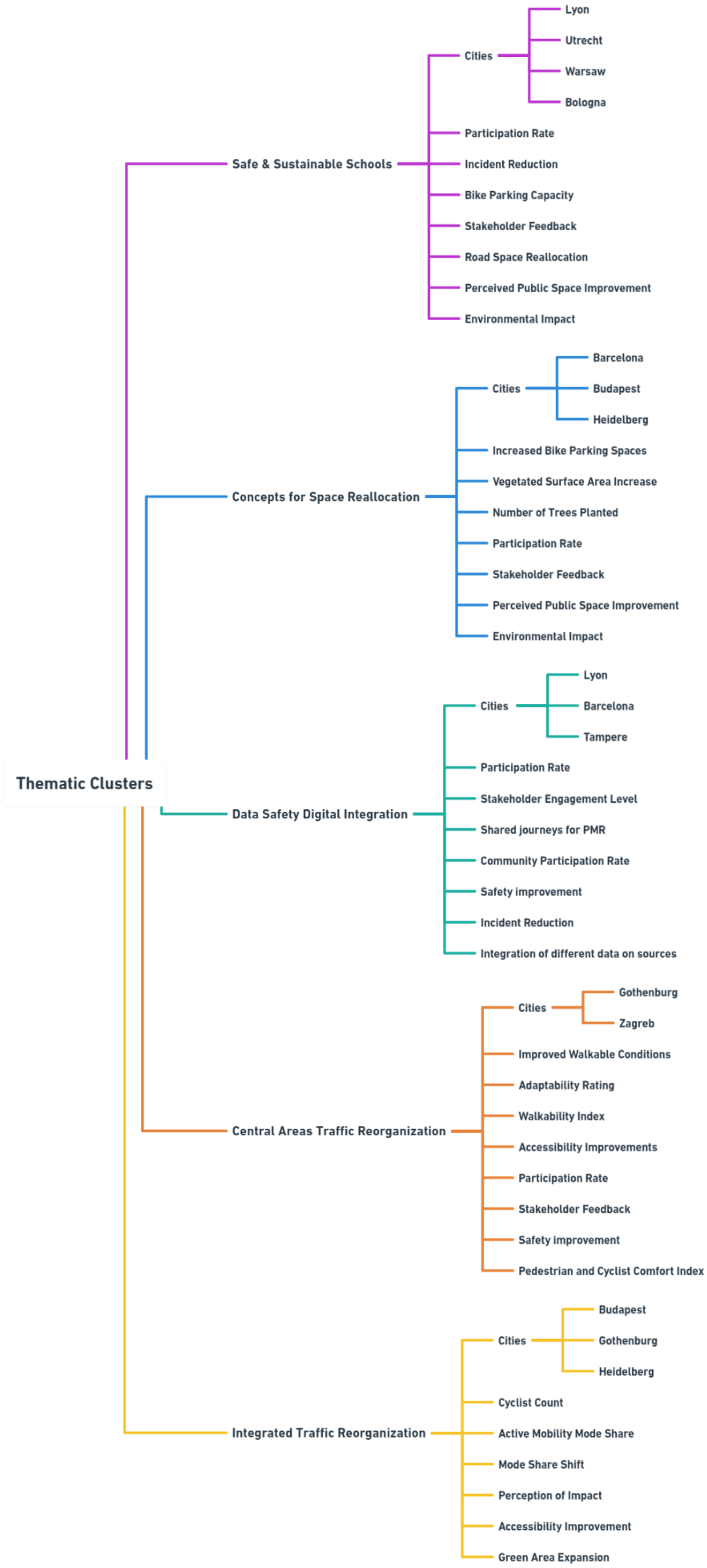


Figure 5. Common Indicators per Thematic Cluster (TC) and the included SSMLs

3.2 Impact assessment areas

This chapter describes the methodologies of the impact areas (Layer 3) introduced in the Section 2.2.2.3. Each Impact Assessment (IA) begins with a micro-level analysis, focusing on the horizontal application using common indicators. Subsequently, we progress to the macro level to gather the necessary data for comprehensive evaluation. This approach illustrates the connection between top-down and bottom-up processes, as depicted in Figure 2.

3.2.1 Climate Targets, Environmental and Circularity Impact Assessment

This section provides information on which data should be collected to assess the sustainability targets defined on the micro level within the project. Furthermore, indicators will be evaluated whether they can be achieved through classic life cycle assessment methodology. Therefore, the general methodology will focus on the Life-Cycle Assessment (LCA) framework given in the classic ISO standards (ISO 14044/ 14040) to provide a first guideline on how to assess the pilots on micro level.

In this context, the following sections will focus exclusively on the impact areas related to environmental effects (Climate Targets, Environmental and Circularity Impact Assessment).

The aim is to describe a harmonised approach across all pilots to reduce the effort involved in collecting data and carrying out evaluations.

3.2.1.1 Climate targets and Environmental assessment

3.2.1.1.1 Establishing the basis

To carry out a transversal assessment among the very different pilots, it was necessary to identify common KPIs that would enable comparability of the assessment among the different cities and pilots. As most of the interventions focus on road reallocation and modal shift, traffic data such as traffic volume, vehicle and fuel types, etc. (further information in the next section) will be used as the main parameters to perform a comparative analysis of the situation and to estimate the associated environmental impacts before and after the interventions. First, these parameters are used to assess the current situation (baseline scenario) by providing an estimate of the environmental impact before the intervention. In the next step, the same data are collected after the implementation of the intervention and used to analyse the environmental impact of the a “pilot scenario”. Finally, the two scenarios are compared to identify emission hotspots and the extent to which the indicator targets have been achieved.

An initial desktop review of the different KPIs was carried out as baseline for defining to which extent the tasks and indicators can be assessed under the proposed evaluation framework. More detailed information is provided in the next section.

Specifically for the assessment of Climate Targets and Environmental Impact, as mentioned above, the framework is based on streamlined LCA methodologies. It uses the impact category Climate Change, measured as global warming potential (GWP) in the unit CO_2 equivalents, as the main category of analysis and comparison. The particulate matter formation potential (PM) can be considered for the assessment as a complementary alternative measurement to on-site air pollution emissions. Other environmental impact indicators are not considered in the proposed framework. More information on the evaluation methodology for Climate and Environmental KPIs is provided in section 3.2.1.1.2.

Regarding the Circularity Assessment, the first step was to define Circularity in the context of the REALLOCATE project to make sure that the evaluation methods are applicable and comparable across the different cities and pilots. The evaluation is based on selected Circularity Properties (CPs) which are further described in section 3.2.1.1.2.

3.2.1.1.1.1 Identification of the Measures

Common measures have been identified and are clustered into groups in the table below. As the impact assessment for some of these measures do not fit into the proposed LCA calculation methodology, prioritisation levels have been assigned to indicate the degree of feasibility of assessing the selected KPIs within the proposed framework (Table 3):

- 1 - Measures fall within LCA Methodology applicability and can be either directly or indirectly assessed;
- 2 - Measures do not fall within LCA Methodology but might be indirectly assessed by means of the results of LCA analysis;
- 3 - Measures do not fall within LCA Methodology and cannot be assessed without further ado.

Table 3. General measures and feasibility according to classic LCA methodology

Air Pollutant Emissions	1
Noise Reduction and Hindrance	3
Greenhouse Gas (GHG) Emissions	1
Active Mobility	1
Urban Functional Diversity and Mobility Space Usage	3
Urban green spaces	1
Climate friendly areas	2

3.2.1.1.1.2 Indicators

Indicators are defined for all Measures. These describe specifically how the respective measure shall be achieved or evaluated. Only those indicators whose measures were identified as possible in the previous section (marked with “Yes” or “Maybe” are listed below (Table 3)). Like the section ‘Measures’, the feasibility of these Indicators is evaluated by prioritization. The prioritisation was determined based on 4 categories:

1. Indicators can be measured well with proven methods and are within the general methodology framework.
2. Indirect Indicators that can possibly be evaluated on a specific (data) basis.
3. Certain methods are required for evaluation, which can only be carried out with the help of external experts
4. Indicators that are difficult to determine quantitatively or cannot be evaluated using classic LCA methodology; definition of Indicators too general and evaluation is dependent on many other aspects.

In addition, to analyse the indicators using the LCA methodology, the indicators must be able to be linked to an impact category. The impact category mainly considered in the context of the project is climate change (kg CO_2e). Another impact category is particulate matter (PM; unit: disease incidence). The latter means that the impact of particulate matter is assessed based on how often it causes disease within a population and is not within the scope of this work by default.

Further impact categories are subject to discussion as these might not be directly related to the indicator (e.g. water deprivation, primary energy demand, etc.).

Table 4. Defined indicators across all cities and pilots (incl. feasibility analysis)

City	Measure	KPI	Impact category	Priority
BA	**Air Pollutant emissions**	Reduction in fuel consumption	CC; PM	1
		Reduction in vehicle emissions	CC; PM	1
		Number of eco-friendly driving practices adopted		4
		Air Quality improvement		4
	Active mobility	Length of cycling lanes and walking paths created or improved		4
		Active mobility usage		3
		Reduction in motorized transport	CC; PM	1
		Health and environmental benefits	CC; PM	1
	Greenhouse Gas (GHG) Emissions	Fuel efficiency improvement	CC; PM	2
		Reduction in fuel consumption	CC; PM	1
		GHG emission intensity	CC	1
BU	**Active mobility**	Green Area expansion		3
		Percentage of green spaces in public areas		3
		improvement in travel times	CC; PM	3
		Reallocation of public space		2
HE	**Air Pollutant Emissions**	Air Quality Index Improvements		3
		Reductions in traffic emissions	CC; PM	1
		Public acceptance and satisfaction		4
LY	**Air Pollutant Emissions**	Air Pollutant concentrations		3
		GHG Emissions	CC	1
		Impact of parking policy modifications on reducing emissions	CC; PM	1
		Effectiveness of parking policy changes on cleaner vehicles		2

City	Measure	KPI	Impact category	Priority
		Compliance with new policies		4
TA	Active Mobility	Active Mobility mode share	CC; PM	2
		Effectiveness of visualization tools		4
		Enhancements in green spaces		3
		Reallocation of public space		2
		Increase in shaded pedestrian areas		4
WA	Urban Green Spaces	Area converted from impermeable to permeable surfaces		3
		Number of trees planted		4
		Increase in biologically active areas		4
		Emission reduction progress	CC; PM	1
		Cooling effect of tree planting		4
ZA	Climate Friendly Areas	Green and climate friendly area ratio		4
		Number of climate friendly features implemented		3
		Improvement in accessibility for vulnerable road users		4
		Environmental impact of converting impermeable to vegetated surfaces		3
		Average lifespan of products used in the project		2

CC: Climate Change, PM: Particulate Matter

3.2.1.1.2 Methodology Framework (LCA)

To provide a general methodology on micro level the common LCA approach following ISO 14044:2006 was chosen to be applied on all pilots across all cities. Possible deviations from the methodology given below are subjects for discussion with the respective cities.

It is important to note that a full LCA is **not** within the scope of this work. Therefore, the method applied is following a **streamlined** approach without any claim of conformity for any standards or reporting requirements. The focus of this methodology is clearly set on scenario analysis to quantify possible changes of environmental impacts and to evaluate the respective KPIs.

The framework includes 5 different steps:

The goal **(Phase 1: Defining the goal)** corresponds to the evaluation of the KPIs defined for the pilots in the respective cities listed in the above subsection on Impact assessment areas. To achieve this a Functional Unit (FU) will be defined together with the cities (e.g., driven km in target area over a certain time span). The FU is needed to compare the baseline scenario with the results from the intervention[1].

The system boundaries **(Phase 2: Setting system boundaries)** are set according to the pilot area. If the pilot area is not clearly defined the entire city is considered as the "product" system.

[1] **Definition**: The functional unit quantifies the functions of the product/service under investigation and, thus, acts as a reference unit to which the inputs and outputs of the product system are related. For this purpose, it is necessary to determine an associated reference flow. The reference flow is a measure of the outputs within the given product system and indicates the quantity of products required to fulfil the Functional Unit (ISO 14040).

The focus of the REALLOCATE project are streets or traffic interventions to improve safety and mitigate motorized traffic.

The evaluation of the KPIs because of infrastructure measures (e.g., physical interventions such as the construction of individual road elements, etc.) is not considered. The evaluation of infrastructural measures is associated with a high level of data collection that cannot be fulfilled by the cities in the given timeframe. In addition, regarding the whole pilot area most of the impact of physical interventions can be considered negligible. Therefore, the assessment will concentrate on street and traffic data. Evaluations and recommendations for physical interventions can be addressed within the scope of WP3.

Life cycle inventory **(Phase 3: Life Cycle Inventory (LCI) – Data Collection)** includes the quantification of all Inputs and Outputs within the system boundaries according to the defined functional unit. As described in point 2, the LCA will focus on traffic improvements (if not defined otherwise). Accordingly, respective data must be collected from the cities. Depending on the pilot assessed, this **may include, but is not limited to,** the following points:

- Length of road (in km)
- Traffic volume (number of vehicles within pilot area)
- Vehicle type (small, medium, large size)
- Fuel type (electric, diesel, petrol)
- Fuel consumption (in L or kWh in total[2] or per km)
- Number of public vehicles
- average occupancy of public vehicles (in %)
- driven km in target area (in km)[3]

3.2.1.1.3 Life Cycle Impact Assessment (LCIA)

The Life Cycle Impact Assessment (LCIA) evaluates the considered impact categories in relation to the LCI and the FU. The impact categories relate either to greenhouse gas emissions or PM formation. Further impact categories must be determined individually after consultation with the respective city and as soon as more details about the approach in the individual pilots have been determined.

As LCAs do not intend to evaluate emission reduction by default, the scenario analysis is used to compare the different situations mentioned. Therefore, basically, two LCAs must be conducted regarding the baseline and post-intervention data. After successful evaluation, both scenarios can

[2] If total consumption is given amount of driven km is needed.
[3] As a general assumption all vehicles will be considered as EURO 5 cars. This is justified with the general regulation on emission-reducing measures for vehicles in European cities.

be compared to determine how the emissions have changed in the target area. The causes of the changes depend on the intervention and can range from a reduction in motorised traffic through superblocks or by a modal shift to public transport.

The final LCA phase **(Phase 4: Interpretation)** interprets the results of the LCIA and highlights any key factors. A reference can be made to the respective KPIs, e.g., "*A reduction in GHG emissions was achieved by reducing fuel consumption in the target area XY*". It is also possible for several KPIs to be related to each other and thus contribute to the same result (e.g., reduction in motorized transport and reduction in fuel consumption).

It is important to note that environmental KPIs might be interrelated for example (e.g., reduction in fuel consumption and reduction in vehicle emissions). For this reason, the interpretation of the results should be done as a whole, whereas a separate evaluation does not make sense (Figure 6). Therefore, it is important to define what KPIs should be reported in the final statement.

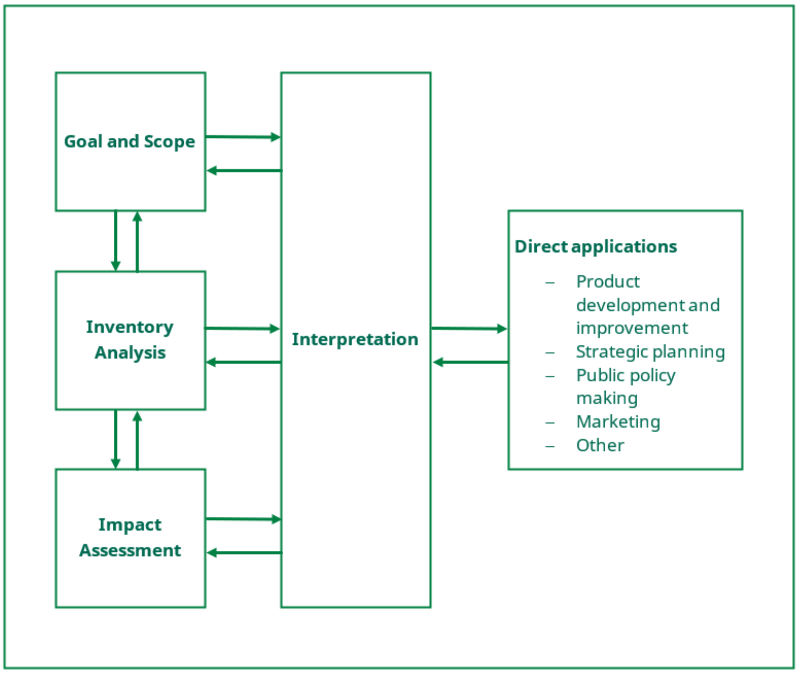


Figure 6. General LCA framework depicted according to ISO 14040

In the evaluation process, certain KPIs may be interrelated, making independent assessment less meaningful. Therefore, it is crucial to clearly delineate what should be included in the final evaluation to ensure a comprehensive and coherent assessment that accurately reflects the interconnected nature of the KPIs.

3.2.1.1.4 Tools

To assess the KPIs using the LCA methodology, two different tools are available to be deployed. The choice of tool depends on the availability and quality of the data.

Umberto: Umberto is a classic LCA modelling software that is linked to the database ecoinvent. It is widely used within the LCA community and allows an exact assessment of the life cycle of products and services. Within the tool, all primary or secondary activity data can be implemented in a single flowchart (see an example in Figure 7). The data can then be linked to the ecoinvent background database, which contains more than 20,000 datasets providing life cycle data and emission factors. In addition, the most up-to-date evaluation methods (e.g., IPCC 2021) can be selected to calculate the state-of-the-art impact assessment. All results can be exported automatically to prepare them for the final presentation.

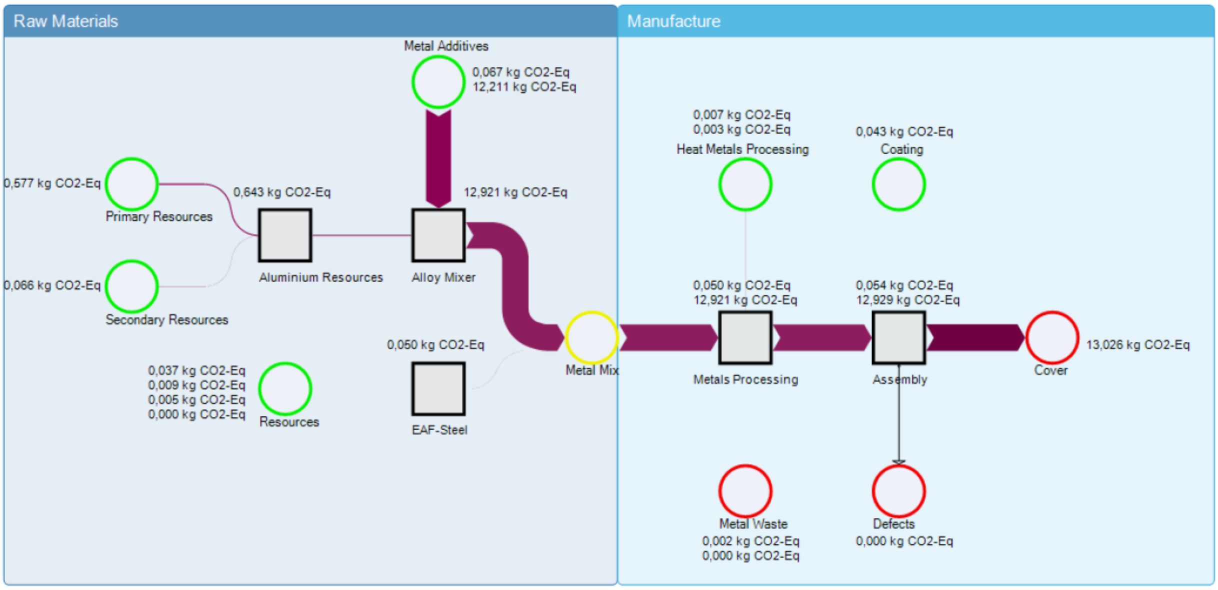


Figure 7. Example for a cradle to gate assessment of a metal cover

Excel Based Emissions Calculator: The Excel-based tool is a specific application for calculating the GHG impact of Sustainable Urban Mobility Plan (SUMP) and Sustainable Urban Mobility Plan (NUMP) projects. The emissions can be measured both for the existing state as well as for alternative, climate-friendly mobility scenarios. The tool was developed specifically for cities and SUMP projects and addresses the transport sector including passenger and freight transportation. In contrast to Umberto, only an Intergovernmental Panel on Climate Change (IPCC) evaluation is carried out. Furthermore, no background database is linked and activity data with stored emission factors are provided as standard, for which values must be entered. After calculation, results are presented automatically as diagrams that can be used for presentation.

3.2.1.2 Circularity assessment

To standardize the methodology and ensure comparability between the different measures of the various pilots, four different circularity parameters (CP) have been chosen and defined within the context of REALLOCATE and the respective pilots of the cities. The selected CPs are listed below: **a) Share of alternative mobility; b) Post-consumer recycled content in infrastructure (and**

recyclability at end of life); c) Circular business models, and d) Community engagement. Specific indicators are chosen following the framework given by the EU Horizon 2020 project **"*CityLoops - Closing the loop for urban material flows*"** to evaluate the respective CPs. It should be noted that some circularity indicators may overlap with those used in the screening LCA assessment. Therefore, care must be taken to avoid double evaluation to reduce the overall effort.

3.2.1.2.1 Share of alternative mobility

It encourages the use and demand for **alternative means of transport** with the potential of reducing environmental burdens from conventional fossil fuels. The following relevant **measures** are selected: a) definition of "*Alternative mobility*", b) increase of e-mobility, c) increase of solutions for public transport and sharing mobility, and d) increase of active mobility (e.g., walking and cycling infrastructure). In Table 5, the respective indicators are identified, their definition, methodology and unit of measurement.

Table 5. Circulatory: share of alternative mobility indicators

Transport modal share in commuting (cars, motorcycles, taxi, bus, metro, tram, bicycle, pedestrian) • Share of different transport modes used (and modal shift) • **Methodology:** https://cityloops.metabolismofcities.org/indicators/#indicator-26 • **Unit:** %
Amount of people with new access to public transport or door to door service within given range (e.g., pilot area) • **Unit:** Number of people
Amount of people with new access to public transport or door-to-door service within given range (e.g., pilot area) • **Unit:** Number of people
Potential energy savings due to modal shift • Calculation of total energy demand in commuting and the respective shift occurring because of public or active mobility increase. • **Unit:** % or kWh
Percentage of new cars that are zero-emission vehicles • The share of new passenger cars or light commercial vehicles with zero tailpipe GHG emissions, e.g. battery electric or hydrogen cars • **Methodology:** https://cityloops.metabolismofcities.org/indicators/#indicator-25 • **Unit:** %

These indicators, in this and the following sections, will be mapped and matched to the current list of indicators (e.g., inception report) to avoid redundancy. This process is crucial and highlights the dynamic nature and importance of periodic follow-up and updates of these lists. Regular reviews ensure that overlapping indicators, which may be part of existing clusters or metrics, are identified and managed appropriately. Figure 8 and Figure 9 present possible visualizations of data analyses resulting from those indicators.

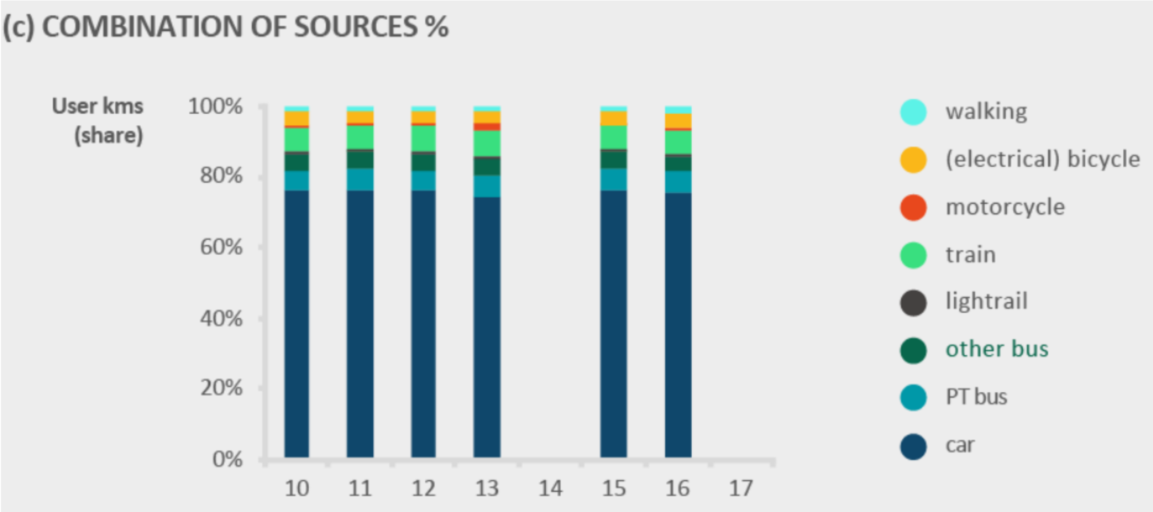


Figure 8. Development of modal share over given timeframe source: circular economy indicators for person mobility and transport (https://ce-center.vlaanderen-circulair.be/en/publications/publication/10-circular-economy-indicators-for-person-mobility-and-transport)

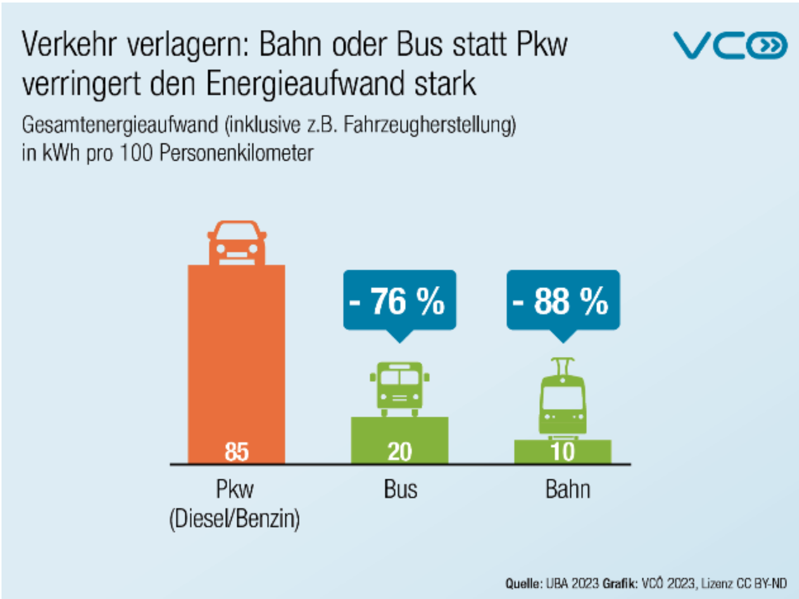


Figure 9. Energy savings due to modal shift (Source: https://vcoe.at/grafiken/detail/oeffentlicher-verkehr-und-

3.2.1.2.2 Post-consumer recycled content in infrastructure and recyclability at end of life

Promotes the use of **secondary materials** from sources previously discarded by consumers and **reintroduced into the loop via recycling** practices (and the use of materials, that can be recycled at end of life (EoL)). Measures are the definition of "*post-consumer recycled content*," quantification of post-consumer recycled content (in %), chemical composition (focus: SVHC), recycling, and reusability. Some of the relevant indicators might have to be adapted to pilot area as these are assessing circularity on a higher level (Table 6).

Table 6. Circulatory: post-consumer recycled content in infrastructure and recyclability at end-of-life indicators

Share of renewable raw materials (in domestic material consumption) • This indicator assesses the significance of renewable materials in the economy, i.e. resources that have a natural rate of availability and yield a continual flow of services which may be consumed in any time period without endangering future consumption possibilities as long as current use does not exceed net renewal during the period under consideration. • **Methodology:** https://cityloops.metabolismofcities.org/indicators/#indicator-40 • **Unit:** %
Share of (locally) secondary materials (in domestic material consumption) • This indicator assesses the significance of secondary materials in the economy • **Methodology:** https://cityloops.metabolismofcities.org/indicators/#indicator-41 • **Unit:** %
Share of renewable energy in total energy demand • Renewable energy usage in the city (pilot area) as a share of total energy demand. • **Methodology:** https://cityloops.metabolismofcities.org/indicators/#indicator-37 • **Unit:** %

3.2.1.2.3 Circular business models

Encourages the transition from **linear to circular business models**, reducing resource use, waste, pollution, and social costs, and promotes sustainable partnerships and collaborative platforms along the supply chain. Measurement includes the definition of a "*circular business model*," the share of self-sufficiency in areas such as energy, and the share of circular contracts, such as take-back and recycling for temporary solutions. Classic classifications of circular business models (CBM) include Retain Product Ownership (RPO), Product Life Extension (PLE), and Design for Recycling (DFR). To be classified as a CBM, certain criteria must be met, including evident environmental benefits such as waste reduction through high reuse and recycling shares, prolonged product lifetimes compared to linear business models, and a higher share of recycled content. Table 7 describes the respective indicators.

Table 7. Circularity: Circular business models indicators

Eco-innovation: Qualitative description • Describe the business model, including how it contributes to moving up the waste hierarchy. • **Methodology:** https://cityloops.metabolismofcities.org/indicators/#indicator-23 • **Unit:** Qualitative
Eco-innovation: Impact • For each case of implementation of CE business models in indicator number 23, describe impact in terms of value creation and material flow. • **Methodology:** https://cityloops.metabolismofcities.org/indicators/#indicator-24 • **Unit:** Monetary value, Tonnes / year
CE-based employment • Assess the impact of demonstration actions or at sector/city level by estimating the increase in CE related jobs. • **Methodology:** https://cityloops.metabolismofcities.org/indicators/#indicator-33 • **Unit:** Jobs
Reduced costs due to improved circularity • For selected cost type(s) (e.g., transport, virgin material costs, waste treatment costs), direct impacts on costs should be estimated.

- **Methodology:** https://cityloops.metabolismofcities.org/indicators/#indicator-32
- **Unit:** Monetary value

3.2.1.2.4 Community engagement

Ensuring that measures are designed, and decisions are made with the **participatory involvement** of **local communities, supported by relevant stakeholders**, encourages longer-lasting deployments that make better use of natural, financial, and social resources. **Measurement** includes the **quantification of community engagement, the share of co-creation, and the share of co-governance for circular solutions**.

Community engagement involves active collaboration and co-creation of solutions with and for local communities, encompassing those affected by the solution and those supporting its implementation. The main target is to establish a solid basis for decision-making and to ensure long-term success. Awareness-raising and training involve educational activities conducted with local communities to contextualise, educate, promote a multiplication effect, and foster implementation, acceptance, and long-term success of solutions. A collaborative and community-led approach increases the level of ownership by local communities, reflecting how much the community is involved in the development, implementation, management, and monitoring of the project. A participatory and inclusive approach ensures that community members are informed, can ask questions, and provide feedback regardless of their level of involvement in the project or their social background. Stakeholder involvement tracks the number of local businesses and relevant stakeholders involved in the project and their level of involvement, including government institutions, non-profit organizations, experts/academics, local investors, and others. The exchange of perspectives among these stakeholders ensures sustainable long-term implementation. Partnerships enable knowledge transfer through platforms and educational activities, fostering innovation through joint efforts and efficient use of resources, including human capital and know-how. Policy and regulatory support involve the implementation of policies by local government and recognised institutions to promote community engagement for the co-creation and co-implementation of the project. The respective indicators are presented in Table 8.

Table 8. Circularity: community engagement indicators

Circularity related stakeholder activities
- Description of activity type and dialogue methods, which stakeholder groups and when in the process, number of people involved.
- **Methodology:** https://cityloops.metabolismofcities.org/indicators/#indicator-6
- **Unit:** Qualitative data, number of people

Stakeholder contribution to improved circularity
- Qualitative description of input from stakeholder activities and how it has contributed to improved circularity and leading to acceptance and participation.
- **Methodology:** https://cityloops.metabolismofcities.org/indicators/#indicator-10
- **Unit:** Qualitative data and potentially quantitative impact data

CE-related knowledge building campaigns
- Description of knowledge building campaigns; number of campaigns, number of people reached for each campaign.

• **Methodology:** https://cityloops.metabolismofcities.org/indicators/#indicator-4 • **Methodology 2:** https://cityloops.metabolismofcities.org/indicators/#indicator-5 • **Unit:** Number of campaigns, number of people
Communication measures on circular transformations (and waste prevention) • Describe type of communication measures, e.g. campaigns, provision of information, events for the public/companies. • **Methodology:** https://cityloops.metabolismofcities.org/indicators/#indicator-11 • **Unit:** Number of communication measures, number of people

3.2.2 Social Inclusiveness and Accessibility Assessment

The social inclusiveness and accessibility impact assessment methodology is designed to evaluate how urban interventions, particularly those focused on transportation and public space, affect different social groups. This assessment ensures that all community members, especially the marginalised and vulnerable, benefit from urban development projects. This methodology is relevant for creating equitable, inclusive, and accessible urban environments, aligning with the principles of sustainable urban mobility and social justice.

The primary objectives of this impact assessment methodology are to assess the inclusiveness of pedestrian infrastructure and public spaces, to evaluate the accessibility of urban areas for various social groups, including children, elderly, disabled individuals, and economically disadvantaged communities, to identify and address barriers to mobility and inclusivity, to promote equitable distribution of urban resources and infrastructure, and to ensure that urban interventions enhance social cohesion and community well-being (Table 9).

Table 9. Social inclusion and Accessibility indicators

Indicator Name	Definition
Pedestrian Space Utilization Rate	Measures the extent to which reallocated road space is actively used by pedestrians, expressed as a percentage.
Community Satisfaction with Public Spaces	Assesses the satisfaction levels of citizens regarding the quality, accessibility, and safety of public spaces, gathered through qualitative feedback from surveys and interviews.
Safety Perception Index	An index score that measures how safe citizens perceive newly created public spaces, considering factors like traffic flow and lighting.
Accessibility and Inclusivity Assessment	Evaluates the accessibility and inclusivity of public spaces for all community members, including children, elderly, and disabled individuals, using a qualitative assessment.
Green Space Enhancement	Measures the increase in green spaces resulting from urban interventions, quantified in square meters.
Social Inclusion Index	An index score that measures the extent to which different social groups feel included in urban spaces.
Mobility Accessibility Score	Evaluates the accessibility of public transport and pedestrian infrastructure for marginalized groups, using a score ranging from 0 to 100.

Data collection for these indicators involves a combination of quantitative and qualitative methods. Surveys, interviews, focus groups, and direct observations are primary methods for gathering data. Advanced tools such as Geographic Information Systems (GIS) and AI-powered analytics can enhance the accuracy and efficiency of data collection and analysis. Conducting regular surveys and interviews with community members is essential to gather feedback on public space quality, safety, and accessibility. Ensuring diverse representation in survey samples helps capture the experiences of all social groups. Systematic observations of public spaces should be performed to assess usage patterns and identify barriers to accessibility, using trained observers to record data on pedestrian movements, interactions, and infrastructure usage. Organizing focus groups with marginalized communities allows for understanding their specific needs and challenges, using participatory methods to engage community members in the assessment process. Utilizing GIS tools to map accessibility and inclusivity indicators spatially and conducting spatial analysis to identify areas with high or low accessibility and inclusiveness, is also important.

The implementation of this methodology requires a structured approach involving various stakeholders, including city planners, community organizations, and residents. Engaging stakeholders in the planning and implementation process will ensure their needs and preferences are considered. Conducting workshops and public meetings gathers input and feedback from the community.

The Social Inclusion Monitor Europe (SIM) framework has been instrumental in measuring social inclusion across European countries, providing valuable insights and metrics (Bertelsmann Stiftung, 2017). To integrate the SIM framework into the existing REALLOCATE city pilots, we adapted some indicators to the specific contexts of each pilot city, engaging local stakeholders to identify key assessment areas like service accessibility, program inclusiveness, and participation barriers. We will incorporate aspects of the framework to the localized surveys, checklists, and audits that are relevant to the current actions to facilitate data collection. Accessibility will also be considered in the selection and use of tools and instruments, as well as in the evaluation materials used for data collection.

A mixed-methods approach will be used for data collection, combining quantitative data from surveys and standardized tools with qualitative data from interviews, focus groups, and case studies. Similar methodologies have been successfully applied in projects like the Urban Innovative Actions (UIA) initiative, which combines qualitative and quantitative methods to evaluate urban development projects (UIA, 2020).

Data analysis will involve statistical methods to identify trends and gaps from quantitative data, while qualitative data will be analysed using thematic analysis to uncover key themes and patterns. The integration of findings from both data types will provide a well-rounded assessment. Feedback and validation are essential steps, where preliminary findings will be presented to stakeholders and pilot site participants for their input. This iterative feedback process will help refine the framework and findings. The World Bank's social inclusion assessment tools provide a model for this approach, emphasizing the importance of participatory feedback in refining assessment frameworks (World Bank, 2013).

The final assessment report will compile the entire process, findings, and recommendations, including illustrative case studies and examples. Additionally, capacity-building sessions will be provided for stakeholders to enhance their ability to assess and improve social inclusiveness and accessibility, fostering a community of practice to share experiences and solutions.

3.2.3 Transformative Governance Impact Assessment

This chapter focuses on the assessment of governance changes and their alignment with the objectives of the project and the wider EU climate and urban mobility goals. This work assesses the impact of REALLOCATE on three topics central to transformative governance:

- The operationalization of the Climate Neutral and Smart Cities Mission into goals for the SSMLs;
- Alignment of the EU-level and SSML-level goals with the outcomes of the SSMLs;
- Resulting learning and opportunities for generalization.

Data for this **macro-level assessment** is collected through structured interviews with chosen expert members of the city teams (e.g., urban planners, transportation engineers, environmental scientists, policy analysts, community stakeholders, technology innovators who work in departments focussing on Urban Planning and Development, Transportation and Infrastructure, Environmental Sustainability, Policy and Governance, Community Engagement and Stakeholder Relations, Technology and Innovation, etc.). These interviews are composed of three themes (see below). Discussion of each theme, in turn, combines scalar variables (self-assessment questions on 5-point Likert scales) for comparison and open questions to clarify and add detail to the interpretation of Likert responses.

The interview outline is shown in Annex E: Transformative Governance interview.

The first dimension, **'Operationalization of goals'**, focuses on the role of REALLOCATE in contributing to the achievement of cities' broader goals. The second dimension, **'Alignment of goals and outcomes'**, in turn assesses the alignment of REALLOCATE outcomes (up to the date of each interview) with the cities' central strategic objectives. The third dimension, **'Learnings and opportunities for generalization'**, focuses on outlining the impact of REALLOCATE on capacity building and especially transformative capacities of cities.

On the **micro level impact assessment**, the assessment of transformative governance impacts focuses on the transformation. It is difficult to assess the impacts on governance based on the limited number of 1-2 pilots in each city, as the relationship between experiments and broader, city-wide mobility change and policies is unclear (Bertolini, 2020). However, their transformative potential should be measured, as they provide important experiences and evidence of the potential for transformation. Bertolini (2020) describes the transformative potential of experiments through five criteria. Experiments should be **radical, challenge-driven, feasible, strategic and communicative/mobilising**.

The micro level impact assessment is done through the selection of KPIs outlined in Table 10 below. Together, these KPIs provide indications on the potential for transformation of the SSMLs in each of the REALLOCATE cities. The exact indicators vary depending on the city and the characteristics of the SSMLs, since transformative governance is very rooted in the local context (Table 10). The idea is also not to burden cities in collecting extra indicators.

The selected indicators combine two features; the scalability/replicability of the pilot and the stakeholder engagement/interest. They work as proxies for especially three of the aforementioned criteria, assessing the feasibility, strategic nature, and communicative/mobilising power of the SSMLs. The two other criteria are assessed as part of the macro level impact assessment.

Table 10. Selection of KPIs for the micro level TG impact assessment

City	**Scalability/replicability**		**Stakeholder engagement/interest**	
	Indicator ID	**Indicator name**	**Indicator ID**	**Indicator name**
Barcelona	BCN_MS28 / IND5	Potential for Cooperation Extension	BCN_MS26 / IND1	Number of Local Stakeholders Engaged (in Pilot 1 only)
			BCN_MS26 / IND1	Participation Rate (in Pilot 1 only)
Bologna			BO_MS26 / IND1	Number of Participants in Co-Creation Workshops
Budapest	BUD_MS28 / IND2	Percentage of Intervention Elements (to be) Replicated		
Gothenburg	GOT_MS28 / IND1	Feasibility for Replication	GOT_MS27 / IND2	Participation Rate in Focus Groups
Heidelberg	HD_MS28 / IND1	Extendability Index		
	HD_MS28 / IND2	Replicability Rating		
Lyon	LYS_MS28 / IND1	Replicability Potential	LYS_MS28 / IND4	Stakeholder Feedback
	LYS_MS28 / IND2	Scalability Index	LYS_MS27 / IND2	Stakeholder Engagement Level
	LYS_MS28 / IND3	Transferability Score		
Tampere	TMP_MS27 / IND1	Replication Potential	TMP_MS10 / IND3	Community Participation Rate
	TMP_MS28 / IND2	Scalability		

City	Scalability/replicability		Stakeholder engagement/interest	
Utrecht	UTR_MS28 / IND1	Replicability Index	UTR_MS26 / IND1	Number of Participants Engaged
	UTR_MS28 / IND2	Adoption Rate	UTR_MS26 / IND2	Participation Rate
Warsaw	WAW_MS28 / IND1	Replicability Score	WAW_MS28 / IND5	Stakeholder Interest
	WAW_MS28 / IND2	Adaptability Rating	WAW_MS26 / IND1	Number of Participants
	WAW_MS28 / IND3	Transferability Potential	WAW_MS26 / IND2	Participation Rate
Zagreb	ZG_MS28 / IND2	Replication Potential Assessment	ZG_MS28 / IND4	Stakeholder Interest in Replication
	ZG_MS28 / IND3	Adaptability Rating		

The replicability framework addresses these challenges by structuring replication feasibility into three key categories:

- Identifying barriers (adoption feasibility; e.g., legal, administrative, and financial) that influence whether an intervention can be realistically implemented in other areas.
- Assessing how well an intervention can be expanded within the same city or adapted to other cities with different urban contexts (i.e., scalability).
- Identifying the role of community engagement, stakeholder support, and behavioural adaptability in determining whether an intervention can be successfully implemented elsewhere (i.e., acceptance).

By integrating these factors, the assessment ensures that interventions are not only technically viable but also socially, economically, and politically feasible for replication. The table below (Table 11) provides a summary of key replicability challenges for monitoring the transferability of interventions across different urban contexts. The replicability (high, medium low) of the outcomes related to primary indicators across cities is presented in Table 16 (section 4.1) and of the major indicators per pilot and city are presented in Tables Table 34 Table 43 (Annex A: Data Collection Instruments).

Table 11. Replicability indicators

Pilot	Replicability Category	Key Challenges to Replication
Gothenburg: Peri-Urban Mobility	Adoption Feasibility	Policy barriers, funding constraints
Gothenburg: Traffic Management	Scalability	Localized nature of digital twin tools

Pilot	Replicability Category	Key Challenges to Replication
Tampere: School Safety	Acceptance Factors	Parental perception, school engagement
Heidelberg: Regional Mobility	Scalability	Regional coordination complexity
Lyon: Parking Policy	Adoption Feasibility	Enforcement challenges, policy harmonization
Budapest: Superblock	Acceptance Factors	Business & resident resistance
Barcelona: Superblocks Expansion	Scalability	Traffic network adjustments, commercial stakeholder resistance
Warsaw: Safe School Mobility	Adoption Feasibility	Public transport route limitations, school-level support
Zagreb: Traffic Corridor Optimization	Scalability	Integration with existing road infrastructure
Bologna: Safe School Districts	Acceptance Factors	Parental and school involvement
Tampere: AI-Driven Traffic Safety	Scalability	AI infrastructure availability, municipal digital policies

This structured approach strengthens the ability of pilot cities to scale up interventions within their jurisdictions while also providing valuable insights for other European cities looking to adopt similar measures. The indicators outlined in Table 11 will serve as a benchmark for evaluating whether an intervention has the necessary conditions for long-term success in new locations.

Assessing how well an intervention can be expanded within the same city or adapted to other cities with different urban contexts.

3.2.4 Safe System and Road Safety Pillar Integration

Two methodologies are discussed in this section: the Safe System approach and the Road Safety related analysis.

3.2.4.1 *Safe System approach*

The Safe System approach, also often referred to as Vision Zero, is today seen as the way to achieve near casualty-free road traffic (Aarts, 2022). Adopted by the European Commission and the World Health Organization, it represents the way forward to meet the global goal of a 50% reduction in traffic fatalities by 2030 (WHO, 2021). Since early adopters like the Netherlands and Sweden in the 1990s (which have demonstrated that reductions of 30%-50% in fatalities could be achieved), an increasing number of countries and cities (such as Montreal, Brussels, London or more recently Lyon[4]) have adopted a Safe System approach.

In contrast with traditional reactive approaches (where crash concentrations are mainly used for prioritising and mitigating countermeasures), the approach is generally characterised as a proactive and preventive approach that starts from a human-centred perspective.

As a holistic approach, it encompasses the diversity of the initial situations in the 10 Cities as described in D2.1; from the healthy superblocks concept in the centre of Budapest to the digital twin use in Gothenburg, from the Heidelberg's *Spielstrassen* considerations to the safeguarding of school areas in Lyon: considering the various Vulnerable Road Users (VRUs) in a diversity of physical as well as cultural contexts requires a multi-angle approach.

A key reason for engaging the REALLOCATE cities in the Safe System is the alignment of both approaches in setting the highest standards of safety through a holistic methodology. This alignment supports REALLOCATE's multi-objectives, which include promoting healthy mobility, achieving climate neutrality, and fostering social inclusion, among others.

3.2.4.1.1 Objectives

Engaging as a City into a Safe system self-assessment is not an end in itself:

→ it creates support to initiate discussion between stakeholders, either internal (other cities' departments) or external (public, private or civil-society organisations, buyers and sellers of transport equipment and services, private and public vehicle fleet owners or individuals…).

→ it offers the possibility for each stakeholder to identify its own contribution to the whole safety system and its relations with other stakeholders. In practice, partners are not always fully aware of the contribution of their activities to safety, and engaging a safe system approach helps them to understand this.

→ it supports the engagement of the different stakeholders towards the common objective of reducing risks and promoting safety.

[4] En Vie Demain, Charte d'engagement pour la sécurité des déplacements, Métropole Grand Lyon.

→ it offers the possibility to assess systemic impact of an action or a policy by inviting to identify collateral effects (to other pillars or key components).

→it suggests ways to identify actions to increase safety in a consistent and systematic way.

3.2.4.1.2 Operationalization

The Safe System approach is based on four fundamental principles (ITF, 2022):

- people make mistakes that can lead to crashes,
- the human body has a limited physical ability to tolerate strong forces,
- a shared responsibility exists between road users and system designers,
- all parts of the system must be strengthened.

Those four principles should be key elements of the safe system approach. On top of them the International Transportation Forum (ITF) recommends adding "*Establish robust institutional governance*" as a fifth **key component** because of the importance of the institutional context to elaborate and implement efficient public policies (Table 12; ITF, 2022).

Table 12. The Five Key Components of the Safe System Framework (ITF, 2022)

Key component	Description
1. Establish robust institutional governance	Permanent institutions are required to organise government intervention covering research, funding, legislation, regulation and licencing and to maintain a focus on delivering improved road safety as a matter of national priority.
2. Share responsibility	Those who design, build, manage and use roads and vehicles and provide post-crash care have a shared responsibility to prevent crashes resulting in serious injury or death.
3. Strengthen all pillars	When all road-safety pillars are stronger, their effects are multiplied; if one part of the system fails, road users are still protected.
4. Prevent exposure to large forces	The human body has a limited physical ability to tolerate crash forces before harm occurs; the system should prevent those limits from being exceeded.
5. Support safe road-user behaviour	While road-user errors can lead to serious harm, the Safe System focuses on roads and vehicles designed for safe interaction with road users. It supports humans not to make mistakes and tune their tasks as much as possible to their competencies.

In addition, **six road safety pillars**[5] have been identified for achieving a Safe System: a**) Road-safety management; b) Safe roads; c) Safe vehicles; d) Safe speeds; d) Safe road-user behaviour; e) Post-crash care.**

[5] Additionally, in some sources, road safety management (ITF, 2022), multimodal transport and land use planning (WHO, 2021) are mentioned as important road safety pillars.

Finally, to assess progress and identify implementation gaps in developing a Safe System, the ITF Working Group found it useful to define the various stages of Safe System development. For this self-assessment in the 10 cities involved in REALLOCATE, three stages have been retained as relevant (Stages 1-3; see Figure 10):

Stage 0: Starting	Stage 1: Emerging	Stage 2: Advancing	Stage 3: Mature	Stage 4: Perfect
There is no knowledge of Safe System principles and hence no implementation of Safe System activities.	There is awareness and knowledge of what a Safe System looks like.	Interventions and policies are linked and organised by robust institutional governance focused on road safety, transport and mobility.	Highly sophisticated technical and public-policy interventions are implemented.	In this hypothetical Safe System implementation, there are zero fatalities and zero serious injuries.

Figure 10. The stages of the Safe System development (ITF, 2022)

As a result, the ITF Working Group has produced an **Operational framework**, applicable to practical situations. It provides descriptions of what road-safety situation to expect in each of the three different stages of development of Safe System implementation (Table 13).

Table 13. The operational-level Safe System Framework (ITF, 2022)

Key component	**1. Road-safety management**	**2. Safe roads**	**3. Safe vehicles**	**4. Safe speeds**	**5. Safe road-user behaviour**	**6. Post-crash care**
1. Establish robust institutional governance	**Cell 1.1**	**Cell 1.2**	**Cell 1.3**	**Cell 1.4**	**Cell 1.5**	**Cell 1.6**
2. Share responsibility	**Cell 2.1**	**Cell 2.2**	**Cell 2.3**	**Cell 2.4**	**Cell 2.5**	**Cell 2.6**
3. Strengthen all pillars*	Cell 3.1	Cell 3.2*				
4. Prevent exposure to large forces	Cell 4.1	Cell 4.2	Cell 4.3	Cell 4.4	Cell 4.5	Cell 4.6
5. Support safe road-user behaviour	Cell 5.1	Cell 5.2	Cell 5.3	Cell 5.4	Cell 5.5	Cell 5.6

** Five of the cells in the third row of the table are merged into a single cell, as the key component "Strengthen all pillars" leads to simultaneous safety improvements across all road-safety pillars.*

An ideal Safe System implementation programme addresses all five key components and all six pillars at the same time. But experience demonstrates that there is no simple recipe for implementation. Indeed, countries such as Sweden and the Netherlands, where REALLOCATE pilots also exist, have been working on Safe System implementation for decades now, and development continues. The main purposes are: a) to locate the different interventions; b) to identify the partners needed to build cooperation; and c) to find opportunities for improvement.

3.2.4.2 Implementation for REALLOCATE cities

To facilitate this exercise for the cities, an operational framework was operationalised. This process has been conducted by:

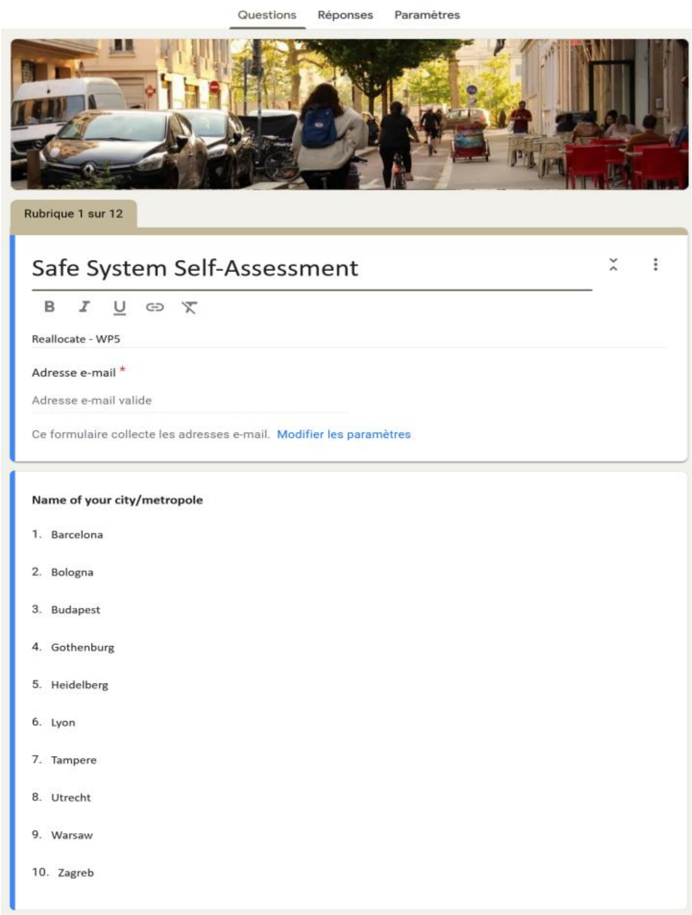
1. Transforming the theoretical description of each of the 26 cells (as listed in ITF "High-level Framework") into a list of real-life items and measures: To tackle this step, collective workshops have been organised, to feed every cell (Table 14) with a set of existing items and measures in cities around the world that have implemented totally or partly safe system / vision zero approaches), based on decades of case studies and supported operations. This process has shown synergies with the "multi-level perspective" adopted for the WP5 conceptual framework, since the existing concrete measures can also be seen according to their direct (local/individual practices), indirect (dominant practices, urban policies) and diffuse impacts (cultural and normative values).

Table 14. Extract from the grid filled after several collective brainstorming sessions

5. Support safe road-user behaviour	Behaviour monitoring : → declared behaviour (wearing a helmet, etc.)	→ visibility masks → obstacles	→ vehicles authorised to circulate	→ Speed limits adapted to infrastructure and users (message)	→ education programme aimed at which population: children, young people, senior citizens, people with disabilities, etc. → control: punctual by the police	→ first aid training
	Behaviour monitoring : → observed behaviour (wearing a helmet, etc.)	→ parking → pedestrian crossings (cf Chambéry) → adhesion, signalling, lighting	→ User equipment (helmet, chasuble, etc.) → delivery vehicles (town hall buyer) → mobility (public transport, self-service) → internal charter	→ control (communication skills) (?) → infrastructure (speed reduction measures)	→ Infrastructure: designed to induce behaviour → control: automatic (video tagging)	→ Ambulance service: trained and accompanied to improve driving behaviour → structuring and location of rescue/care centres
	Behaviour monitoring : → automatic measurements: traffic, speed, accidents, who, what risks → budget, planning, team in charge	→ provision of a space adapted to speed (separation at high speed) → accident monitoring → budget → planning	→ fleet of agents → ADAS (Advanced Driver Assistance Systems) = electronic driving aids. E.g.: Lavia, EAD, etc. → tracking of the vehicle fleet speed of replacement	→ Form a common culture in relation to speed, or even a social norm → vehicles (restricting scooters, geofencing). → work on the « atmosphere » (e.g. greening of the roadsides) and the perception of risk (wall effect) → Tracking of the vehicle fleet (?) → Number of passengers detectors imposed by the local authority (cf to avoid more than 1 person on self-service scooters)	→ social control 3 pillars to influence behaviour: Engineering, Education, and Enforcement (« 3Es ») What is controlled: → parking → behaviour other than speeding (alcohol, stop signs, priority, use of cell phones while driving, reserved express lanes, etc.)	→ personal equipment, such as Ecoll (compulsory) or Libertyrider (voluntary) Emergency personnel :

2. designing a comprehensive questionnaire derived from the grid: Built upon the filled grid, representing a kind of "ideal model" of safe system city, a questionnaire has been realised, adding through the suggested answers the 3 levels of possible developments: emerging, advancing and mature.

***3. Elaborating a spreadsheet model for calculating results*:** Finally, an internal calculation tool has been developed (Figure 12), to produce an automatic filling of the ITF operational framework, adding the level of development (emerging, advancing or mature) of each of the 26 cells.


Questions Réponses Paramètres

Rubrique 1 sur 12

Safe System Self-Assessment

Reallocate - WP5

Adresse e-mail *

Adresse e-mail valide

Ce formulaire collecte les adresses e-mail. Modifier les paramètres

Name of your city/metropole

1. Barcelona
2. Bologna
3. Budapest
4. Gothenburg
5. Heidelberg
6. Lyon
7. Tampere
8. Utrecht
9. Warsaw
10. Zagreb

Figure 11. Screen capture of the questionnaire

3.2.4.2.1 Activities

By SSMLs, the identification of the local "*Safe System Referent*" in each city, also known as "*Local Evaluation Managers (LEMs)*" will be undertaken. The referent will involve a small group of relevant stakeholders from city departments, such as road maintenance, town planning, and transport/mobility, and, when possible, include external stakeholders such as emergency services, police, and delivery companies. A 2–3-hour meeting will be organised to collectively complete the questionnaire, thereby gathering data for the self-assessment of their city in terms of the Safe System. This process will also initiate or further reinforce the dynamic of a working group dedicated to safety at the city level. Individual feedback will be provided for each city through their respective LEMs, and a summary of the self-assessments from the 10 cities will be conceived and shared at the Reallocate level, with additional feedback from the ITF.

This operational Safe System framework is to be completed before and after the cities' interventions. In addition to providing a comprehensive assessment of the current and future states of mobility systems at the city level, this evaluation exercise will also bring a data pool of inspiring practices at the REALLOCATE level and an instructive overview of the diversity of mobility patterns across the European territory.

Question ID	Question	Answer	Note	Cells
1	Votre ville dispose-t-elle de services de mobilité partagée ?	Oui	/	A1
2	Concernant ces services de mobilité partagée, la collectivité a-t-elle une politique en matière de mobilité partagée ?	Oui, pour certains	3	A1
3	Ces services sont-ils encadrés par une réglementation locale ou des engagements de la part des opérateurs privés dans un objectif de sécurité ? (contrôle du profil des utilisateurs, limitation des vitesses, règles pour le stationnement des véhicules, ...) ?	Oui, pour certains	2	A1
4	Votre ville a-t-elle conçu un SUMP - Sustainable Urban Mobility Plan ?	Non	2	A1
5	Les enjeux de sécurité ont-ils été pris en compte dans le SUMP ?	Exhaustivement et de manière explicite	3	A1
6	Votre ville a-t-elle mis en place une instance de coordination dédiée à la sécurité des déplacements (observatoire des mobilités, comité des parties-prenantes, etc.) ?	Oui	2	A1

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA
1		A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	C1	C2	C4	C5	D1	D2	D4	D5	E1	E2	E4	E5	F1	F2	F4	F5
2																											
3	**Level**	**2**					**2**					**3**					**3**		**3**				**2**				
4	Nb of answe	6	0	0	0	0	2	0	0	0	0	1	0	0	0	0	1	0	3	0	0	0	2	0	0	0	0
5	Min	2	0	0	0	0	2	0	0	0	0	3	0	0	0	0	3	0	3	0	0	0	2	0	0	0	0
6	Max	3	0	0	0	0	3	0	0	0	0	3	0	0	0	0	3	0	3	0	0	0	2	0	0	0	0
7	Nb of /	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	Question ID																										
9	1	/																									
10	2	3																									
11	3	2																									
12	4	2																									
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20	12																										
21	13																										
22	14						2																				
23	15																										
24	16																										
25	17						3																				
26	18											3															

Results

		Pillars					
		A. Road-safety management	B. Safe roads	C. Safe vehicles	D. Safe speeds	E. Safe road-user behaviour	F. post-crash care
Key components	1. Establish robust institutional governance	2	2	3			
	2. Share responsibility				3		
	3. Strengthen all pillars						
	4. Prevent exposure to large forces						
	5. Support safe road-user behaviour				3	2	

Figure 12. Screen captures of a test session of the calculation model

3.2.4.3 Road Safety

The Road Safety Impact Assessment (RSIA) methodology aims to evaluate and enhance road safety, aligning with the goals set forth in Vision Zero and leveraging both infrastructure improvements and technological advancements. This methodology integrates a comprehensive assessment of road safety indicators, data collection techniques, and stakeholder engagement strategies. The ultimate objective is to minimise the number of traffic accidents and the severity of resulting injuries. Thus, special attention can be laid on those incidents involving vulnerable road users (VRUs) such as pedestrians, cyclists, and children.

The primary **objectives** of the RSIA methodology used within the REALLOCATE project are to achieve significant reductions in traffic-related fatalities and injuries, enhance safety for vulnerable road users, promote sustainable mobility, and integrate road safety initiatives with broader urban mobility plans. These goals align with Vision Zero's aim of eliminating traffic fatalities and severe injuries through systemic changes and proactive safety measures.

The RSIA methodology consists of several key components. Regarding the targets of the REALLOCATE project, the following three are described more detailed: infrastructure improvements, technological advancements, and stakeholder engagement

Infrastructure Improvements: This involves implementing traffic calming measures such as speed humps and road diets, enhancing pedestrian and cyclist infrastructure by adding dedicated lanes and crosswalks, and upgrading road signage and lighting to improve visibility and awareness.

Technological Advancements: This includes among many others the deploying of AI-powered traffic cameras and sensors for real-time monitoring, utilizing data analytics to identify high-risk areas and patterns to enhance traffic management and safety.

Stakeholder Engagement: Conducting workshops and focus groups with local communities and stakeholders, involving citizens in planning and decision-making processes, and regularly collecting feedback through surveys and public meetings to ensure interventions are relevant and accepted.

3.2.4.3.1 Data Collection and Indicators

Data collection for the RSIA involves a combination of traffic cameras and AI sensors, police and hospital reports on traffic incidents, surveys and feedback from road users, and urban planning and infrastructure records. Key indicators for assessing road safety include pedestrian and cyclist counts, near-miss incidents, accidents and injuries, public space utilization rates, community satisfaction levels, safety perception indices, and green space enhancements. The REALLOCATE indicators focus on road safety measures and their impacts (Table 15).

Table 15. Road safety indicators

Indicator	Definition
Pedestrian Count	The number of pedestrians passing through areas where safety measures have been implemented.
Cyclist Count	The number of cyclists using newly created or improved cycling infrastructure

Indicator	Definition
Micro-Mobility Count	The number of persons using modes of micro-mobility like e-scooters, monowheels, fast e-bikes, etc.
Motorised Traffic Count	The number of cars, vans and trucks using the infrastructure within the pilot areas
Near-Miss Incidents	Reported incidents where accidents were narrowly avoided, providing insight into potential safety risks
Accidents and Injuries	The number and severity of traffic accidents and injuries in targeted areas and the whole city over a longer period, the kinds of accidents, the involved parties, external influences, etc.
Public Space Utilization Rate	The percentage of public space actively used by the community following reconfiguration.
Community Satisfaction	Qualitative feedback on the quality, accessibility, and safety of public spaces.
Safety Perception Index	An index score measuring perceived safety in public spaces.
Green Space Enhancement	The area of green spaces added or enhanced through road space reallocation

3.2.4.3.2 Methodology Steps

The RSIA methodology follows a structured process to ensure comprehensive assessment and effective implementation of safety measures:

1. Hazardous Spot Identification: Identify locations with a high incidence of traffic accidents. Classification based on the kind of road participation and injury severity. Usage of historical and current data and AI-powered tools to pinpoint risk areas.

2. Data Collection: Deploy traffic cameras and sensors to monitor real-time traffic conditions, gather data from city repositories and historical records, and conduct surveys and focus groups to collect qualitative feedback.

3. Data Analysis: Analyse collected data to identify patterns and trends, evaluate the effectiveness of current safety measures, and model potential outcomes of proposed interventions.

4. **Implementation of Safety Measures**: Introduce traffic calming measures and enhance VRU infrastructure, improvement of public transport and its accessibility, upgrade road signage, lighting, and crossing facilities, and integrate technological solutions for real-time monitoring and alerts.

5. Monitoring and Evaluation: Continuously monitor traffic conditions and safety outcomes, collect ongoing feedback from road users and stakeholders, and adjust interventions based on data-driven insights.

6. Reporting and Dissemination: Regularly report findings and progress to stakeholders, share best practices and lessons learned with other cities and regions, and utilize digital twins for simulation and visualization of interventions.

3.2.4.3.3 Integration with Digital Twins

Digital twins play a crucial role in the RSIA methodology by providing a dynamic, real-time simulation environment to model and test road safety interventions. They enable real-time data integration, virtual testing, and optimization of safety measures, enhancing the accuracy and reliability of impact assessments. While digital twins offer significant benefits, including continuous updates and enhanced decision-making capabilities, they also present challenges such as high initial setup and maintenance costs, interoperability issues, and potential data privacy and security concerns as input data quality issues.

3.2.4.3.4 Connection with Cascade Cities

The RSIA methodology promotes collaboration with cascade cities, facilitating knowledge sharing and replication of successful interventions. This approach builds collaborative networks for urban sustainability, enhancing the scalability and transferability of impact assessment findings. However, diverse urban contexts may limit direct applicability, and coordinating and aligning across cities requires standardized frameworks for consistent assessment.

4 Macro Evaluation at City Level

The macro evaluation at the city level (T5.1.2) assesses the impacts and outcomes of interventions implemented across cities participating in the REALLOCATE project, capturing pilot area-wide effects. This assessment uses city-specific indicators that may differ between cities, reflecting each urban environment's unique characteristics and needs. This chapter details the methodology, data collection processes, and city-specific indicators used in the macro evaluation.

Customization to the local context is necessary. Indicators are tailored to reflect each city's unique characteristics, considering its size, geographic features, demographic composition, economic activities, and existing infrastructure. Specific challenges (e.g., traffic congestion, air pollution) and opportunities (e.g., availability of green spaces, public transport infrastructure) are identified, and indicators are developed accordingly. Indicator selection and definition ensure relevance and feasibility, with each indicator defined in specific and measurable terms, including measurement unit, data source, and frequency of measurement.

Local stakeholder workshops involving city officials, urban planners, transportation experts, community representatives, and residents are organised to gather insights, priorities, and specific city needs. Feedback from these stakeholders (e.g., the needs assessment conducted in T2.1; D2.1) is integrated to ensure that the indicators are relevant, feasible, and aligned with local priorities.

Macro (city-specific) indicators can effectively feed into micro (project-specific) indicators through a structured and interconnected process. Initially, city-level data is collected on specific indicators such as traffic volumes, air quality, social inclusiveness, and safety. These indicators are then aggregated and analysed to identify relevant data points applicable to specific projects. By categorizing city indicators into impact areas like climate targets, social inclusiveness, safety, and transformative governance, project goals can be aligned with these clusters to ensure consistency and relevance. This integration of macro-level data into micro-level applications ensures that findings from city-specific indicators are utilised to refine and improve project plans, aligning project outcomes with broader urban mobility and sustainability goals. By following this approach, city-specific indicators provide a robust foundation for assessing the impact of specific projects, ensuring their effectiveness and alignment with strategic objectives.

The macro indicators are then aligned with the broader goals and objectives of the REALLOCATE project. Additionally, the indicators are matched with thematic clusters (e.g., Safe & Sustainable Schools, Central Areas Traffic Reorganisation) to maintain coherence across different cities and facilitate comparative analysis, thereby creating the selection of the common (micro) indicators.

4.1 Data Collection Plan per Pilot

To ensure a robust and systematic impact assessment, the data collection framework for each pilot has been refined to provide a clear structure regarding data collection methods, timeframe, and sources (Table 16). The approach follows a before (i.e., baseline) - after (i.e., intervention) assessment methodology, allowing for a detailed comparison of conditions prior to and following intervention implementation. Each pilot has a defined data collection duration, specifying the length of time for baseline and post-intervention measurements, ensuring that results capture both immediate and longer-term impacts. In the KPI category, we provide information on the **priority KPIs**, which are the key indicators selected for both the city-specific and cross-city interim assessment (T5.3). They will feed the co-created corrective actions that will be developed based on the findings from these analyses. The replicability potential is categorised based on:

- Interventions that are widely transferable (i.e., high potential) across different urban contexts with minimal policy or structural limitations (e.g., active mobility interventions, pedestrian reallocation).
- Interventions that require specific urban planning regulations, governance support, or community acceptance (i.e., medium potential) but have strong scalability potential (e.g., parking policies, intersection redesigns).

The target values have been carefully adjusted to reflect the specific and smaller scale of the pilot areas rather than broader city-wide shifts. They are designed to measure incremental progress rather than large-scale changes.

Table 16. Data Collection Plan per Pilot

City	Pilot	KPI Category	Data Collection Duration	Data Sources	Replicability Potential	Potential Target Value
Gothenburg	Peri-Urban Mobility & Safety	Active Mobility Mode Share, Number of Participants in Co-Creation Workshops, Feasibility for replication for SSA in Road Safety, Active Travel and School and Sports Club Mobility	6 months before, 12 months after	Household travel surveys, data from school routes, co-design reports, walk audits	High	Increase by 10%
	Traffic Management at Korsvägen	Active Mobility Mode Share, Number of Participants in Co-Creation Workshops, Replicability in relation to Traffic Flow, Pedestrian Safety, Digital Twin-based Traffic Modelling	3 months before & after	Digital twin simulation modelling, chatbot-based feedback, pedestrian volume tracking, co-design reports, expert observations	Medium	Improve pedestrian crossing times by 7%

City	Pilot	KPI Category	Data Collection Duration	Data Sources	Replicability Potential	Potential Target Value
				and reporting		
Tampere	School Travel & Safety	Active Mobility Mode Share, Number of Participants in Co-Creation Workshops, number of endorsements	6 months before & after	AI-based traffic monitoring, school surveys, co-design reports, number of letters (counts)	High	Increase school walking rates by 10%
Heidelberg	Regional Mobility (mobility hubs and last-mile bike sharing)	Active Mobility Mode Share, Number of Participants in Co-Creation Workshops, Impact on traffic flows	12 months before & after	Simulation modelling, modal shift surveys, co-design reports	Medium	Increase cycling share by 15%
	Public Space Reallocation	Active Mobility Mode Share, Number of Participants in Co-Creation Workshops, Inclusivity and accessibility index	6 months before & after	Sidewalk scans, co-design reports, pedestrian counts, survey and expert observations	High	Increase pedestrian space by 10%
Utrecht	School Safety	Active Mobility Mode Share, Number of Participants in Co-Creation Workshops, Public incl. Parental Perception of traffic conditions,	3 months before, 6 months after	Parent-reported school mobility surveys, co-design reports, pedestrian audits	High	Increase safe routes to school by 10%

City	Pilot	KPI Category	Data Collection Duration	Data Sources	Replicability Potential	Potential Target Value
		e.g. traffic Conflicts				
Lyon	School Safety Enhancements	Active Mobility Mode Share, Number of Participants in Co-Creation Workshops, Motorised transport Reduction, Permeable area conversion	6 months before, 12 months after	Nature based survey, co-creation and workshop reports, modal shift surveys	High	Increase student cycling rates by 10%
	Vision Zero & Parking Policy	Active Mobility Mode Share, Number of Participants in Co-Creation Workshops, Reduction in car parking spaces, Compliance with Parking Policy	12 months before & after	Co-design reports, parking enforcement records, real-time sensor data (Merging data from the police (accidents), emergency services (hospital, firemen), traffic (flow, speed), drivers' behaviour (hard breaking), mobility operators (Waze, Bike sharing, e-scooters sharing)	Medium	Improve compliance by 15%

City	Pilot	KPI Category	Data Collection Duration	Data Sources	Replicability Potential	Potential Target Value
Warsaw	School Zone Traffic Calming	Active Mobility Mode Share, Number of Participants in Co-Creation Workshops, School Route Usage Rate	6 months before & after	School street pedestrian volume counts, co-design reports, co-design reports, nature-based survey, traffic and parking measurements, waling audits	High	Increase pedestrian share by 10%
Zagreb	Intersection Redesign	Active Mobility Mode Share, Number of Participants in Co-Creation Workshops, Public perception of traffic conditions incl. Safety, Accessibility	6 months before & after	Traffic signal analysis, intersection mobility scans, co-design reports, survey	Medium	Improve pedestrian accessibility by 10%
Barcelona	Shared Space Optimization	Active Mobility Mode Share, Number of Participants in Co-Creation Workshops, Conflicts removed/ mitigated, Replicability of Bicycle Policies	3 months before, 6 months after	User counts, survey, co-design reports, interactive workshop between pedestrians and cyclists results/ report, experts' observation	High	Increase pedestrian and cyclist activity by 10%

City	Pilot	KPI Category	Data Collection Duration	Data Sources	Replicability Potential	Potential Target Value
				data and assessment.		
	Demand-Responsive Transport (DRT) & Accessibility	Active Mobility Mode Share, Number of Participants in Co-Creation Workshops, Service Coverage of DRT	6 months before & after	DRT service data, user surveys, co-creation reports	Medium	Improve DRT coverage by 15%
Budapest	Peri-Urban Intersection	Active Mobility Mode Share, Number of Participants in Co-Creation Workshops, Intersection Safety, Traffic Flow	12 months before & after	Drone footage, AI-based traffic analysis	Medium	Improve intersection safety by 10%
	Healthy Streets & Superblock	Active Mobility Mode Share, Number of Participants in Co-Creation Workshops, Public Space Usage, Air Quality	6 months before & after	Air quality sensors, pedestrian volume tracking	Medium	Increase public space utilization by 10%
Bologna	Public Space Redesign	Active Mobility Mode Share, Number of Participants in Co-Creation Workshops, Pedestrian and Cyclist Comfort Rating	6 months before & after	User perception surveys, co-creation reports	High	Improve comfort rating by 15%

This table presents the primary indicators per SSML. The data collection plan tables addressing most indicators per pilot in each city can be found in Annex A.

The indicators presented for each city in this chapter are relevant to the actions and the SUMI category for pilots. The complete list of indicators for each city and pilot can be found in the inception report. Due to its extensive length, the inception report is not fully included here, but it complements this document.

4.2 Gothenburg

4.2.1 Safe System Approach for Children's Active Travel in Peri-Urban Areas (Pilot 1)

Interventions and Indicators

This pilot focuses on improving the safety and autonomy of children's travel in peri-urban areas by employing a Safe System Approach. The interventions include conducting workshops and engagement activities to understand children's mobility needs, co-creation and co-design of safety solutions with residents, and the implementation of these solutions through community collaboration. Table 17 provides an indicative mapping of interventions to their respective measures and indicators, emphasizing the relationship between these elements and their impact assessment areas.

This mapping serves as a preliminary framework to illustrate how various interventions align with different SUMI categories and impact assessment areas, such as road safety, social inclusiveness, and environmental factors. It is essential to note that Table 17 is indicative and subject to refinement based on the actual process and nature of each intervention. The next steps involve defining the data paths from the beginning to the end points, ensuring that the interventions are effectively monitored and evaluated throughout their implementation. This holds true for all Tables in this Chapter.

Table 17. Actions, indicators and Impact Assessment Areas (Gothenburg – Pilot 1)

Action/ Intervention	Indicator	SUMI Category	Impact Assessment Area
AHA analysis	Share of Active Modes (Walking and Cycling) Use	Air pollution	Road safety, Safe system approach
Workshops and engagement	Usage of Virtual Mobility Hub	Modal share	Social inclusiveness and accessibility
Co-creation workshops	Cyclist Count	Modal share	Transformative Governance, Social inclusiveness
Outcome synthesis	Community Engagement Index	Other	Transformative Governance

Action/ Intervention	Indicator	SUMI Category	Impact Assessment Area
Mobility solutions testing	Share of Active Modes (Walking and Cycling) Use	Air pollution	Road safety, Environmental

Impact Assessment

The impact assessment for this pilot will be conducted using both qualitative and quantitative data. Direct effects include the reduction of motorized trips and an increase in sustainable trips, as children use safer, newly designed pathways. Indirect effects include improved community engagement and enhanced safety perceptions among residents. Other effects might be changes in local traffic patterns due to the reallocation of space for pedestrian and cycling paths.

Corrective actions will be applied based on continuous monitoring and feedback mechanisms, ensuring that any emerging issues are promptly addressed. For instance, if certain routes are not being used as expected, further community engagement sessions will be held to understand the barriers and make necessary adjustments.

System Dynamics Model (SDM) Application Example

A System Dynamics Model will be used to simulate different scenarios and predict long-term impacts of the interventions. For example, the model can assess how different levels of community engagement affect the uptake of new routes by children. By integrating feedback loops and time delays, the SDM will help in understanding the dynamic interactions between various factors and guide decision-making.

By focusing on creating safer routes and involving the community in co-creating solutions, the pilot addresses road safety and environmental sustainability, fostering a modal shift towards active travel modes like walking and cycling.

- **Climate Target:** Increase active modes of travel, reducing emissions by encouraging sustainable travel methods in peri-urban areas.
- **Expected Impact:** Transition to more sustainable travel in the entire Archipelago region.

The impact assessment methodology, using city-specific indicators and SDM predictions, ensures continuous monitoring and optimization of interventions to meet these targets effectively.

4.2.2 Harnessing Digitalization to Foster Safe and Sustainable Solutions in Transformative Urban Mobility (Pilot 2)

Interventions and Indicators

This pilot aims to leverage digital tools to enhance urban mobility, focusing on improving the conditions for cyclists and pedestrians and increasing the use of public transport through better planning and real-time data utilisation. Interventions include the digitisation of temporary traffic design processes, provision of mobility services for visitors, and the use of digital twins for visualization and stakeholder engagement (Table 18).

Table 18. Actions, indicators and Impact Assessment areas (Gothenburg – Pilot 2)

Action/ Intervention	Indicator	SUMI Category	Impact Assessment Area
Digitize traffic design process	VRUs' Perception of Safety	Accident and Injuries	Environmental, Circularity
Mobility services for visitors	Share of Active Modes (Walking and Cycling) Use	Modal share	Social inclusiveness and accessibility
Co-creation with citizens	Community Engagement Index	Other	Transformative Governance, Social inclusiveness
Use digital tools for visualization	Satisfaction with Engagement Process	Other	Technology and innovation

Impact Assessment

The impact assessment for this pilot will focus on both immediate and long-term effects of the interventions. Direct effects include better traffic management and increased public transport usage, while indirect effects include higher citizen engagement and improved public perception of urban mobility solutions. Additional effects might involve improved data-driven decision-making capabilities for city planners.

Corrective actions could involve iterative improvements based on real-time data and continuous stakeholder feedback. For example, if digital tools reveal inefficiencies in temporary traffic designs, adjustments will be made promptly to optimize traffic flow and safety.

System Dynamics Model (SDM) Application Example

The SDM will simulate how different digital interventions affect overall mobility patterns. For instance, it can model the impact of increased public transport use on traffic congestion and emissions. By continuously updating the model with real-time data, the city can make informed decisions to enhance urban mobility effectively.

This pilot leverages digital tools to enhance urban mobility by improving conditions for cyclists and pedestrians and increasing public transport use. By digitising traffic design processes, implementing mobility services, and using digital twins for visualization, Gothenburg can optimize traffic management, reduce emissions, and enhance citizen engagement.

- **Climate Target:** Increase active modes of transport to cultural venues, reduce emissions.
- **Expected Impact:** Reaching a zero-climate footprint, with emissions lowered by at least 10.3% annually.

These interventions directly contribute to the city's goals for reducing traffic congestion and promoting sustainable mobility solutions, thereby supporting the achievement of climate neutrality.

The impact assessment methodology, supported by SDM, allows for real-time data analysis and adaptive management to ensure the interventions' effectiveness in meeting climate targets.

4.3 Heidelberg

4.3.1 Regional Commuter Plan for Climate Neutrality (Pilot 1)

The Heidelberg Pilot 1 is focused on developing a regional commuter plan aimed at achieving climate neutrality. This initiative is structured around key actions and activities designed to foster cooperation between the city of Heidelberg and its surrounding municipalities. The pilot emphasises the importance of understanding and addressing common mobility challenges through collaborative workshops, engagement sessions, and strategic interventions. Table 19 outlines the interventions and indicators involved in this pilot, categorized by SUMI and impact assessment areas.

Table 19. Actions, indicators and Impact Assessment Areas (Heidelberg - Pilot 1)

Action/ Intervention	Relevant Indicator(s)	SUMI Category	Impact Assessment Area
Workshops and co-creation	Number of participants in workshops	Other	Social inclusiveness
Engagement and collaboration with adjoining municipalities	Modal Share	Modal share	Transformative Governance
Public transport service level improvements	Public Transport Ridership	Emissions	Environmental
Expansion and creation of mobility hubs	Transfer Efficiency	Congestion	Environmental
Public transport infrastructure improvements	Public Transport Travel Time Reduction, Public Transport Ridership	Modal share	Social inclusiveness

Impact Assessment

The impact assessment for this pilot will be conducted through a combination of quantitative and qualitative methods, including data collection on public transport usage, emissions, and user satisfaction. Direct effects will include improved public transport services and reduced emissions. Indirect effects may involve enhanced regional cooperation and a shift towards sustainable commuting practices. Corrective actions will be implemented based on ongoing data analysis to address any identified issues. For example, if user satisfaction with public transport services does not improve as expected, targeted surveys and stakeholder consultations will be conducted to identify and address specific concerns.

System Dynamics Model (SDM) Application Example

In the collaborative effort among multiple municipalities to enhance regional mobility and achieve sustainability goals, SDM serves by simulating the impact of joint investments in public transport infrastructure and coordinated policies promoting cycling and walking, SDM predicts changes in modal share across the region. This modelling approach considers variables such as population growth, economic development, and infrastructure expansion rates to forecast shifts from private vehicles to more sustainable modes of transport.

Heidelberg's Regional Commuter Plan aims to reduce commuter-related CO_2 emissions by improving public transport and creating mobility hubs. By fostering cooperation with neighbouring municipalities, the pilot promotes a modal shift from car travel to public transport and cycling, directly impacting emissions reductions. Continuous assessment and community engagement ensure adaptive management of interventions, enhancing the plan's effectiveness in achieving climate neutrality.

- **Climate Target:** Reduce individual commuter traffic inflow, significantly reducing CO_2 emissions.
- **Expected Impact:** Reduce GHG/CO_2 emissions from transport by 40% by 2030.

The impact assessment methodology, incorporating SDM predictions, enables thorough analysis of the interventions' impact on emissions and commuter behaviour.

4.3.2 Contextual & Tactical Public Space Reallocation (Pilot 2)

Heidelberg Pilot 2 focuses on the reallocation of public space to create low-traffic areas, promoting vibrant and sustainable urban environments. The pilot involves a series of co-creation sessions with citizens, detailed conceptual and design phases, and the deployment of tactical urbanism measures. Table 20 below summarizes the interventions, measures, and indicators for this pilot.

Table 20. Actions, indicators and Impact Assessment areas (Heidelberg - Pilot 2)

Intervention	Relevant Indicator(s)	SUMI Category	Impact Assessment Area
Citizen engagement and co-creation	Survey-based perception of space and safety	Access to mobility services	Social inclusivity and accessibility
Conceptual phase	Air Quality Index (AQI) Improvement	Air pollution	Environmental
Design phase	Pedestrian and Cyclist Counts	Modal share	Circularity
Participation phase	Community Engagement and Acceptance	Access to mobility services	Transformative Governance
Deployment phase	Number of Reported Accidents	Accident and injuries	Road safety, Safe system approach
Assessment of deployed solutions	Public Acceptance and Satisfaction	Other	Transformative, Governance

Impact Assessment

The impact assessment for Pilot 2 will focus on evaluating the effectiveness of public space reallocations and their impact on urban vibrancy and safety. Direct effects will include the creation of low-traffic zones and improved safety for pedestrians and cyclists. Indirect effects might encompass increased public acceptance of sustainable urban designs and enhanced local business environments. Corrective actions will be determined through continuous monitoring and stakeholder feedback, ensuring that interventions are optimized based on real-world outcomes. For instance, if traffic accidents do not decrease as projected, additional traffic calming measures may be implemented.

System Dynamics Model (SDM) Application Example

SDM could simulate the effects of pedestrian-friendly infrastructure and tactical urbanism measures, and predict improvements in safety, air quality, and community engagement.

This pilot focuses on reallocating public space to create low-traffic areas and enhance safety for pedestrians and cyclists. Through co-creation with local citizens and the implementation of tactical urbanism measures, Heidelberg aims to reduce car use and emissions, increase green spaces, and improve urban liveability. Continuous monitoring and feedback will optimize these interventions, ensuring they align with the city's climate goals.

- **Climate Target:** Increase sustainable mobility and discourage car use.
- **Expected Impact:** Contribute to Heidelberg's aim to be 100% climate neutral by 2030.

The impact assessment methodology, including SDM applications, ensures precise tracking and adjustment of interventions to maximize their climate impact.

4.4 Barcelona

4.4.1 Pedestrians, Cyclists & MMV in Shared Spaces (Pilot 1)

The first pilot in Barcelona aims to enhance the safety and accessibility of shared spaces for pedestrians, cyclists, and MMVs (Micro-Mobility Vehicles). It includes a variety of interventions aimed at understanding and mitigating conflict points, engaging stakeholders, and testing solutions (Table 21).

Table 21. Actions, Indicators, and Impact Assessment Areas (Barcelona – Pilot 1)

Action/ Intervention	Relevant Indicators	SUMI Category	Impact Assessment Area
Accident & mobility data	Number of accidents, types of accidents, locations of accidents	Accident and Injuries	Road Safety

Action/ Intervention	Relevant Indicators	SUMI Category	Impact Assessment Area
Data on complaints received from citizens (IRIS)	Number of Local Stakeholders Involved, Complaints	Other	Social Inclusiveness and Accessibility
Perceived safety	Safety Perception Index for Cyclists and Pedestrians	Accident and Injuries	Social Inclusiveness and Accessibility
Safety auditing	Number of identified hazards, recommendations for improvements	Accident and Injuries	Road Safety
Behavioural analysis	Observation data on pedestrian and cyclist behaviour	Modal Share	Safe System Approach
Traffic counting	Number of Pedestrians and Cyclists, Traffic Flow Efficiency	Modal Share	Environmental
Spatial analysis	Pedestrian Comfort Improvement Index, Number of Pedestrians and Cyclists	Congestion	Circularity and Climate Targets
Legislation benchmark	(Potential) Policy Compliance	Other	Transformative Governance
Benchmark of current communication & educational measures	Satisfaction with Public Spaces	Other	Social Inclusiveness and Accessibility
Overview of best practices	Replication Potential of Conflict Resolution Measures	Other	Transformative, Governance
Stakeholder and citizen engagement	Number of Participatory Workshops, Frequency of Engagement	Other	Social Inclusiveness and Accessibility
Testing and evaluation of conflict resolution	Number of Conflicts Addressed Between Cyclists and Pedestrians, Reduction in Pedestrian Risks	Accident and Injuries	Road Safety
Awareness campaign methodology	Public Perception of Climate Targets Achievement, Reach and impact of campaigns	Emissions, Air pollution, Noise pollution	Environmental
Proposals of regulations of road sign changes	(Potential) Policy Compliance	Other	Transformative Governance
Elaboration of guideline document	Comprehensive guideline document, adoption by other cities	Other	Transformative, Governance

System Dynamics Model (SDM) Application Example

For instance, in implementing a new Bus Rapid Transit (BRT) system, SDM can simulate changes in modal share, traffic flow, and environmental quality. By incorporating variables like population growth and economic factors, SDM allows to assess different scenarios and optimize strategies for reducing congestion and improving air quality. This approach supports adaptive management by providing insights into the long-term impacts of interventions.

Barcelona's first pilot focuses on enhancing shared spaces for pedestrians, cyclists, and MMVs by addressing conflict points and implementing safety measures. By promoting active travel and reducing motorized traffic, the pilot directly contributes to lowering emissions and improving urban sustainability, in line with the city's climate goals.

- **Climate Target:** Increase space for pedestrians and cyclists, reduce emissions.
- **Expected Impact:** Improved safety and accessibility in shared spaces.

The impact assessment methodology, with SDM applications, ensures precise monitoring and adjustment of interventions to meet climate targets effectively.

4.4.2 Increased and Integrated Public Transport Accessibility System for People with Disabilities (Pilot 2)

The second pilot in Barcelona focuses on improving accessibility to public transport for people with disabilities. It involves evaluating the current service, developing shared journey schemes, and engaging stakeholders in co-creation processes (Table 22).

Table 22. Actions, Indicators, and Impact Assessment Areas (Barcelona – Pilot 2)

Action/ Intervention	Relevant Indicators	SUMI Category	Impact Assessment Area
Baseline	User satisfaction with accessible information/booking services	Other	Social Inclusiveness and Accessibility
Historical data analysis	Complaints	Other	Social Inclusiveness and Accessibility
Stakeholder participation process	Number of workshops with stakeholders	Other	Social Inclusiveness and Accessibility
Development of descriptive map	Accessibility Information Availability	Other	Social Inclusiveness and Accessibility
Benchmarking of best practices	Usage of DRT Services	Access to mobility services	Transformative Governance
Definition of shared journey scheme	Service coverage of Demand-Responsive Transport (DRT)	Access to mobility services	Social Inclusiveness and Accessibility
Stakeholder participation	Involvement/consultation of PwD and/or representatives (associations) in workshops	Other	Social Inclusiveness and Accessibility
Development of a shared journey scheme	Accessibility Improvements	Other	Social Inclusiveness and Accessibility
Use-case drafting	Perception of Comfort and satisfaction	Other	Social Inclusiveness and Accessibility
Feasibility test & implementation	Passenger Satisfaction (Survey)	Other	Social Inclusiveness and Accessibility

Impact Assessment

The **direct effects** of the interventions will be measured through the identified indicators. For example, the number of accidents, complaints, and user satisfaction levels will provide immediate feedback on the effectiveness of the interventions.

Indirect effects include broader changes in public behaviour, shifts in modal share towards more sustainable options, and long-term improvements in urban safety and accessibility. These will be tracked through longitudinal studies and trend analyses.

Corrective actions will be identified based on continuous monitoring and feedback from stakeholders. These may include adjustments to the interventions, additional training for users and operators, and updates to the regulatory framework to better support the desired outcomes.

System Dynamics Model (SDM) Application Example

An example of the SDM application could be the use of safety auditing and behavioural analysis to identify conflict points and high-risk behaviours in shared spaces. Based on these findings, targeted interventions such as improved signage, awareness campaigns, and physical modifications to the environment can be implemented. The effectiveness of these interventions will be monitored through ongoing data collection and stakeholder feedback, allowing for iterative improvements to ensure the highest level of safety and accessibility for all users.

This pilot improves public transport accessibility for disabled individuals by developing shared journey schemes and engaging stakeholders in co-creation processes. By enhancing service efficiency and promoting inclusive mobility, Barcelona can increase public transport use, reduce car dependency, and support its climate neutrality targets.

- **Climate Target:** Enhance public transport accessibility, promote sustainable commuting.
- **Expected Impact:** Increased satisfaction and accessibility for disabled individuals using public transport.

The impact assessment methodology, supported by SDM, provides comprehensive analysis and optimization of interventions to ensure their effectiveness in achieving climate goals.

4.5 Budapest

4.5.1 Improving Traffic Safety in Budapest's Peri-urban Areas (Pilot 1)

This pilot aims to enhance traffic safety in Budapest's peri-urban areas by focusing on interventions such as data collection and analysis, cycling infrastructure improvement, AI-based traffic modelling, and space reallocation. The baseline and data collection will involve user surveys and the placement of measurement equipment to gather essential data. Cycling infrastructure improvements include rearranging curbs, lanes, and painting cycle lanes at intersections. AI-based traffic modelling and measurements will be conducted through the implementation of monitoring stations, data analysis, and pollution modelling. Space reallocation will focus on completing missing sections of the cycle network, eliminating irregular parking, and exploring further potential interventions. The indicators connected to these interventions will help measure environmental, social, and operational impacts (Table 23).

Table 23. Actions, Indicators and Impact Assessment areas (Budapest – Pilot 1)

Action/ Intervention	Relevant Indicator(s)	SUMI Category	Impact Assessment Area
Baseline data collection	Number of user surveys completed	Other	Social inclusiveness and accessibility
Cycling infrastructure improvement	Number of new cycle lanes at intersections	Modal share	Road safety, Safe system approach
AI-based traffic modelling	Number of Identified Conflict Points	Accident and Injuries	Road safety, Environmental
Space reallocation	Percentage of cycle network completed	Modal share	Environmental, Circularity

Impact Assessment

The impact assessment will focus on evaluating the direct, indirect, and other effects of the interventions. **Direct effects** include improved traffic safety, reduced vehicle speeds, and better cycling infrastructure. **Indirect effects** involve enhanced perceptions of accessibility and safety among residents and users. Other effects may include shifts in local travel patterns and increased active mobility. **Corrective actions** will be applied based on continuous monitoring and feedback, ensuring adaptive management of the interventions.

System Dynamics Model (SDM) Application Example

By simulating dynamic interactions within the transportation system, SDM enables evidence-based decision-making and helps achieve climate neutrality goals through targeted infrastructure improvements and policy interventions. DM could simulate the effects of adding new cycle lanes at intersections and reallocating road space to enhance safety and encourage cycling as a mode.

Budapest's pilot aims to enhance traffic safety in peri-urban areas through data collection, cycling infrastructure improvements, AI-based traffic modelling, and space reallocation. By reducing conflict points and promoting active mobility, the pilot contributes to lower emissions and improved urban liveability, supporting the city's climate neutrality efforts.

- **Climate Target:** Promote active and sustainable modes of transport, reducing emissions and carbon impact.
- **Expected Impact:** Improved safety in peri-urban areas and a significant reduction in emissions.

The impact assessment methodology, incorporating SDM, ensures continuous tracking of safety improvements and their effect on emissions reduction.

4.5.2 Healthy Superblock (Pilot 2)

This pilot aims to transform urban neighbourhoods into calm, attractive, and safe spaces by implementing measures such as baseline data collection, stakeholder engagement, co-creation, and various interventions to improve cycling networks and urban space redesign. Baseline data collection will include traffic management tools and emission measurements. Stakeholder engagement will foster collaboration with local authorities and citizens. Implementation measures will enhance safety for Vulnerable Road Users (VRUs) and contribute to a greener urban environment. Indicators will measure the environmental, social, and operational impacts of these interventions (Table 24).

Table 24. Actions, Indicators and Impact Assessment Areas (Budapest – Pilot 2)

Action/ Intervention	Relevant Indicator(s)	SUMI Category	Impact Assessment Area
Baseline data collection	Number of emission measurement points	Air pollution	Environmental
Stakeholder engagement & co-creation	Number of stakeholder engagement activities	Other	Transformative Governance, Social inclusiveness
Implementation of measures	Length of new cycling paths	Modal share	Environmental, Circularity
Monitoring of implemented solutions	Number of reduced conflict points	Accident and Injuries	Road safety, Environmental

Impact Assessment

The impact assessment for this pilot will evaluate **direct effects** such as reductions in greenhouse gas emissions, air pollution, and noise pollution. **Indirect effects** will include improved accessibility and quality of public spaces. Other effects may involve changes in travel behaviour and increased use of active mobility modes. Continuous monitoring and stakeholder feedback will guide **corrective actions** to optimize the interventions.

System Dynamics Model (SDM) Application Example

SDM simulates the collection and analysis of emission data to predict the environmental impact of the pilot, including reductions in air pollution and greenhouse gas emissions and another model evaluates the effectiveness of engagement activities in fostering collaboration with local authorities and citizens, crucial for ensuring community support and effective implementation.

This pilot transforms urban neighbourhoods into calm, safe, and attractive spaces by enhancing cycling networks, redesigning urban spaces, and reducing emissions. Through stakeholder engagement and continuous monitoring, Budapest ensures that these interventions support a modal shift towards sustainable mobility, aligning with the city's climate targets.

- **Climate Target:** Reduce air pollution, create new green areas, and promote active mobility.
- **Expected Impact:** 20% decrease in accidents by 2030; fully electrified public transport by 2040.

The impact assessment methodology, using SDM, provides detailed predictions and real-time data analysis to optimize the interventions.

4.6 Lyon

4.6.1 Public Space Redesigning and Enhancing Road Safety in the Schools' Surroundings (Pilot 1)

Interventions and Indicators

This pilot aims to create safer and more child-friendly urban spaces around schools by implementing a series of targeted interventions. These include the development of guidelines, collecting best practices, quantitative and subjective data collection, and deploying traffic calming measures. The indicators linked to these interventions focus on environmental improvements, social engagement, and operational efficiencies (Table 25).

Table 25. Actions, Indicators and Impact Assessment areas (Lyon – Pilot 1)

Action/ Intervention	Relevant Indicator(s)	SUMI Category	Impact Assessment Area
Development of Guidelines	Stakeholder Feedback	Other	Transformative Governance
Best Practices Catalogue	Knowledge Sharing and Documentation	Other	Social inclusiveness and accessibility
Traffic Speed Analysis	Traffic Calming Effectiveness	Accident and Injuries	Road safety
Air Quality Monitoring	Air Pollutant Concentrations	Air Pollution	Environmental
User Surveys	User Feedback	Other	Social inclusiveness and accessibility
Traffic Calming Solutions	Traffic Calming Effectiveness	Accident and Injuries	Road safety, Safe system approach
Parking Reallocation and Greening	Green Space Coverage	Air Pollution	Environmental
Monitoring of Solutions	Environmental Impact	Emission, Air Pollution, Noise Pollution	Environmental

Impact Assessment

The impact assessment for this pilot will be conducted using both qualitative and quantitative data. Direct effects include reduced traffic speeds and improved air quality. Indirect effects encompass enhanced community engagement and improved safety perceptions among residents. Corrective actions could be applied based on continuous monitoring and feedback mechanisms, ensuring timely adjustments. For example, if certain interventions do not yield expected results, further community engagement sessions could be held to identify barriers and implement necessary changes.

The impact assessment for this pilot will focus on several direct, indirect, and other effects. **Direct effects** include a reduction in traffic speeds around school areas due to traffic calming measures such as speed limits, car-free zones, and superblocks, which will enhance safety for children and other pedestrians. Additionally, the greening initiatives will directly increase green spaces, contributing to better environmental quality and aesthetic appeal.

Indirect effects will include enhanced community engagement through workshops and focus groups, fostering greater collaboration and a stronger sense of ownership for the interventions. The perception of safety among parents and children will improve as traffic speeds decrease, and public spaces are enhanced. Behavioural changes are anticipated as awareness campaigns and user surveys encourage increased walking and cycling to school, reducing reliance on motorized transport.

Other effects might involve changes in local traffic patterns due to parking reallocation and car-free zones, which could reduce congestion in some areas while potentially increasing it in others. Economic impacts may arise as improved public spaces and safer school environments attract more families to the area, potentially increasing property values and local business activities. Additionally, educational benefits will result from integrating road safety and environmental stewardship components into awareness campaigns, fostering a better understanding among children.

System Dynamics Model (SDM) Application Example

A System Dynamics Model will be used to simulate different scenarios and predict long-term impacts of the interventions. For example, the model can assess how different levels of community engagement affect the uptake of new routes by children. By integrating feedback loops and time delays, the SDM will help in understanding the dynamic interactions between various factors and guide decision-making.

Lyon’s Vision Zero pilot around schools aims to improve safety and air quality by implementing traffic calming measures, reducing vehicle speeds, and enhancing walking and cycling routes. These interventions will reduce emissions, promote active travel, and improve the safety and health of children, directly contributing to the city’s climate neutrality targets by fostering a shift away from car dependency.

- **Climate Target:** Reclaim road space to green and public spaces, meet long-term environmental, health, and climate challenges.
- **Expected Impact:** Significant improvements in children's safety and environmental quality in school areas.

The impact assessment methodology, supported by SDM, provides detailed insights into the effectiveness of safety measures and their contribution to climate goals.

4.6.2 Road Safety Tech & Non-Pollution Parking Policy (Pilot 2)

Interventions and Indicators

This pilot aims to enhance road safety and promote sustainable parking policies through data-driven and technological interventions. The interventions include data collection and parking policy analysis, deployment of AI technology, and the usage of digital twin systems. The indicators associated with these interventions focus on environmental impacts, social acceptance, and operational efficiencies (Table 26).

Table 26. Actions, Indicators and Impact Assessment Areas (Lyon – Pilot 2)

Action/ Intervention	Relevant Indicator(s)	SUMI Category	Impact Assessment Area
Data Collection and Parking Analysis	Parking Policy Efficiency	Congestion	Transformative Governance
AI Technology Deployment	Traffic Safety Hazard Detection	Accident and Injuries	Road safety
Digital Twin System	Digital Twin Simulation Accuracy	Other	Transformative Governance
Parking Policy Modification	Parking Policy Compliance	Congestion	Environmental, Transformative Governance
Communication Activities	Public Acceptance Index	Other	Social inclusiveness and accessibility
Manual Production	Knowledge Sharing and Documentation	Other	Transformative Governance

Impact Assessment

The impact assessment for this pilot will focus on both immediate and long-term effects of the interventions. For this pilot, **direct effects** will include a reduction in air pollution as the non-pollution parking policy imposes higher tariffs on heavy and polluting vehicles, lowering emissions of CO_2 and particulate matter. The deployment of AI technology will directly identify traffic safety hazards through real-time data collection and evaluation, leading to timely interventions. Enhanced traffic safety is expected from incorporating real-time nudges and warnings, increasing safety awareness and reducing traffic accidents.

Indirect effects will include increased acceptance of new parking policies through effective communication activities and the production of manuals, fostering a culture of compliance and support for sustainable practices. Behavioural shifts are anticipated as the parking policies encourage residents to adopt more sustainable transportation modes, such as cycling, walking, or using public transport. Enhanced data-driven decision-making will result from using a digital twin system to simulate user interactions and integrate safety solutions.

Other effects might involve addressing social equity by considering the needs of low-income households and large families in the parking policy, ensuring inclusiveness and fairness. Technological advancements will promote innovation in urban mobility management through integrating AI and digital twins, potentially serving as a model for other cities. Knowledge sharing through internal communication and exchanges with other French cities will disseminate best practices and lessons learned, contributing to broader regional improvements in urban mobility and safety.

Corrective actions could involve iterative improvements based on real-time data and continuous stakeholder feedback. For instance, if digital tools reveal inefficiencies in temporary traffic designs, adjustments will be made promptly to optimize traffic flow and safety.

System Dynamics Model (SDM) Application Example

The SDM will simulate how different digital interventions affect overall mobility patterns. For instance, it can model the impact of increased public transport use on traffic congestion and emissions. By continuously updating the model with real-time data, the city can make informed decisions to enhance urban mobility effectively.

This pilot focuses on using AI technology and digital tools to improve road safety and promote sustainable parking policies. By implementing data-driven interventions and encouraging the use of electric vehicles and bikes, Lyon can reduce emissions and enhance urban mobility. Continuous monitoring and community engagement will ensure the effectiveness of these measures in achieving the city's climate goals.

- **Climate Target:** Reduce carbon footprint by modifying parking tariffs according to vehicle weight and fuel.
- **Expected Impact:** By 2030, decrease daily car trips by 36%, halve car trips in the city centre, and triple bicycle trips by 2026.

The impact assessment methodology, with SDM predictions, allows for adaptive management and real-time optimization of interventions.

4.7 Tampere

4.7.1 AI for Increased Road Safety, Space Reallocation & Parametric Design

Interventions and Indicators

The Tampere pilot aims to enhance road safety, promote space reallocation, and utilize parametric design through the application of AI technology. Key interventions include identifying hazardous spots, collecting and analysing traffic and accident data, installing AI-cameras, engaging citizens in safety planning, and implementing road space reallocation measures. Indicators for these interventions focus on reducing near-miss situations, improving traffic safety, and increasing the feeling of safety among residents (Table 27).

Table 27. Actions, Indicators and Impact Assessment Areas - Tampere

Action/ Intervention	Relevant Indicator(s)	SUMI Category	Impact Assessment Area
Hazardous Spot Identification	Near-Miss Incidents	Accident and Injuries	Road safety, Safe system approach
Data Collection from City Repositories	Public Space Utilization Rate	Other	Transformative Governance
Historical Data Analysis	Safety Violations	Accident and Injuries	Road safety, Safe system approach
Installation of AI-Cameras	Interaction Safety Index	Other	Road Safety
Algorithm Testing	Visualization Tool Effectiveness	Other	Road Safety
Citizen Engagement	Community Participation Rate	Other	Social inclusiveness
Road Space Reallocation	Public Space Reallocation	Other	Environmental, Social inclusiveness
Data Monitoring and Implementation	Pedestrian and Cyclist Comfort Index	Accident and Injuries	Road safety, Safe system approach

Impact Assessment

The impact assessment for this pilot will consider direct, indirect, and other types of effects. Direct effects include a reduction in the number of hazardous spots and near-miss situations due to the installation of AI-cameras and improved traffic data collection. Indirect effects involve enhanced community engagement and increased public awareness of road safety issues, leading to more responsible traffic behaviour. Other effects may include advancements in AI technology and urban planning practices, contributing to broader applications of these innovations in other cities. The continuous monitoring of data and the application of corrective measures based on real-time feedback will ensure the effectiveness of the interventions.

For the Tampere pilot project, the impact assessment will cover various aspects, including direct, indirect, and other effects. **Direct effects** involve the immediate outcomes of interventions such as the reduction in the number of near-miss situations, an increase in the feeling of safety among road users, and the improvement of traffic flow and safety index. **Indirect effects** include enhanced community engagement and participation in traffic safety initiatives, leading to a broader awareness and adoption of safer travel behaviours. Additionally, improved data collection and algorithm testing will provide long-term benefits by informing future traffic management strategies. **Other effects** encompass the integration of innovative technologies like AI cameras and VR tools for visualization, which contribute to smarter urban planning and real-time monitoring of traffic conditions. By addressing these diverse impacts, the pilot aims to create a safer, more sustainable urban environment in Tampere.

The Tampere pilot uses AI technology to identify hazardous spots, engage citizens in safety planning, and reallocate urban space. By improving road safety and promoting sustainable travel behaviours, the pilot supports Tampere's climate neutrality goals through reduced emissions and enhanced urban liveability.

- **Climate Target:** Promote low-carbon mobility and reduce environmental impact.
- **Expected Impact:** Achieve a 72% reduction in GHG emissions and a 69% sustainable modes of transport increase in modal share by 2030.

The impact assessment methodology, supported by SDM, ensures continuous monitoring and real-time optimization of interventions to meet climate targets.

4.8 Utrecht

4.8.1 Safety-proofing schools in vulnerable neighbourhoods

Interventions and Indicators

This pilot focuses on making primary school environments or routes safer and more attractive in vulnerable neighbourhoods. The interventions include the selection of participating schools, conducting workshops with pupils and parents, collecting data on near-misses and conflicts between pedestrians, cyclists, and e-scooters, and using advanced technologies for data visualization and simulation. The indicators connected to these interventions include improvements in the feeling of safety, reduction in near-miss situations, and increased walking and biking to school, reflecting the project's environmental, social, and operational impacts (Table 28).

Table 28. Actions, Indicators and Impact Assessment Areas (Utrecht)

Action/ Intervention	Relevant Indicator(s)	SUMI Category	Impact Assessment Area
Selection of participating schools	Engagement with Schools	Other	Social inclusiveness and accessibility
Workshops with pupils & parents	Community Engagement, Number of Participants Engaged	Other	Governance, Social inclusiveness
Complementary data collection	Identification of Hotspots	Accident and Injuries	Road safety
Input analysis	Simulation Accuracy	Other	Road safety
Observations utilizing GoPro recordings	Pedestrian Count, Cyclist Count	Accident and Injuries	Road safety
Customization of uCrowds/SimCrowds 3D application[6]	Use of Digital Twin and Simulation	Other	Transformative Governance
Collect supplementary data on traffic flows, speeds, and pollution	Change across several environmental indicators	Air pollution, Noise pollution	Environmental
Co-design workshops with parents, children	Co-Design Workshops/Meetings, Feedback and Ideas Collected	Other	Transformative, Road Safety, Governance, Social inclusiveness
Use of VR technology and 3D digital boards	Simulation Impact, Use of Technology for Simulation	Other	Road Safety, Transformative Governance
Conduct experiments (parking, speed limits)	Bottleneck Resolutions	Congestion	Environmental, Social inclusiveness, Road safety
Implement behavioural measures	Active Mobility Engagement	Modal share	Environmental, Social inclusiveness
Develop a method for broader application	Replicability Index, Feasibility Score	Other	Transformative Governance

Impact Assessment

For the Utrecht pilot project, the impact assessment will cover various aspects, including direct, indirect, and other effects. **Direct effects** involve immediate outcomes such as increased feeling of safety among pedestrians and cyclists, reduced number of near-miss situations, and improved air and noise quality in the selected locations. These interventions will also lead to an increase in the number of parents and children walking or biking to school. **Indirect effects** include enhanced community engagement through participation and co-design workshops, fostering a sense of ownership and collaboration among residents, parents, and children. The implementation of VR

[6] uCrowds/SimCrowds: A 3D application for simulating and analyzing crowd behaviour and dynamics.

technology and 3D digital boards for visualizing interventions will provide educational and engagement benefits, contributing to a deeper understanding and support for the measures. **Other effects** encompass the development of methods and solutions that can be applied to other school settings, promoting a scalable approach to enhancing road safety and liveability. These comprehensive assessments aim to ensure that the interventions not only improve immediate safety and environmental conditions but also foster long-term community involvement and sustainable urban planning in Utrecht.

System Dynamics Model (SDM) Application Example

A System Dynamics Model will be used to simulate different scenarios and predict long-term impacts of the interventions. For example, the model can assess how different levels of community engagement affect the uptake of new routes by children. By integrating feedback loops and time delays, the SDM will help in understanding the dynamic interactions between various factors and guide decision-making.

Utrecht's pilot focuses on enhancing safety around schools through workshops, data collection, and advanced visualization technologies. By improving safety and promoting active travel, the pilot reduces emissions and fosters sustainable mobility, aligning with the city's climate targets.

- **Climate Target:** Improve air quality, reduce noise pollution, and promote active mobility.
- **Expected Impact:** Significant reduction of near-misses and over 51% of residents satisfied with road safety.

The impact assessment methodology, using SDM predictions, provides comprehensive analysis and optimization of interventions to ensure their effectiveness in achieving climate goals.

4.9 Bologna

4.9.1 Neutral, Safe, and Sustainable School District along the Knowledge Path

Interventions and Indicators

This pilot aims to create a safer, more sustainable school district along Bologna's Knowledge Path by enhancing infrastructure for active mobility, promoting behavioural changes, and engaging the community. Interventions include co-creation sessions, awareness campaigns, infrastructure development, and implementing immaterial interventions such as foot and bicycle buses. The indicators connected to these interventions measure environmental, social, and operational impacts (Table 29).

Table 29. Actions, Indicators and Impact Assessment Areas (Bologna)

Action/ Intervention	Relevant Indicator(s)	SUMI Category	Impact Assessment Area
Co-creation sessions and workshops	Number of Participants in Co-Creation Workshops	Other	Road Safety, Social inclusiveness
Data analysis and sharing	Number of Ideas/Proposals Generated	Other	Transformative Governance
Awareness campaigns	Active Mobility Mode Share	Modal share	Environmental, Social inclusiveness
Guidelines creation	Number of Ideas/Proposals Generated	Other	Road safety, Environmental
Creation of active mobility facilities	Usage of Active Mobility Infrastructure	Access to mobility services	Road safety, Environmental
Cycling signage	Accessibility Rating for Cyclists	Access to Mobility services, Other	Social inclusiveness
Implementation of design features	Incident Reduction	Accidents and injuries	Road safety
Foot and bicycle buses	User Satisfaction Score	Other	Social inclusiveness
Plaza planning	Improved Walkability	Other	Social inclusiveness
Co-design phase with citizens	Number of Participants in Co-Creation Workshops	Other	Transformative Governance
Monitoring and Evaluation	Incident Reduction Rate	Accident and Injuries	Road Safety, Transformative Governance

Impact Assessment

For the Bologna pilot, the direct effects include increased usage of active mobility infrastructure, improved safety for pedestrians and cyclists, and enhanced satisfaction with public spaces. Indirect effects involve a reduction in motorised vehicle trips, lower greenhouse gas emissions, and a heightened community perception of safety and security. Other effects may encompass higher participation rates in co-creation workshops and increased engagement in awareness campaigns. Continuous monitoring and corrective actions will ensure that interventions align with community needs and safety standards, contributing to Bologna's climate neutrality and SUMP goals.

System Dynamics Model (SDM) Application Example

As a suggestion, the Bologna pilot could benefit from utilizing a System Dynamics Model (SDM) to simulate and predict the long-term impacts of the interventions on active mobility. For instance, the SDM could model how the introduction of new cycling infrastructure and pedestrian paths might affect traffic patterns and safety incidents over time. By integrating feedback loops and continuously updating the model with real-time data, such as usage statistics and safety metrics, the SDM could provide valuable insights into how these interventions influence the reduction of motorized vehicle trips and greenhouse gas emissions. This approach could help optimize the interventions, ensuring they align effectively with Bologna's climate neutrality and SUMP goals.

Bologna’s pilot creates green corridors to improve safety and reduce emissions along high-traffic routes. By implementing active mobility infrastructure and green spaces, the pilot enhances urban resilience and supports the city’s climate neutrality goals.

- **Climate Target:** Accelerate reaching neutrality through increased active modes and engagement.
- **Expected Impact:** 40% reduction of GHG transport emissions, 16% reduction of CO2 emissions from cars by 2030.

The impact assessment methodology, incorporating SDM, ensures precise monitoring and adaptive management to maximize the interventions' climate impact.

4.10 Warsaw

4.10.1 Warsaw Pilot: Green & Safe Road to School

Interventions and Indicators

The Warsaw pilot focuses on creating a safer and more environmentally friendly route to school for children. The interventions include area selection and data collection, citizen science engagement, children's traffic behaviour survey and monitoring, analysis of local land uses, co-development of safety measures, and implementation and monitoring of measures (Table 30).

Table 30. Actions, Indicators and Impact Assessment areas (Warsaw)

Action/ Intervention	Relevant Indicator(s)	SUMI Category	Impact Assessment Area
Area Selection & Data Collection	Safety Improvement Index	Accident and Injuries	Road Safety
	Community Engagement Rate	Other	Social inclusiveness
	Perceived Safety Improvement	Accident and Injuries	Road Safety
	Number of Trees Planted	Air pollution	Environmental
Citizen Science Engagement	Number of Participants	Other	Transformative Governance
	Community Engagement Rate	Other	Transformative Governance
Children's Traffic Behaviour Survey and Monitoring	Child Traffic Behaviour	Modal share	Social inclusiveness
Analysis of Local Land Uses	Participatory Safety Measures	Air pollution	Environmental
Co-Development of Safety Measures	Safety Improvement Index	Accident and Injuries	Road Safety

Action/ Intervention	Relevant Indicator(s)	SUMI Category	Impact Assessment Area
	Number of Participants	Other	Social inclusiveness, Road Safety
Implementation & Monitoring of Measures	Road Space Reallocation	Air, Noise pollution	Environmental
	Environmental Benefits	Air pollution	Environmental

Impact Assessment

The impact assessment for the Warsaw pilot will involve evaluating both direct and indirect effects. Direct **effects** include improved road safety and reduced traffic accidents, as well as enhanced air quality due to reduced vehicle emissions. **Indirect effects** involve increased community engagement and social cohesion, as citizens participate in co-creation workshops and contribute to the planning process. **Other effects** include a greater sense of ownership and satisfaction among residents, especially parents and children, who feel safer and more involved in their local environment.

System Dynamics Model (SDM) Application Example

A System Dynamics Model (SDM) can be used to simulate the long-term impacts of these interventions. For instance, the model could assess how increased community engagement and improved road safety measures lead to higher usage of pedestrian and cycling routes, thus reducing overall traffic congestion and emissions. This approach helps in understanding the dynamic interactions between various factors and supports informed decision-making to enhance urban mobility and safety.

Warsaw's pilot aims to create safer and greener routes to school by implementing road safety measures, engaging citizens, and improving local land use. These interventions reduce emissions, enhance safety, and promote active travel among children, supporting the city's climate neutrality goals.

- **Climate Target:** Increase biologically active areas to sequester carbon along school routes.
- **Expected Impact:** Reach net-zero GHG emissions by 2030 and accelerate the transition from the current economy.

The impact assessment methodology, incorporating SDM, ensures continuous monitoring and adaptive management to maximize the interventions' climate impact.

4.11 Zagreb

4.11.1 Central Traffic Corridor Holistic Solutions

Interventions and Indicators

This pilot focuses on implementing holistic traffic solutions to improve the safety and efficiency of the central traffic corridor in Zagreb. The interventions include peak hour investigations, smart traffic lights and mobility solutions, microsimulation of intersections, urban redesign solutions, public engagement, and continuous monitoring and evaluation (Table 31).

Table 31. Actions, Indicators and Impact Assessment Areas (Zagreb)

Action/ Intervention	Relevant Indicator(s)	SUMI Category	Impact Assessment Area
Peak hour investigation	Peak Hour Safety Index	Road Safety	Road Safety
Smart traffic lights and mobility solutions	Smart Intersection Safety Score	Access to Mobility services	Road Safety
Microsimulation of intersection	Pedestrian and Cyclist Comfort Index	Other	Social Inclusiveness, Road Safety
Urban redesign solutions	Safety Perception Index	Other	Road Safety
Public engagement	Community Engagement Rate	Other	Transformative Governance
Monitoring and evaluation	Environmental Impact	Other	Environmental

Impact Assessment

The impact assessment for the Zagreb pilot will focus on evaluating both direct and indirect effects. **Direct effects** include improved road safety, reduced greenhouse gas emissions, and enhanced public transport efficiency. **Indirect effects** involve increased community engagement and satisfaction, enhanced urban greenery, and better traffic flow management. Continuous monitoring and feedback mechanisms will ensure timely identification and resolution of any emerging issues, facilitating an adaptive approach to urban mobility and safety improvements.

System Dynamics Model (SDM) Application Example

A System Dynamics Model (SDM) can be utilized to simulate various scenarios and predict the long-term impacts of the interventions implemented in the Zagreb pilot. For example, the SDM can model the effect of installing smart traffic lights and mobility solutions on traffic congestion and greenhouse gas emissions over time. By incorporating feedback loops and time delays, the SDM helps to understand the dynamic interactions between traffic flow, public transport usage, and pedestrian safety. This predictive modelling aids in decision-making by showing how different levels of intervention and public engagement can influence overall traffic efficiency and environmental quality, guiding the optimization of future urban mobility strategies.

Zagreb's pilot focuses on improving the central traffic corridor by implementing smart traffic lights, urban redesign solutions, and continuous monitoring. These measures enhance traffic flow, reduce emissions, and improve safety, contributing to the city's climate targets through sustainable urban mobility strategies.

- **Climate Target:** Prioritize sustainable transport modes, reduce congestion, and emissions.
- **Expected Impact:** Greenhouse gas reduction by 40% by 2030.

The impact assessment methodology, with SDM applications, provides detailed predictions and real-time data analysis to optimize interventions and ensure their alignment with climate goals.

4.12 Twinning cities

The impact assessment framework for the REALLOCATE project will focus on leveraging the collaborative potential of twinning cities (Figure 13). By establishing shared data, the cities will facilitate seamless data exchange.

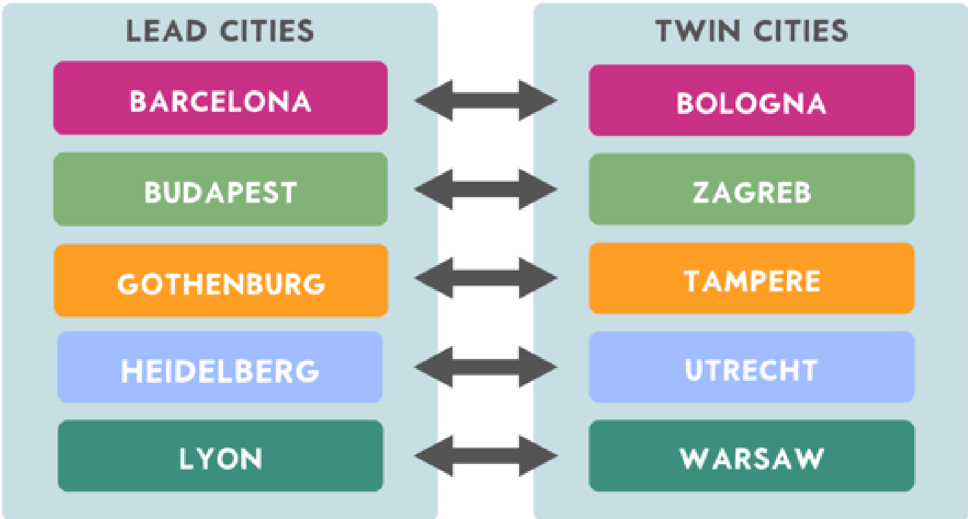

Figure 13. Lead & Twin cities

Next, "What-if" analyses will explore potential outcomes of different policy decisions and urban planning strategies, providing a comprehensive understanding of the implications of these interventions across both urban landscapes.

Stakeholder engagement and co-creation will play a crucial role in this framework. City planners, local government officials, urban designers, and citizens from both cities will be actively involved in the co-creation and co-evaluation processes. Public consultations using digital twin visualizations will be organized to gather feedback and foster collaborative decision-making. This inclusive approach ensures that the interventions are tailored to meet the specific needs and preferences of the communities in both cities.

Performance monitoring and reporting will be facilitated through shared dashboards that track KPIs related to traffic flow, energy consumption, emission levels, and citizen satisfaction. These real-time reporting tools will provide instant insights, enabling both cities to make data-driven decisions. The continuous monitoring of these KPIs will help in assessing the operational efficiency, environmental impact, and social impact of the interventions.

By focusing on these components and indicators, the impact assessment framework will ensure a comprehensive, collaborative, and adaptive approach to urban development. This framework will leverage the strengths and insights of both lead and twin cities to achieve optimized urban systems and sustainable development.

4.13 Cascade cities

Cascade cities will learn from the successful interventions from pilot cities to achieve urban sustainability goals through knowledge transfer, capacity building, and tailored strategies. Impact will be assessed using indicators for replication and scaling, capacity building, and sustainability impact. Replication will be measured by the number of interventions chosen to be successfully replicated and adapted. Capacity building will be estimated by the number of training sessions and improvements in governance and stakeholder engagement. Sustainability impact will be estimated by reductions in carbon footprint and enhancements in resilience.

The impact assessment methodology involves documenting best practices from pilot cities, developing guidelines and toolkits, and conducting training sessions for local officials and stakeholders. Interventions will be tailored to the specific contexts of cascade cities through stakeholder engagement. Implementation will be supported by ongoing guidance from pilot cities, with performance monitored using predefined indicators.

4.14 The procedure for SSMLs

4.14.1 Step 1: Collect Baseline Data

Baseline data collection is the foundational step in the impact assessment process, providing a reference point for measuring changes. At the project level, we are gathering data on the current state across common indicators and per impact area, including traffic patterns, accident rates, environmental conditions, and public space utilisation. This data is being collected through traffic sensors, environmental sensors, and surveys of residents and businesses. Additionally, historical data from city repositories and recent surveys are being used to add context and depth to the micro baseline assessment.

At the city level, we are collecting pilot-specific baseline data. We are utilising existing city data platforms to integrate project-level data into these pilot metrics, providing a comprehensive view of the urban environment before SSML interventions begin. This thorough baseline data collection ensures we have an accurate and detailed understanding of the current state, which is crucial for measuring the impact of our interventions.

4.14.2 Step 2: Engage Users, Citizens & Stakeholders

Stakeholder engagement is a component of the SSML process, ensuring that interventions align with community needs and priorities. We are engaging local stakeholders, including residents, business owners, public officials, and community organizations, through workshops and focus groups to gather valuable insights and foster a sense of ownership and collaboration.

Participatory methods, such as co-design workshops and public consultations, are allowing stakeholders to contribute to the planning and implementation phases of SSML interventions. This collaborative approach enhances the relevance and acceptance of interventions and helps identify potential challenges and opportunities from diverse perspectives. Regular communication and feedback loops with stakeholders throughout the project lifecycle ensure continuous engagement and adaptability.

4.14.3 Step 3: Implement Data Collection Tools

Effective data collection is vital for monitoring and evaluating SSML interventions. At the project level, we are implementing advanced tools like sensors and cameras to enable real-time monitoring of traffic flows, environmental conditions, and pedestrian activities. Mobile apps and digital surveys are being used to gather user feedback and satisfaction data, providing insights into community perceptions and utilization of interventions.

At the city level, we are employing monitoring systems for air quality, traffic flows, and public space usage to assess specific impacts. By integrating project-level data into these systems, we enhance our ability to evaluate the cumulative effects of multiple SSML initiatives. Leveraging existing city data platforms and repositories ensures our data collection efforts are efficient and comprehensive.

4.14.4 Step 4: Monitor and Evaluate

Ongoing monitoring and evaluation are essential to assess the effectiveness of SSML interventions and ensure they meet defined objectives. At the project level, we will conduct interim evaluation, such as quarterly, to measure progress against KPIs. These evaluations employ mixed methods, combining quantitative data (e.g., sensor data, traffic counts) with qualitative feedback (e.g., surveys, interviews) to provide a holistic view of project impacts.

4.14.5 Step 5: Report and Communicate Findings

Transparent reporting and effective communication of findings are required for maintaining stakeholder engagement and fostering public trust. At the project level, we are preparing detailed reports that summarize findings, progress, and any necessary adjustments, which could be shared with stakeholders and the community. Visual tools like dashboards and infographics can be used to convey complex data in an accessible and understandable format.

At the city level, we could be compiling comprehensive reports for city officials that integrate findings from multiple projects. Public dashboards and open data platforms could be utilised to share results with the broader community, promoting transparency and accountability. Regular communication through various channels, including public meetings, newsletters, and social media, ensures stakeholders are kept informed and engaged throughout the process.

4.14.6 Step 6: Review and Iterate (corrective actions)

The final step in the impact assessment methodology involves using the evaluation findings to refine and adjust project implementations and city-wide strategies. Continuous engagement with stakeholders to incorporate feedback and improve future projects is expected for the iterative nature of SSMLs. This approach ensures that interventions remain relevant, effective, and aligned with evolving community needs and priorities.

5 Data Collection and Analysis

Combining quantitative and qualitative data yields a robust assessment, leveraging advanced data collection tools for real-time monitoring. However, the high reliance on technology and data quality, coupled with the subjectivity of qualitative data, presents challenges. Continuous data integration and updating are essential but resource intensive.

5.1 Collection of Baseline and Intervention Data Strategies

A robust data collection strategy is pivotal to ensuring the effectiveness and credibility of the impact assessment in the SSMLs. This section outlines the methods and processes involved in gathering baseline and intervention data at various stages of the project to facilitate meaningful comparisons and analyses.

The initial step in data collection involved defining the scope and objectives of the project. This included KPIs relevant to the project's goals (i.e., initial GA descriptions and categories of KPIs). Once the KPIs were established, the next step is to develop a comprehensive data collection plan.

This plan will specify the data sources, collection methods, frequency of data collection, and the tools and technologies to be used and this process has been initiated with the third version of the inception report and will be reported in D5.3. The basic principles are presented in this Chapter and Section 4.14.

Baseline data collection is the foundation upon which all subsequent data will be compared. It involves gathering data on the current state of the project area before any interventions are implemented. This data provides a snapshot of the existing conditions and serves as a reference point for measuring changes and impacts over time. Once the baseline data is collected, it is essential to establish a systematic approach for monitoring and recording data during the intervention phase. This includes setting up a regular schedule for data collection to ensure consistency and comparability. Automated data collection tools, such as IoT devices and AI-powered cameras, can significantly enhance the efficiency and accuracy of this process.

Intervention data collection involves gathering data on the changes and impacts resulting from the implemented measures. This phase requires close coordination with project stakeholders, including local authorities, community groups, and technical experts, to ensure that all relevant data is captured. At this stage, participatory data collection methods, such as citizen science and crowdsourcing, can engage the community in the data collection process, fostering a sense of ownership and collaboration.

Data quality assurance is a critical aspect of the data collection strategy. Implementing rigorous quality control measures ensures the accuracy, reliability, and validity of the collected data. This includes regular calibration of data collection instruments, cross-checking data from multiple sources, and conducting periodic audits. Furthermore, establishing clear protocols for data management, storage, and security is essential to protect the integrity and confidentiality of the data.

Finally, the collected data will be systematically organised and stored in a centralised database or data management system (dashboard of T5.2). This system will be designed to facilitate easy access, retrieval, and analysis of the data by project team members and stakeholders. It will further provide visualization, analysis, and reporting, enabling stakeholders to monitor progress, identify trends, and make informed decisions (T5.5).

5.2 Integration of Subjective Views in Data Analysis

Incorporating subjective views in data analysis is a critical component of impact assessment in urban living labs. Subjective data, which includes personal opinions, perceptions, and experiences of individuals, provides valuable insights that quantitative data alone cannot capture. This section discusses the importance of integrating subjective views into data analysis and outlines methodologies for achieving a holistic understanding of urban interventions' impacts.

Subjective data will be collected through surveys, interviews (walking, terminal, etc.), focus groups, and participatory workshops. This data reflects the lived experiences and perceptions of community members, stakeholders, and users of urban spaces. By integrating subjective views, cities can gain a deeper understanding of how interventions affect people's lives, identify areas for improvement, and ensure that urban projects are aligned with community needs and expectations.

One of the primary methods for integrating subjective views is through mixed-methods research, which combines quantitative and qualitative data. Mixed-methods research allows for a comprehensive analysis by leveraging the strengths of both data types. Quantitative data provides measurable and objective evidence of intervention impacts, while qualitative data offers context, depth, and insights into the underlying reasons behind these impacts.

5.3 Data quantity, quality and privacy

Ensuring the quality and quantity of data collection is fundamental for the success of any impact assessment (IA) methodology. This process begins with identifying the specific objectives of the data collection effort, determining the type of data needed (whether quantitative or qualitative), identifying the sources, and specifying the required granularity. Developing a comprehensive data collection plan that outlines methodologies, tools, timelines, and assigns responsibilities to personnel is currently the critical second step (after identifying the Measures and their indicators). As such, the next step is to identify and validate the data sources. Ensuring that data sources are reliable, relevant, and comprehensive is necessary to sketch each point in the data paths for each indicator. This involves determining where the data will come from, such as sensors, surveys, administrative records, or external databases. Validating these sources for credibility, reliability, and relevance ensures the integrity of the data. Additionally, it is important to verify that these sources cover all necessary aspects of the study, including geographic and demographic considerations.

Tool selection and calibration is the step taken currently in parallel in this process. This involves identifying the appropriate (and existing) data collection tools, such as sensors, survey platforms, or data loggers, and ensuring they are correctly calibrated to provide accurate and consistent data. Conducting pilot tests to ensure that these tools function correctly and collect accurate data is also essential. Implementing the data collection plan systematically follows the preparation phase. This involves training the data collectors to ensure consistency and accuracy in data collection. Establishing and enforcing standard operating procedures (SOPs) for data collection helps maintain uniformity. Continuous monitoring of the data collection process ensures adherence to protocols and allows for prompt addressing of any issues that arise.

Ensuring data privacy is paramount throughout the data collection process. It involves safeguarding sensitive information collected from specific population groups, such as personal details of older citizens, children, disabled travellers, and commuters. We adhere to stringent privacy protocols in collaboration with local community organizations to protect individual identities and uphold confidentiality. This includes anonymising or pseudonymising data before sharing to prevent identification of individuals. Secure data management practices, including encryption during transmission and storage, will be implemented in the REALLOCATE dashboard to mitigate risks of unauthorised access or data breaches. Regular audits and reviews of data handling procedures reinforce the process of maintaining high standards of data privacy and security throughout the impact assessment process. The technical and operational measures are addressed by D1.3 'Data Management Plan'.

Ensuring data quality through validation and control measures is another critical step. This involves checking data for accuracy, completeness, and consistency. Implementing regular quality control checks, including random sampling and cross-verification, helps maintain high data quality. Identifying and correcting errors or anomalies promptly ensures the reliability of the data. Proper data management and storage are also essential components of the data collection process. Using secure and scalable data storage solutions, such as cloud storage or databases, ensures data integrity and accessibility. Regular data backups prevent data loss, and access control measures restrict data access to authorized personnel, enhancing data security. Analysing and reporting the collected data is the final step in the process. This involves cleaning the data to remove duplicates, errors, and irrelevant information. Using appropriate statistical and analytical methods to derive insights from the data is crucial. Presenting the findings in a clear, concise, and actionable manner ensures that the data collected serves its intended purpose.

To ensure high-quality data collection, specific metrics must be applied. Data quality can be measured through several key metrics: **Accuracy** refers to the degree to which data correctly describes the real-world objects or events it represents. It can be measured by the percentage of data entries without errors. **Completeness** measures the extent to which all required data is collected, using metrics like the percentage of missing data fields. **Consistency** assesses the degree to which data is consistent across different sources and over time, with the number of conflicting data entries across sources as a metric. **Timeliness** measures the degree to which data is up-to-date and collected within the required time frame, using metrics like the average time lag between data collection and availability for analysis. **Validity** measures the extent to which data conforms to required formats and value ranges, with the percentage of data entries meeting predefined criteria as a metric. **Reliability** measures the degree to which data collection methods produce stable and consistent results, using metrics such as standard deviation or variance of repeated measurements.

Ensuring the quantity of data involves additional metrics like **data volume** measures the total amount of data collected, with the number of data points or records as a metric. Coverage measures the extent to which data represents the entire population or area of interest, using the percentage of the target population or area covered by the data. Frequency measures the rate at which data is collected over time, with metrics like the number of data collection instances per unit of time (e.g., daily, weekly). **Data density** measures the granularity of data collected, with metrics such as the number of data points per unit area or population. **Response Rate** measures the proportion of respondents or data sources that provide data, using the percentage of surveys or data requests completed as a metric.

By meticulously implementing these procedures and using the specified metrics, the quality and quantity of data collection for an impact assessment project can be ensured, leading to more accurate and actionable insights. These practices and metrics form the backbone of a robust data collection strategy, facilitating the achievement of reliable and comprehensive IA results. This process is facilitated under a common data collection protocol template (Annex D).

6 Impact Assessment Tools and Strategies

6.1 Design of Evaluation Tools

The design and implementation of tools for evaluating the impacts of the REALLOCATE project are essential for ensuring accurate and meaningful assessments. These tools are tailored to measure various aspects of mobility, safety, environmental impact, and user engagement, customised for each pilot city. The following outlines the tools used in each city, their specific purposes, related actions or interventions, and the horizontal partners involved in their deployment. The information has been refined and updated based on the deployment plans detailed in Deliverable D2.2 and is not exhaustive; it only provides an overview. A summary of instruments and tools used in various city pilots for traffic, safety, and environmental analysis, including their uses, related interventions, and involved partners can be found Annex A: 'Data Collection Instruments' (Table 33).

In **Barcelona**, the tools include pedestrian counting sensors to measure pedestrian traffic flow and cyclist counters to track cyclist traffic flow. Safety audits are conducted to evaluate safety measures, and traffic counting is used to measure traffic volume. Spatial analysis tools are employed to assess spatial usage, while survey tools collect feedback from disabled individuals. Descriptive mapping tools analyse and visualize transportation models, and qualitative analysis tools evaluate shared journey schemes. These tools are implemented by BSC, UCD and ECF, with safety audits involving IFP. Additionally, the pilot involves interventions for cyclist-pedestrian conflict resolution, awareness campaign methodology, and the development of a guideline document for shared space design.

Gothenburg uses AHA analysis tools to analyse human approaches to mobility through fieldwork and engagement, supported by UCD and ECF. Workshop facilitation tools are used for co-creation workshops, and safety system analysis tools test new mobility solutions. The digital twin tool visualizes and simulates temporary traffic arrangements, and mobility service platforms provide visitor mobility solutions. Co-creation tools engage citizens in urban design processes. These initiatives involve UCD and IFP. The pilot also includes tools for analysing traffic patterns, safety, and mobility services for visitors, involving DEKRA and CERTH.

Heidelberg focuses on understanding mobility needs and challenges through survey tools, workshops, and co-creation facilitated by UCD, Fraunhofer, DEMOS, Nudgd and IFP. Planning and analysis tools aim to improve public transport access, and environmental data collection measures environmental parameters. Stakeholder engagement tools involve citizens in urban design discussions, with Fraunhofer supporting the planning and analysis. The pilot also involves the use of tools for spatial analysis and environmental predictions, involving CERTH and DEKRA.

In **Lyon**, traffic cameras monitor traffic speeds in school zones, and air quality monitoring stations measure air quality parameters. Survey tools collect user feedback, AI technology identifies traffic safety hazards, and the digital twin simulates user interactions. These efforts are supported by UCD, Factual, and ECF. The pilot includes interventions such as the deployment of descriptive mapping tools, LiDAR sidewalk scanners, and qualitative analysis tools to evaluate/visualize traffic accident analysis, involving IFP and BSC, respectively.

Budapest employs mobile measuring equipment to measure traffic and pollution levels, and smart camera devices monitor traffic and identify conflict points using AI-based modelling. Survey tools gather resident perceptions, and traffic management tools analyse traffic flow and emissions. Stakeholder engagement tools foster collaboration, and environmental monitoring tools measure air and noise pollution. Activities are supported by UCD, BSC, and IFP. The pilot also involves CERTH and DEKRA.

Warsaw utilizes road safety assessment tools to assess safety levels and pedestrian crossings, involving UCD and CEREMA. Citizen science engagement tools engage citizens in data collection and area audits, while survey tools monitor children's traffic behaviour. 2D and 3D visualization tools visualize local land use and safety measures, and traffic measurement tools analyse traffic patterns. The pilot also includes tools for analysing local land uses and co-development of safety measures, involving CEREMA and DEKRA.

In **Zagreb**, traffic volume counters measure traffic volumes during peak hours, and smart traffic lights adapt signals based on real-time data. Microsimulation tools simulate traffic scenarios, and urban redesign tools redesign sidewalks, crossings, and intersections. Stakeholder engagement tools involve the public in planning, and monitoring tools collect continuous traffic data. These initiatives are supported by several partners, including CERTH, BSC, IFP. The pilot also includes tools for public engagement and microsimulation of intersections.

Tampere uses AI cameras to identify near misses and safety hazards, supported by CERTH and CEREMA. Traffic pattern analysis tools analyse historical traffic patterns, and citizen engagement tools involve citizens in planning safe environments. Visualization tools, such as VR, visualize road space reallocation, and data monitoring tools implement and evaluate safety solutions, with contributions from Ertico, BSC and UCD. The pilot also involves tools for the analysis of hazardous spots and implementation of smart technology for traffic monitoring, involving BSC and DEKRA.

Utrecht employs GoPro recording devices to observe children's bike rides, and 3D simulation tools simulate cyclist and e-scooter behaviour. VR technology involves children in the design process, and survey tools collect data from parents and children. Traffic data collection tools gather information on traffic flows, speeds, and pollution levels, supported by CERTH and DEKRA. The pilot also includes tools for co-design workshops and simulation of large-scale interventions using digital twins, involving ARUP and BSC.

In **Bologna**, workshop facilitation tools conduct co-creation sessions, and awareness campaign tools promote sustainable commuting. Mobility infrastructure tools create dedicated lanes and paths, and safety auditing tools implement safety design features. Community engagement tools involve the local community in decision-making, and data collection tools monitor commuting patterns and safety metrics for continuous evaluation. These initiatives are supported by UCD, ECF, and IFP. The pilot also includes tools for the implementation of behavioural and choice design interventions, involving Nudgd and DEKRA.

6.1.1 System Dynamic Modelling Approach

This approach involves using system dynamics to model the complex interactions and feedback loops within urban mobility systems. It helps in understanding how different interventions influence each other and the overall system. System modelling supports scenario analysis, risk mitigation, and data-driven decision-making. It enables simulation and prediction of outcomes, enhancing intervention optimisation. Despite these benefits, sophisticated modelling tools and expertise are required, and models are sensitive to initial assumptions and data accuracy, demanding high computational resources.

The System Dynamic Model (SDM) aims to simulate and analyse the complex interactions within urban mobility systems, assessing both project-specific (micro) and pilot-specific (macro) impacts. This model helps in understanding how different interventions influence KPIs and impact areas over time. To effectively use the SDM, the following types of data are required: baseline data, intervention data, and real-time data. Baseline data includes traffic volumes and patterns, accident and safety records, air quality measurements (e.g., NO_2), noise levels, social inclusiveness metrics (e.g., accessibility scores), and existing infrastructure details. Intervention data encompasses changes in traffic flow post-intervention, safety improvements and incident reductions, environmental impacts (e.g., reduction in emissions), social data (e.g., user satisfaction, inclusiveness), and economic data (e.g., cost-benefit analysis). Real-time data involves sensor data for traffic and environmental monitoring, user feedback through surveys and mobile applications, and dynamic data from mobility services (e.g., public transport usage).

The SDM processes each impact area or indicator methodically. For safety, the model uses accident records, near-miss incidents, road design features, and speed data. Historical accident data is used to calibrate the model, and interventions such as speed reductions, improved signage, and road redesigns are simulated to evaluate changes in accident rates and near-misses. For climate targets and environmental footprint, the model requires emission levels (CO_2, NOx), energy consumption, and vehicle types and usage patterns. It simulates the impact of interventions on emission reductions and changes in vehicle usage patterns, assessing the overall reduction in environmental footprint.

Social inclusiveness is evaluated using accessibility scores, user satisfaction surveys, and demographic data. The model assesses the impact of interventions on accessibility for different population groups, simulating improvements in public space usability and inclusiveness, and collects user feedback to refine interventions. Transformative governance is assessed using policy implementation records, stakeholder engagement levels, and governance structures. The model evaluates the effectiveness of governance models in implementing interventions, simulates the impact of different governance structures on project outcomes, and assesses stakeholder engagement and its influence on project success.

The SDM conducts mid-term and final assessments to evaluate the interventions' progress and outcomes. The mid-term assessment, conducted halfway through the intervention period, aims to measure interim progress, identify necessary adjustments, and ensure interventions are on track to meet targets. Data collection for the mid-term assessment involves updated data on traffic, safety, environmental impact, and social metrics, using surveys and sensors for real-time data. The SDM simulates the current state and predicts future impacts, comparing against baseline and initial targets, and generates interim reports highlighting progress, challenges, and recommended adjustments.

The final assessment, conducted at the end of the intervention period, measures the overall success of the interventions, identifies lessons learned, and provides recommendations for future projects. Comprehensive data collection on all impact areas is conducted using long-term data from sensors, surveys, and administrative records. The SDM provides a final assessment of impacts, evaluating the achievement of climate targets, safety improvements, social inclusiveness, and governance effectiveness. The final report details the outcomes, successes, areas for improvement, policy recommendations, and future intervention strategies.

6.1.1.1 Example Outcome: Improvement in Walkability Index, Perceived Safety, and Acceptance of Interventions

For example, as part of the REALLOCATE project's interventions, a specific urban area implemented measures such as widening sidewalks, improving street lighting, adding pedestrian crossings, and creating pedestrian-only zones. The goal is to enhance the walkability of the area, increase perceived safety among residents, and ensure high acceptance of the interventions. The SDM will simulate the impact of these interventions over a 24-month period, assessing changes in the Walkability Index, perceived safety, and acceptance of interventions.

For example, if the Walkability Index would be low due to narrow sidewalks, poor lighting, and few pedestrian crossings, with a baseline score of 50 on a scale of 100. The SDM would predict a steady increase in the Walkability Index, reaching 85 by the end of the 24-month period. Similarly, if perceived safety among residents is initially low (e.g., with a baseline score of 40 on a scale of 100). Following the interventions, the SDM could predict an improvement in perceived safety, with a targeted score reaching 80 after 24 months. Acceptance of interventions would be measured through resident surveys, compared to baselines (e.g., initially showing an acceptance rate of 60% or lower). Over time, as residents experience the benefits of the interventions, acceptance would increase, with a target to reach 90% by the end of the simulation period.

Based on the initial conditions and the anticipated effects of the interventions in the project area, we propose the following hypotheses to guide our analysis and measure the impact of the interventions:

- The implementation of improved pedestrian infrastructure, such as wider sidewalks, enhanced lighting, and safer crossings, will significantly increase the Walkability Index scores in the area (**Walkability Hypothesis; WH)**.
- Enhancements in pedestrian infrastructure, including better lighting and safer crossings, will lead to higher perceived safety scores among residents, indicating an increased feeling of safety while walking in the area (**Perceived Safety Hypothesis; PSH)**.
- Continuous engagement with residents, coupled with visible improvements in pedestrian infrastructure, will result in higher acceptance of the interventions, demonstrating successful implementation and positive feedback from the community (**Acceptance Hypothesis; AH)**.

The diagram below (Figure 14) illustrates the relationship between various factors affecting urban mobility at both micro (project) and macro (city) levels, along with the integration between these levels. At the micro level, Infrastructure Quality (IQ) represents the quality of infrastructure in a specific project area, the Walkability Index (WI) measures the walkability of the area, and Resident Satisfaction (RS) indicates how satisfied residents are with the infrastructure and walkability. Flows and feedback loops at this level include the Infrastructure Improvement Rate (IIR), which improves IQ, the Walkability Improvement Rate (WIR), which enhances WI, and the Resident Feedback Rate (RFR), which influences RS and provides feedback to improve IIR. The flow from IQ to WI, WI to RS, and RS back to IIR represents a positive feedback loop enhancing overall infrastructure quality and resident satisfaction.

At the macro level, City-Wide Infrastructure Quality (CWIQ) represents the overall infrastructure quality across the city, the Aggregated Walkability Index (AWI) measures the overall walkability of the city, Environmental Quality (EQ) indicates the environmental conditions in the city, and Social Inclusiveness (SI) represents the level of social inclusiveness in the city. Flows and feedback loops at this level include the City-Wide Infrastructure Improvement Rate (CWIIR), which improves CWIQ. The flow from CWIQ to AWI, AWI to EQ, EQ to SI, and SI back to CWIIR represents a positive feedback loop enhancing overall city infrastructure and social inclusiveness.

The integration between systems is shown by improved IQ contributing to better CWIQ and increased WI enhancing AWI at the macro level. Conversely, enhanced CWIQ supports local IQ improvements, and improved EQ supports better resident health and satisfaction (RS) at the micro level.

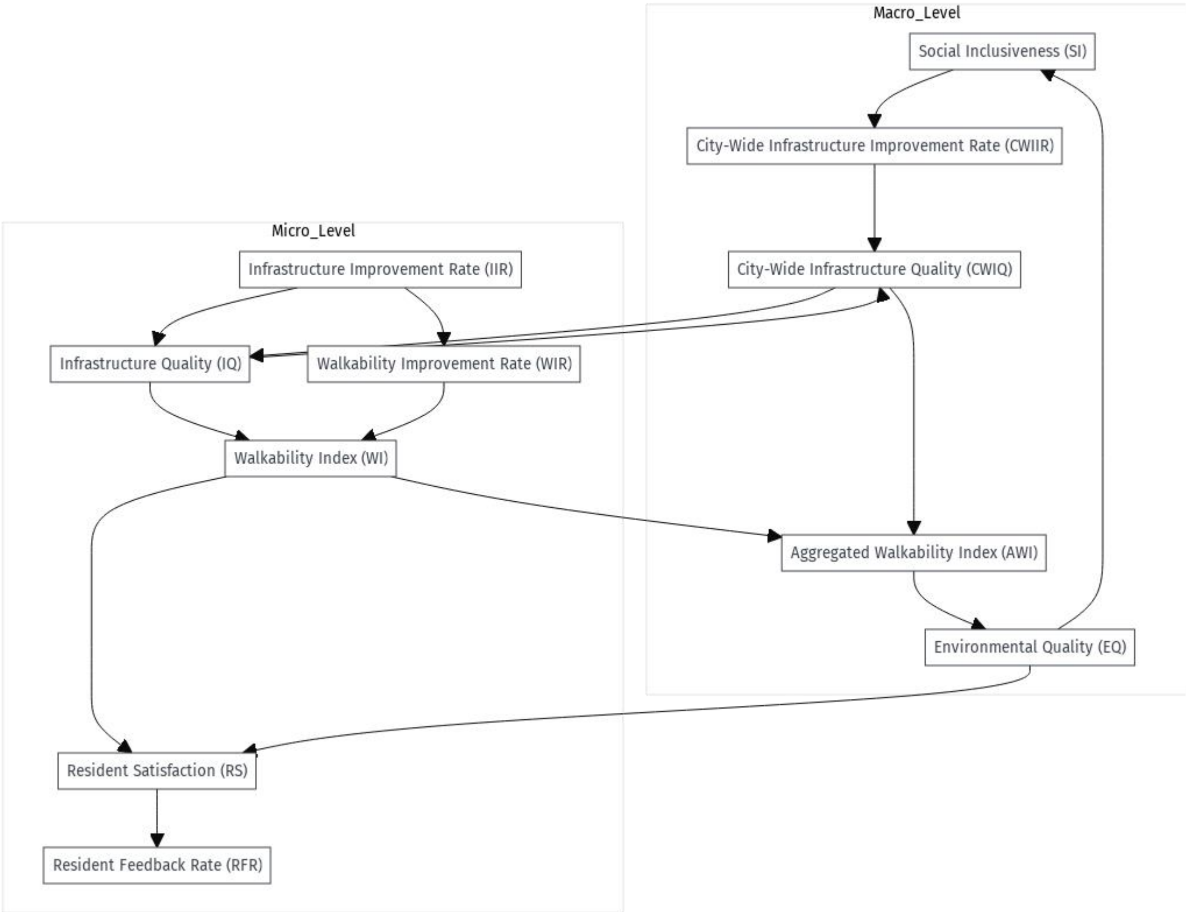

Figure 14. Urban mobility factors and feedback loops at micro and macro levels (an SDM flowchart example)

These examples illustrate how the SDM can predict and quantify the impacts of urban mobility interventions across various indicators, providing valuable insights for future urban planning and policy-making within the REALLOCATE project.

While SDM is a valuable tool in our analysis, it will not be the only technique employed. The choice of analysis techniques will heavily depend on the types and quality of data collected. Other methodologies, such as GIS analysis, statistical modelling, and qualitative assessments, will also be utilised to ensure a comprehensive evaluation. The extent to which SDM will be used will also depend on the volume and quality of the data available. This multi-faceted approach will help address all our measures and indicators effectively.

6.2 Strategies for Specific Population Groups

We are assessing the impact of urban mobility and safety interventions on specific population groups, such as older citizens, children, disabled travellers, and commuters, using tailored strategies.

Firstly, we are identifying and categorizing these groups by collaborating with local community organizations, schools, elder care facilities, and disability advocacy groups. We use demographic data to map the distribution of these groups and conduct focus group discussions to understand their unique mobility and safety challenges.

For data collection, we are employing inclusive and accessible methods tailored to each group's characteristics. We design surveys and questionnaires to be age-appropriate and considerate of each group's needs. For example, our surveys for older citizens focus on ease of access and safety, while those for children use simple language and visual aids. Surveys for disabled travellers address accessibility and usability, and for commuters, we focus on efficiency and comfort. We are also conducting in-depth interviews and observational studies to gain detailed insights, while using sensor data and IoT devices to track real-time mobility patterns of different user groups.

We apply both quantitative and qualitative analysis methods to interpret the collected data. By using disaggregated data, we highlight differences in impact among the groups. Statistical analysis allows us to compare baseline and post-intervention data to identify significant changes, while GIS mapping visualizes mobility patterns and identifies areas of concern. Sentiment analysis gauges satisfaction levels, and machine learning algorithms help us predict improvements and identify patterns in mobility behaviour, including of vulnerable road users.

To assess impact, we are developing frameworks that incorporate both direct and indirect effects of interventions on specific population groups. Our assessments are ongoing, capturing long-term impacts and adjustments. Pre- and post-intervention studies measure changes by comparing data before and after implementation. Social Impact Assessment (SIA) helps us understand broader social impacts, while accessibility and safety audits focus on specific vulnerabilities. Cost-benefit analysis evaluates economic impacts relative to the benefits observed by each group.

We integrate and report our findings comprehensively to inform policy recommendations and future urban planning efforts. Our multidimensional impact reports highlight differential impacts on each group. We present findings to stakeholders through workshops to validate and refine our conclusions, and we develop policy briefs summarizing key findings and providing actionable recommendations for policymakers.

At the project level, we focus on specific interventions and their immediate impacts on defined groups. We implement localized data collection methods such as neighbourhood surveys, focus groups, and targeted observational studies, along with detailed case studies. At the city level, we aggregate data from multiple projects to identify city-wide trends and patterns. We use city-wide surveys and sensor networks to collect broader data and employ GIS mapping and machine learning techniques to analyse large datasets and identify systemic issues.

By applying these strategies at both the project and city levels, we ensure that the needs of all population groups are met and that the benefits of interventions are equitably distributed.

7 Utilization of Indicators for Urban Planning

In modern urban planning, integrating KPIs and collected data is important for developing data-driven approaches. This ensures interventions are effective, sustainable, and aligned with the needs of diverse urban populations. KPIs serve as quantifiable metrics to measure the success and impact of urban interventions, track progress, identify areas for improvement, and ensure accountability.

We will establish clear KPIs to set measurable goals and objectives that align with broader urban development policies and sustainability targets. For road safety, KPIs like the number of traffic incidents, pedestrian and cyclist safety indices, and response times will provide critical insights. For social inclusiveness and accessibility, KPIs will include the accessibility rating of public spaces, community satisfaction levels, and the number of inclusivity initiatives implemented.

The process starts with comprehensive data collection from various sources, including sensors, traffic cameras, IoT devices, surveys, interviews, and focus groups. We will use big data analytics and AI to process and analyse large datasets, identifying patterns and trends. Advanced analytical techniques like machine learning algorithms and GIS mapping will help visualize data spatially and temporally, revealing high-risk areas for traffic incidents and peak congestion times.

Insights from KPIs and data analysis will inform urban planning decisions. We will prioritize interventions based on evidence, ensuring resources are allocated where they will have the greatest impact. Data-driven decision-making promotes transparency and accountability, as publicly sharing KPI data and planning rationales builds trust with residents and stakeholders.

Urban planning is iterative, benefiting from continuous monitoring and evaluation. KPIs provide a framework for ongoing assessment, allowing us to measure intervention effectiveness over time. Regular data collection and analysis enable real-time adjustments to strategies and interventions. For example, a new cycling lane will be monitored using KPIs like the number of cyclists, cycling accidents, and user satisfaction. If underutilized or associated with accidents, we will investigate and make necessary improvements.

Integrating KPIs and data enhances policy-making processes. Policymakers can develop targeted policies based on data-driven insights, setting realistic targets, monitoring progress, and adjusting as needed. This dynamic approach ensures urban policies remain relevant and effective.

Utilizing KPIs and data fosters collaboration among government agencies, community organizations, businesses, and residents. Involving stakeholders in data collection and analysis ensures diverse perspectives are considered. Publicly accessible data platforms and dashboards will facilitate stakeholder engagement, providing real-time access to KPI data and enabling contributions to the planning process.

8 Expectations for recommendations

8.1 Expectations for recommendations about the Key Findings from the Impact Assessment

In the final reporting, we anticipate providing a comprehensive synthesis of the key findings from the impact assessments conducted throughout the project. This synthesis will highlight the main outcomes, focusing on both successes and areas that require improvement.

The key findings are expected to showcase the effectiveness of various interventions across different thematic areas, such as road safety, social inclusiveness, and accessibility. By systematically evaluating the impact of these interventions, we will identify best practices and successful strategies that have led to measurable improvements in urban environments. For example, we expect to highlight successful road safety measures that have significantly reduced traffic accidents and near-miss incidents, demonstrating the value of targeted interventions and advanced analytics in enhancing urban safety.

Additionally, the findings will underscore the importance of stakeholder engagement and community involvement in the success of urban interventions. The synthesis will reflect on how inclusive planning processes, which actively involve residents and local organizations, contribute to more effective and widely accepted urban solutions. This aspect of the findings will be necessary in emphasizing the need for collaborative approaches in urban planning.

However, the impact assessment is also likely to reveal areas where improvements are needed. These may include challenges related to data collection and integration, the scalability of certain interventions, and the adaptability of solutions across different urban contexts. By identifying these areas, the conclusions chapter will provide a balanced view of the project's outcomes, acknowledging both achievements and the need for ongoing refinement and innovation.

Overall, the synthesis of key findings will serve as a valuable resource for future urban planning efforts, offering evidence-based insights that can guide the design and implementation of effective urban interventions.

8.2 Expectations for recommendations about the Recommendations for Policy Makers and Cities

Based on the project's findings, we expect to provide actionable recommendations for policy makers and city planners. These recommendations will be grounded in the evidence and insights generated from the comprehensive impact assessments conducted throughout the project.

The recommendations will focus on several critical areas, such as the following:

- **Adoption of Data-Driven Approaches:** Policy makers and city planners will be encouraged to integrate data-driven approaches into their urban planning processes. This includes leveraging big data, advanced analytics, and AI to inform decision-making and monitor the impact of interventions in real-time. The recommendations will highlight the importance of establishing robust data collection and analysis frameworks to ensure accurate and timely insights.
- **Prioritizing Inclusive Planning:** Emphasising the need for inclusive planning processes, the recommendations will advocate for the active involvement of diverse community members, including marginalized groups, in urban planning. Policy makers will be advised to implement strategies that ensure broad-based participation, fostering a sense of ownership and support for urban interventions.
- **Scaling Successful Interventions:** Drawing from the project's successful interventions, the recommendations will provide guidance on how to scale these solutions to other urban contexts. This will include practical advice on adapting interventions to different city environments, ensuring they are both effective and sustainable.
- **Enhancing Collaboration and Partnerships:** The recommendations will underscore the importance of fostering collaboration among various stakeholders, including government agencies, private sector partners, and community organizations. Policy makers will be encouraged to build strong partnerships that leverage the strengths and expertise of different actors in the urban ecosystem.
- **Addressing Data Privacy and Security:** Recognizing the critical importance of data privacy and security, the recommendations will outline best practices for safeguarding sensitive information according to the data privacy policy of the project, as outlined in D1.3. Policy makers will be advised to implement robust data governance frameworks that protect individual privacy while enabling the effective use of data for urban planning.
- **Continuous Monitoring and Evaluation:** To ensure the long-term success of urban interventions, the recommendations will stress the need for continuous monitoring and evaluation. Policy makers will be guided on establishing mechanisms for regular assessment of intervention impacts, enabling ongoing adjustments and improvements.

By providing relevant and actionable recommendations, the conclusions chapter will aim to equip policy makers and city planners with the tools and insights needed to create more liveable, resilient, and inclusive urban environments. The recommendations will be designed to be practical and implementable, drawing directly from the project's findings to ensure they are both relevant and impactful.

9 Conclusions

The impact assessment framework outlined in this deliverable highlights the dynamic nature of measures and indicators, which are intrinsically linked to the specific interventions and their implementation processes. The structured evaluation methods, combined with advanced data collection and AI integration, provide a robust mechanism for continuous improvement and data-driven decision-making in urban planning. The multi-level perspective captures direct, indirect, and diffuse impacts, facilitating a comprehensive understanding of intervention effects across different layers of urban systems.

This framework is set on four corner dimensions of the road safety system, social inclusiveness, environment and transformative governance. It establishes indicators to measure the direct, indirect and potentially diffuse effects of the interventions at the micro (project) and macro (pilot) level. Some of the indicators will be commonly assessed across pilots, while others are more specific. Thus, it not only ensures that the interventions are effective in achieving their technical objectives but also resonate with the community, contributing to overall social well-being. By integrating subjective views with quantitative data, the assessment provides a holistic view of the interventions' impacts, ensuring inclusivity and relevance.

Table 32 provides a concise overview of the key outcomes of Deliverable D5.1 considering also the inception report, which is considered an integral part of the framework.

Table 32. Key outcomes of D5.1

Outcome	Description
Development of the Evaluation Framework	Established a comprehensive methodology for evaluating the impacts of the REALLOCATE project's interventions.
Definition of Key Performance Indicators (KPIs)	Identified relevant KPIs to assess the effectiveness of urban mobility interventions. Developed indicators to measure impacts on various aspects.
Identification of Common Indicators per Thematic Cluster	Created a set of common indicators for micro-level assessment across thematic clusters. Ensured consistency and comparability in data collection.
Impact Assessment Framework and Indicators per Area	Defined the impact assessment framework and specific indicators for areas like climate targets, social inclusiveness, accessibility, and road safety.

Outcome	Description
Identification of City Indicators (Macro Level)	Identified city-specific indicators for macro-level assessment. Aligned these indicators with broader municipal strategies and urban development plans.
Preliminary Identification of Baseline and Target Values	Provided baseline data and target values for various KPIs in the inception report. Ensured that initial benchmarks are set for measuring progress.
Definition of Data Characteristics	Detailed data descriptions, types, formats, and units for effective data collection and analysis. Established protocols for ensuring data quality.

Future steps involve refining the evaluation framework, the addressed KPIs, identifying and sketching the data paths per indicators, select the analyses techniques and models on macro- and micro-level, ensuring scalability and replicability (if needed in D5.2 and D5.3 and the subsequent inception reports).

Further, the KPIs and collected data will inform urban planning and policy-making, promoting sustainability, safety, and inclusiveness in urban environments. The key findings from the impact assessment will guide future recommendations for policymakers and city planners, fostering more liveable, resilient, and inclusive cities.

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Annexes

Annex A: Data Collection Instruments

Table 33 provides a comprehensive overview of the instruments and tools utilized across different city pilots, detailing their specific uses, the related actions or interventions they support, and the horizontal partners involved, not necessarily providing the technologies, in each pilot and/or action. The last column is empty if the tool is implemented by the SSML.

Table 33. Data collection tools, actions, and potential HP involvement and support

City	Pilot	Instrument/Tool	Use	Related Action/Intervention	Horizontal Partners Involved
Barcelona	**Pilot 1**	Pedestrian Counting Sensors	Measure pedestrian traffic flow	Data collection and analysis	ECF
		Cyclist Counters	Measure cyclist traffic flow	Data collection and analysis	ECF
		Safety Audits	Evaluate safety measures	Safety auditing	IFP, Factual
		Traffic Counting	Measure traffic volume	Traffic counting	DEKRA
		Spatial Analysis Tools	Evaluate spatial usage	Spatial analysis	CEREMA
	Pilot 2	Survey Tools	Collect feedback from disabled individuals	Analysis of current service, Stakeholder participation process	UCD, IFP
		Descriptive Mapping Tools	Analyse and visualize transportation models	Development of descriptive map, Benchmarking of best practices	
		Qualitative Analysis Tools	Evaluate shared journey schemes	Definition of shared journey scheme, Feasibility test & implementation	UCD
		Conflict Resolution Interventions	Address pedestrian-cyclist conflicts	Temporary measures, road signage, design solutions	ECF
Gothenburg	**Pilot 1**	AHA Analysis Tools	Analyse human approach to mobility	Fieldwork and engagement	
		Workshop Facilitation Tools	Conduct co-creation workshops	Workshops and engagement	UCD, Nudgd
		Safety System Analysis Tools	Test and evaluate new	Suggest and test mobility solutions	CEREMA

City	Pilot	Instrument/Tool	Use	Related Action/Intervention	Horizontal Partners Involved
			mobility solutions		
	Pilot 2	Digital Twin	Visualize and simulate temporary traffic arrangements	Digitize the city's temporary traffic design process	BSC, CERTH
		Mobility Service Platforms	Provide visitor mobility solutions	Mobility services for visitors	ERTICO
		Co-Creation Tools	Engage citizens in urban design	Co-creation with citizens	UCD
		Traffic Pattern Analysis Tools	Analyse historical traffic patterns	Analysis of traffic patterns and safety	DEKRA, CERTH
Heidelberg	**Pilot 1**	Survey Tools	Understand mobility needs and challenges	Workshops and co-creation	UCD, Fraunhofer
		Planning and Analysis Tools	Improve public transport access	Public transport service level improvements, Expansion and creation of hubs	CERTH
	Pilot 2	Environmental Data Collection	Measure environmental parameters	Contracting environmental data calculation	Fraunhofer
		Stakeholder Engagement Tools	Involve citizens in urban design	Stakeholder involvement and design discussion	DEMOS
Lyon	**Pilot 1**	Traffic Cameras	Monitor traffic speeds in school zones	Quantitative data collection and analysis	
		Air Quality Monitoring Stations	Measure air quality parameters	Quantitative data collection and analysis	
		Survey Tools	Collect user feedback	Subjective data collection and analysis	UCD, Nudgd
	Pilot 2	AI Technology	Identify traffic safety hazards	Deployment of AI technology	CERTH
		Digital Twin	Simulate user interactions	Usage of digital twin system	
		Descriptive Mapping Tools	Analyse transportation models	Descriptive mapping and benchmarking	CERTH, BSC
		LiDAR Sidewalk Scanners	Assess sidewalk quality	Sidewalk quality assessment	IFP
Budapest	**Pilot 1**	Mobile Measuring Equipment	Measure traffic and pollution levels	Placement of measurement equipment	

City	Pilot	Instrument/Tool	Use	Related Action/Intervention	Horizontal Partners Involved
		Smart Camera Devices	Monitor traffic and identify conflict points	AI based traffic modelling and measurements	CERTH
		Survey Tools	Understand perceptions of residents and users	Baseline & data collection	UCD
		Microsimulation Tools	Simulate traffic scenarios	Microsimulation of intersection	BSC
	Pilot 2	Traffic Management Tools	Analyse traffic flow and emissions	Baseline & data collection	CERTH
		Stakeholder Engagement Tools	Collaborate with stakeholders	Stakeholder engagement & co-creation	UCD
		Environmental Monitoring Tools	Measure air and noise pollution	Implementation of measures	DEKRA
Warsaw	**Pilot**	Road Safety Assessment Tools	Assess road safety levels and pedestrian crossings	Area selection & data collection	DEKRA
		Citizen Science Engagement Tools	Engage citizens in data collection and area audits	Citizen Science Engagement	UCD, Nudgd, IFP
		Survey Tools	Monitor children's traffic behaviour	Children’s Traffic Behaviour Survey and Monitoring	UCD
		2D and 3D Visualization Tools	Visualize local land use and safety measures	Co-Development of Safety Measures	ARUP
		Traffic Measurement Tools	Measure traffic patterns	Analysis of Local Land Uses	
		Climate Adaptation Tools	Implement climate adaptation measures	Implementation & monitoring of measures	EFD
		Local Land Use Analysis Tools	Analyse local land uses	Increase biological areas	
Zagreb	**Pilot**	Traffic Volume Counts	Count traffic volumes	Peak hour investigation	CERTH
		Smart Traffic Lights	Adapt traffic signals based on real-time data	Smart traffic lights and mobility solutions	
		Microsimulation Tools	Simulate traffic scenarios	Microsimulation of intersection	BSC
		Urban Redesign Tools	Redesign sidewalks, crossings, and intersections	Urban redesign solutions	ARUP, CEREMA, IFP

City	Pilot	Instrument/Tool	Use	Related Action/Intervention	Horizontal Partners Involved
		Stakeholder Engagement Tools	Engage the public in planning	Public engagement	UCD, Nudgd
		Public Engagement Tools	Engage public in planning	Input from residents, businesses, road users	UCD, Nudgd
Tampere	**Pilot**	AI Cameras	Identify near misses and safety hazards	Installation of AI-Cameras and Algorithm Testing	UCD, EFD
		Traffic Pattern Analysis Tools	Analyse historical traffic patterns	Hazardous Spot Identification	CERTH, BSC, DEKRA
		Citizen Engagement Tools	Engage citizens in planning safe environments	Citizen Engagement	UCD
		Visualization Tools (e.g., VR)	Visualize road space reallocation	Road Space Reallocation	ARUP
		Smart Technology Tools	Analyze hazardous spots	Implementation of AI algorithms	CERTH, DEKRA
Utrecht	**Pilot**	GoPro Recording Devices	Record children's bike rides	Observations utilizing GoPro recordings	
		3D Simulation Tools	Simulate cyclist and e-scooter behavior	Customization of the uCrowds/ SimCrowds 3D application	
		VR Technology	Involve children in design process	Participation and design	BSC
		Survey Tools	Conduct surveys with parents and children	Setting the base	UCD, Nudgd, IFP, ECF
		Traffic Data Collection Tools	Collect data on traffic flows, speeds, and pollution	Add extra data	CERTH
		Co-Design Workshops	Facilitate participation and design	Workshops with parents, children	UCD
		Digital Twin Tools	Simulate large-scale interventions	Digital large-scale interventions in DT	ARUP, BSC
Bologna	**Pilot**	Workshop Facilitation Tools	Conduct co-creation sessions	Co-creation and stakeholder engagement	UCD
		Awareness Campaign Tools	Promote sustainable commuting	Behavioural and Choice Design Interventions	Nudgd

City	Pilot	Instrument/Tool	Use	Related Action/Intervention	Horizontal Partners Involved
		Mobility Infrastructure Tools	Create dedicated lanes and paths	Active Mobility Infrastructure Deployment	IDP, ECF, ERTICO
		Safety Auditing Tools	Implement safety design features	Customized Safety Auditing Procedures	DEKRA
		Community Engagement Tools	Involve local community in decision-making	Community Engagement Programs	UCD
		Behavioural Design Tools	Implement choice design interventions	Nudging for sustainable commuting	Nudgd, UCD

The SSML data tables provided below (Table 34 - Table 43) provide structured insights of major indicators into each city's pilot interventions, detailing baseline data collection, intervention actions, and post-intervention impact assessment methodologies and act as an elaboration of Table 16 in section 4.1. Each pilot follows a before-after impact assessment model, ensuring that pre-intervention conditions are well documented to measure the effectiveness of urban mobility, safety, and sustainability measures. Key baseline actions include stakeholder engagement, traffic flow and safety analysis, digital tool integration, and infrastructure assessments. Baseline data sources vary per pilot, incorporating surveys, data tracking, traffic cameras, air quality monitoring, and AI-based mobility assessments. The interventions range from traffic calming measures, digital twin-based urban planning, pedestrianization efforts, and public transport improvements. The expected post-intervention outcomes aim to improve traffic efficiency, increase active transport adoption, and enhance safety for VRUs. Each pilot defines targets and corresponding indicators, such as increased public transport ridership, improved air quality, congestion reduction, and safety perception improvements among VRUs.

The **Gothenburg** pilots (Table 34); the **Peri-Urban Mobility & Safety** pilot focuses on promoting active mobility, improving school and sports club transportation, and enhancing road safety while reducing greenhouse gas emissions through increased sustainable transport use. The **Traffic Management at Korsvägen** pilot aims to optimize pedestrian movement and traffic flow in a major urban node by utilizing digital twin-based traffic modelling and real-time monitoring to enhance pedestrian safety and accessibility. The data collection plan for these pilots follows a structured methodology, beginning with pre-implementation baseline studies, followed by continuous monitoring during the implementation phase, and concluding with post-implementation evaluation to assess the effectiveness of the measures. Household and school travel surveys will be conducted to capture behavioural shifts in mobility, particularly among students and sports club attendees. GPS tracking and pedestrian volume monitoring will provide real-time data on modal shifts and pedestrian movement patterns. AI-powered traffic analysis and digital twin simulations will be used to model traffic flow and evaluate pedestrian safety improvements, while environmental monitoring through greenhouse gas emission modelling and air quality sensors will assess the impact of mobility changes on sustainability. Additionally, stakeholder engagement surveys, public perception studies, and records from co-creation workshops will be analysed to gauge public acceptance and participation in the interventions. The evaluation process is structured into three phases: baseline data collection, conducted six to twelve months before implementation to establish initial mobility patterns, safety concerns, and environmental conditions; ongoing monitoring, using AI-based tools and periodic surveys to track real-time changes throughout implementation; and post-implementation evaluation, occurring three to twelve months after implementation to determine the overall impact and effectiveness of the interventions by comparing KPIs against baseline data. Given Gothenburg's focus on sustainable urban mobility and data-driven policymaking, the methodologies employed ensure high replicability potential, allowing other cities to adapt and scale these interventions based on evidence-backed results. As such, Table 34 provides a structured overview of the KPIs, data sources, replicability potential, and expected outcomes.

The **Heidelberg pilots** (Table 35) are structured around **Regional Sustainable Mobility Planning** and **Public Space Reallocation & Active Mobility**, both aimed at improving environmental sustainability, multimodal transport, and urban space utilization. The data collection plan is methodically designed to capture pre- and post-intervention trends, utilizing a combination of AI-driven monitoring, GIS-based mapping, real-time transport analytics, and citizen feedback surveys. By integrating both quantitative metrics, such as transport ridership and emissions modelling, with qualitative insights, such as public perception and accessibility feedback, the pilots ensure a comprehensive evaluation of their impact. The results will support evidence-based decision-making, enabling adaptive urban mobility planning and replicability in other urban settings.

The **Lyon pilots** (Table 36) focus on two key urban strategies: **Parking Policy & Emission Management** and **Active Mobility & Public Realm Enhancement**. The first pilot aims to optimize urban parking policies using AI-driven decision-making while reducing emissions through targeted interventions. The second pilot enhances pedestrian and cyclist accessibility by reallocating public space, implementing green corridors, and introducing traffic-calming measures. The data collection process involves continuous environmental monitoring, mobility behaviour analysis, stakeholder surveys, and geospatial tracking to evaluate the effectiveness and replicability of the interventions.

The **Barcelona pilots** (Table 37) focus on two core urban mobility challenges. The first pilot, **Pedestrians, Cyclists & MMV in Shared Spaces**, aims to reduce conflicts and enhance safety in areas where multiple modes of transport interact. This is achieved through participatory workshops, infrastructure improvements, and enhanced community engagement. Data collection involves surveys, observational data, and municipal records to track safety perception, public acceptance, and reductions in conflicts.

The second pilot, **Increased & Integrated Public Transport Accessibility**, seeks to improve accessibility for individuals with reduced mobility by optimizing Demand-Responsive Transport (DRT) services, improving infrastructure, and fostering collaboration among key stakeholders. Data collection focuses on user satisfaction surveys and operational data to measure improvements in service efficiency and public perception of accessibility enhancements.

A structured methodology supports data collection in both pilots. Conflict and safety monitoring relies on surveys, accident reports, and observational studies to track changes in safety perceptions and the number of incidents. Public perception and user experience analysis involves participatory workshops, surveys, and feedback forms to assess acceptance and engagement. Transport efficiency and accessibility assessments use operational data, accessibility audits, and cooperation tracking to evaluate service improvements. This robust approach ensures reliable data collection and supports the replicability of mobility interventions in other urban areas.

The **Tampere pilot** (Table 38) is designed to promote active mobility, improve public spaces, enhance security, and increase accessibility through targeted interventions. These measures focus on reallocating public space, improving infrastructure for pedestrians and cyclists, and integrating AI-driven safety monitoring to create safer and more accessible urban environments.

The KPI table (Table 38) includes a comprehensive set of indicators covering various aspects, such as mobility mode share, safety perception, environmental enhancements, and public acceptance. Each KPI is linked to specific data sources and follows a structured data collection process to ensure accuracy and reliability. Target values have been set conservatively, striking a balance between ambition and feasibility to reflect realistic expectations while encouraging progress.

The data collection methodology employs a multi-faceted approach, combining survey-based evaluations, traffic monitoring, participation records, urban planning assessments, and AI-powered safety analysis. A before-during-after evaluation framework is followed, ensuring that data is collected before implementation, at two progress milestones, and after the intervention is completed. Surveys will be conducted periodically to capture citizen and stakeholder feedback, focusing on public perception, satisfaction levels, and mobility behavior. Traffic and safety monitoring will utilize AI-based camera analytics, sensor-based tracking, and municipal safety reports to measure near-miss incidents, safety violations, and active mobility mode share. Urban planning data will be assessed through GIS mapping, participatory audits, and infrastructure records to track changes in public space utilization, accessibility enhancements, and green space allocation. Additionally, stakeholder engagement will be monitored through participation records and qualitative assessments, capturing the level of involvement from local authorities, schools, businesses, and residents.

Each KPI is evaluated based on its replicability potential, ensuring that successful interventions can be scaled or adapted in other cities. By integrating diverse data sources and structured evaluation methods, the pilot provides a robust framework for assessing the impact of urban mobility interventions and guiding future policy decisions.

The **Budapest pilot** (Table 39) focuses on improving urban mobility through targeted interventions in traffic safety, cycling infrastructure, and space reallocation. The primary goal is to enhance accessibility, reduce congestion, and ensure safety for vulnerable road users. Key interventions include AI-based traffic modeling, improved pedestrian infrastructure, and smart mobility solutions. The city aims to achieve a significant reduction in traffic-related injuries, an increase in active mobility, and a more efficient road space allocation.

The data collection methodology in Budapest combines automated traffic monitoring systems, environmental sensors, and user perception surveys. Baseline data is gathered through a combination of pre-existing traffic monitoring cameras, mobile sensors, and public engagement initiatives. AI-powered analysis tools identify high-risk areas, and environmental sensors measure noise and air pollution levels before and after interventions. Additionally, behavioural audits and perception surveys provide qualitative insights into the effectiveness of the measures implemented. The collected data informs adjustments and refinements to urban mobility policies, ensuring a continuous evaluation cycle.

Utrecht's pilot (Table 40) is designed to enhance traffic safety, promote active mobility, and improve environmental conditions in school neighbourhoods. The pilot focuses on Kanaleneiland and Overvecht, two districts characterized by high car dependency and lower socio-economic status, where traffic safety perceptions are a significant concern. To comprehensively evaluate the impact of interventions, the data collection methodology follows a structured pre- and post-intervention analysis.

The baseline data collection phase involves a combination of surveys and observational studies. Surveys with parents, school staff, and residents assess safety perceptions and mobility habits, while school walks help map unsafe spots, traffic conditions, and illegal parking hotspots. A cooperative mapping exercise identifies hazards and missing infrastructure such as zebra crossings and speed mitigation measures. In parallel, air quality and noise pollution monitoring is carried out using environmental sensors placed around school areas, and traffic speed and flow analysis establishes a reference point for evaluating post-intervention outcomes. The implementation and monitoring phase introduces temporary interventions such as school zones, street redesigns, and traffic calming measures to improve safety. The pilot also leverages digital simulation tools, including Minecraft and interactive mapping, to actively engage students in the urban co-design process. Additionally, behavioural assessments track modal shifts and compliance with new safety regulations.

During the post-implementation evaluation phase, from January to June 2025, a comparative analysis of pre- and post-intervention data measures the effectiveness of the safety measures introduced. Follow-up surveys and focus groups with parents, children, and school staff provide qualitative insights into behavioural changes and user satisfaction. AI-based tools support traffic behaviour monitoring, capturing shifts in vehicle speeds, pedestrian activity, and cycling rates. Moreover, environmental impact assessments evaluate improvements in air and noise pollution levels following the interventions.

This data-driven approach ensures informed decision-making while fostering strong stakeholder engagement. Schools, parents, local businesses, and urban mobility experts actively contribute to shaping the interventions, maximizing their long-term impact and replicability across similar urban settings.

The **Warsaw pilot** (Table 41) is designed to enhance pedestrian safety, reallocate public space, and encourage active mobility, particularly around schools. Through a data-driven approach, the initiative seeks to reduce traffic hazards, improve accessibility, and mitigate environmental impacts. To ensure a comprehensive assessment of mobility interventions, data collection is structured into three phases: baseline data collection, implementation and monitoring, and post-implementation evaluation.

The baseline data collection phase focuses on gathering essential data to establish reference points for later assessments. Traffic safety audits analyze pedestrian crossings, road infrastructure, and hazardous zones, while mobility behaviour surveys target schoolchildren, parents, and local residents to understand travel patterns and safety concerns. Environmental monitoring includes the installation of air and noise pollution sensors near school zones, providing insights into the existing conditions. Additionally, traffic data analysis assesses speed compliance, vehicle flow, and congestion levels to identify areas requiring intervention.

During the implementation and monitoring phase various traffic-calming measures are introduced, including school streets, speed limit reductions, and improved pedestrian crossings. Stakeholder engagement plays a key role in this stage, with public workshops, co-design sessions, and digital mapping exercises facilitating community participation. Behavioral assessments are also conducted, using observational studies to evaluate compliance with new safety regulations and infrastructure changes.

The post-implementation evaluation phase measures the effectiveness of the interventions through a comparative analysis of pre- and post-intervention data. This includes assessing road safety improvements, shifts in mobility patterns, and environmental quality changes. Public perception is also evaluated through follow-up surveys and focus groups with parents, children, and school staff. Advanced AI-based tools are used to monitor traffic behavior, measuring modal shifts, pedestrian movement, and changes in travel behaviour.

This structured, evidence-based approach ensures that the interventions in Warsaw contribute to long-term urban mobility planning. By incorporating stakeholder feedback and real-world data, the initiative not only enhances local road safety but also provides a replicable model for similar interventions in other cities.

The **Zagreb pilot** (Table 42) is focused on improving traffic safety, enhancing pedestrian and cyclist accessibility, and optimizing urban mobility through data-driven interventions at the intersection of Selska and Horvaćanska Street. This densely populated area experiences high traffic volumes and significant interaction between VRUs, including pedestrians, cyclists, children, elderly individuals, and people with disabilities. The SSML aims to reduce public transport (PT) and VRU delays, reallocate space to encourage active mobility, improve intersection design, and integrate greening solutions to contribute to greenhouse gas reductions by 2030.

The data collection methodology follows a structured three-phase approach to assess the impact of interventions comprehensively.

During the Baseline Data Collection phase key traffic parameters are recorded, including peak-hour vehicle counts, pedestrian and cyclist movements, and public transport efficiency. A microsimulation of the intersection is developed, integrating data from AI-assisted UAV video analysis to understand congestion points, modal splits, and safety risks. Additionally, surveys are conducted with local residents and commuters to gauge perceptions of traffic safety and mobility challenges.

The Implementation and Monitoring Phase includes the installation of adaptive traffic signals, intersection redesign measures, new bike lanes, and pedestrian safety enhancements such as raised crossings and accessibility improvements. Urban greening is integrated into the area to enhance environmental benefits and reduce heat islands. Smart cameras and AI-driven analytics monitor real-time vehicle speeds, PT priority measures, and intersection flow, ensuring dynamic adjustments to optimize safety and efficiency. Public engagement activities, including workshops and walking audits, facilitate community feedback and co-creation of solutions.

The Post-Implementation Evaluation focuses on assessing the effectiveness of the interventions. Comparative analysis of pre- and post-intervention data provides insights into safety improvements, pedestrian and cyclist behavior changes, and intersection efficiency. Surveys and focus groups with residents, commuters, and city planners assess user satisfaction and identify areas for further optimization. AI-driven analytics continue to track traffic flow, VRU interaction, and PT prioritisation to refine the approach.

The **Bologna pilot** (Table 43) is dedicated to enhancing the safety and accessibility of school areas by promoting sustainable and autonomous home-school mobility. The initiative focuses on redesigning school surroundings to improve access for bicycles and pedestrians, thereby reducing reliance on private carbon-fueled vehicles. This aligns with Bologna’s Climate City Contract, which aims for an 80% reduction in traffic emissions by 2030. The data collection methodology follows a structured pre- and post-intervention analysis, ensuring a comprehensive evaluation of the impact on mobility patterns, safety, and environmental conditions.

The baseline data collection phase includes surveys and co-creation workshops to engage students, parents, and local stakeholders in identifying mobility challenges. Additionally, traffic and pedestrian flow analysis captures vehicle speeds, pedestrian movement, and cycling uptake, while environmental monitoring measures air quality and noise pollution to establish baseline conditions. During the implementation and monitoring phase public space redesign efforts focus on constructing the Gobetti school square along the Knowledge Path (Via della Conoscenza). This period also includes traffic calming measures such as widened sidewalks, dedicated bike lanes, and the creation of green spaces, complemented by stakeholder engagement initiatives, including awareness campaigns and co-design sessions with citizens.

Following the intervention, the post-implementation evaluation phase will compare pre- and post-intervention data to assess changes in mobility behavior and public perception. Public satisfaction and safety perception surveys will further evaluate the effectiveness of interventions, while a long-term sustainability and replicability analysis will determine the potential for scaling these measures to other school districts.

This structured methodology ensures an evidence-based approach to evaluating interventions in SSMLs, offering valuable insights into urban mobility improvements, road safety enhancements, and community engagement strategies.

Table 34. Gothenburg SSML Data for Indicators

Pilot	KPI Category	Data Collection Duration	Data Sources	Replicability Potential	Potential Target Value
Peri-Urban Mobility & Safety	Active Mobility Mode Share	6 months before, 12 months after	Household travel surveys, GPS tracking data from school routes, walk audits	High	Increase by 10%
Peri-Urban Mobility & Safety	Number of Participants in Co-Creation Workshops	6 months before, 12 months after	Attendance records, event participation lists	High	Increase participant engagement by 15%
Peri-Urban Mobility & Safety	Road Safety	6 months before, 12 months after	Accident reports, police records, near-miss analysis	High	Reduce accidents by 15%
Peri-Urban Mobility & Safety	Active Travel	6 months before, 12 months after	User-reported travel behavior, school mobility surveys	High	Increase active travel rates by 12%
Peri-Urban Mobility & Safety	School and Sports Club Mobility	6 months before, 12 months after	School and sports club surveys, GPS data from participating users	High	Increase sustainable mobility participation by 10%
Traffic Management at Korsvägen	Active Mobility Mode Share	3 months before & after	Pedestrian volume tracking, modal shift analysis	Medium	Increase walking and cycling by 8%
Traffic Management at Korsvägen	Number of Participants in Co-Creation Workshops	3 months before & after	Attendance records, feedback forms	Medium	Increase participation rates by 15%
Traffic Management at Korsvägen	Traffic Flow	3 months before & after	AI-based traffic monitoring, real-time flow sensors	Medium	Reduce congestion by 10%

Pilot	KPI Category	Data Collection Duration	Data Sources	Replicability Potential	Potential Target Value
Traffic Management at Korsvägen	Pedestrian Safety	3 months before & after	Pedestrian volume tracking, chatbot-based feedback	Medium	Reduce pedestrian near-misses by 12%
Traffic Management at Korsvägen	Digital Twin-based Traffic Modelling	3 months before & after	Simulation modelling, real-world calibration data	Medium	Improve pedestrian crossing times by 7%
Peri-Urban Mobility & Safety	Greenhouse Gas Emissions (GHG)	6 months before, 12 months after	Emission modelling, air quality monitoring	High	Reduce GHG emissions by 10%
Traffic Management at Korsvägen	VRUs' Perception of Safety	3 months before & after	Resident and visitor perception surveys	High	Increase perceived safety by 10%
Traffic Management at Korsvägen	Public Acceptance of Interventions	3 months before & after	Stakeholder interviews, online surveys	Medium	Increase support for interventions by 20%
Traffic Management at Korsvägen	Feasibility for Replication	3 months before & after	Expert consultations, case study reviews	High	Achieve high feasibility rating (above 75%) in expert evaluations

Table 35. Heidelberg SSML Data with Indicators

Pilot	KPI Category	Data Collection Duration	Data Sources	Replicability Potential	Potential Target Value
Regional Sustainable Mobility Planning	Greenhouse Gas Emissions (GHG) Reduction	6 months before, 12 months after	Emission modelling, air quality monitoring	High	Reduce GHG emissions by 5%
Regional Sustainable Mobility Planning	Noise Reduction from Transport	6 months before, 12 months after	Environmental noise level measurements, AI-based traffic monitoring	Medium	Reduce noise levels by 3 dB
Regional Sustainable Mobility Planning	Public Transport Ridership	6 months before, 12 months after	Public transport operator records, modal shift surveys	High	Increase ridership by 8%
Regional Sustainable Mobility Planning	Travel Time Reduction for Regional Commuters	6 months before, 12 months after	Real-time commuter logs, traffic flow monitoring	High	Reduce travel time by 5%
Regional Sustainable Mobility Planning	Feasibility for Regional Mobility Hubs	6 months before, 12 months after	Expert consultations, stakeholder feedback, infrastructure audits	High	Completion of feasibility study
Regional Sustainable Mobility Planning	Multimodal Integration Index	6 months before, 12 months after	Infrastructure analysis, GIS-based mobility tracking	Medium	Increase integration score by 10%
Regional Sustainable Mobility Planning	Public Acceptance and Satisfaction with Transport	6 months before, 12 months after	Citizen perception surveys, stakeholder interviews	Medium	Improve satisfaction by 10%
Regional Sustainable Mobility Planning	Intermodal Transfer Efficiency	6 months before, 12 months after	Transit hub observations, connectivity surveys	Medium	Reduce transfer time by 5%
Regional Sustainable Mobility Planning	Reduction in Congestion	6 months before, 12 months after	AI-based traffic flow monitoring, commuter diaries	Medium	Reduce congestion by 5%
Regional Sustainable Mobility Planning	Digital Twin-based Traffic Modelling	6 months before, 12 months after	Real-world data integration, simulation modelling	Medium	Validation of model accuracy

Pilot	KPI Category	Data Collection Duration	Data Sources	Replicability Potential	Potential Target Value
Public Space Reallocation & Active Mobility	Active Mobility Mode Share	3 months before & after	Pedestrian volume tracking, modal shift analysis	High	Increase walking and cycling by 10%
Public Space Reallocation & Active Mobility	Increase in Pedestrian & Cyclist Numbers	3 months before & after	Manual pedestrian and cyclist counts, urban mobility audits	High	Increase by 15%
Public Space Reallocation & Active Mobility	Pedestrian and Cyclist Safety	3 months before & after	Accident reports, near-miss analysis, safety perception surveys	High	Reduce reported incidents by 10%
Public Space Reallocation & Active Mobility	VRU Perception of Safety	3 months before & after	Resident and visitor perception surveys	Medium	Improve safety perception by 15%
Public Space Reallocation & Active Mobility	Public Acceptance of Low-Traffic Areas	3 months before & after	Structured interviews, feedback sessions, surveys	Medium	Increase public approval rating by 10%
Public Space Reallocation & Active Mobility	Reduction in Noise Pollution	3 months before & after	Sound level monitoring, urban environmental assessments	Medium	Reduce noise by 2 dB
Public Space Reallocation & Active Mobility	Tactical Urbanism Interventions	3 months before & after	CAD-based intervention tracking, site inspections	Medium	Implement 3 tactical measures

Pilot	KPI Category	Data Collection Duration	Data Sources	Replicability Potential	Potential Target Value
Public Space Reallocation & Active Mobility	Drop-Off Points for Cargo-Bikes & Deliveries	3 months before & after	Observation studies, GIS mapping	Medium	Increase dedicated drop-off spots by 5
Public Space Reallocation & Active Mobility	Car Parking Reduction in Low-Traffic Areas	3 months before & after	GIS mapping, urban space reallocation tracking	Medium	Reduce parking space by 5%
Public Space Reallocation & Active Mobility	Traffic Flow Reduction in Reallocated Streets	3 months before & after	AI-based traffic monitoring, vehicle count data	Medium	Reduce vehicle flow by 7%
Public Space Reallocation & Active Mobility	Pedestrian Comfort & Accessibility	3 months before & after	Accessibility audits, perception surveys	Medium	Improve accessibility ratings by 10%
Public Space Reallocation & Active Mobility	Cycling Infrastructure Utilization	3 months before & after	GPS tracking of cyclists, infrastructure surveys	Medium	Increase cycling facility use by 10%
Public Space Reallocation & Active Mobility	Street Safety Perception	3 months before & after	Feedback collection, key user sentiment analysis	Medium	Improve perceived safety by 15%
Public Space Reallocation & Active Mobility	Public Transport Travel Time Efficiency	3 months before & after	Transit agency performance data, commuter experience surveys	Medium	Reduce travel time by 5%

Pilot	KPI Category	Data Collection Duration	Data Sources	Replicability Potential	Potential Target Value
Public Space Reallocation & Active Mobility	Public Transport Passenger Satisfaction	3 months before & after	Commuter satisfaction surveys, sentiment analysis	Medium	Improve satisfaction by 10%
Public Space Reallocation & Active Mobility	Urban Functional Diversity	3 months before & after	Land use surveys, GIS mapping, accessibility audits	Medium	Improve functional diversity index by 10%
Public Space Reallocation & Active Mobility	Public Transport Accessibility Enhancement	3 months before & after	Transit network analysis, accessibility mapping	Medium	Increase accessibility coverage by 5%

Table 36. Lyon SSML Data with Indicators

Pilot Name	KPI Category	Data Collection Duration	Data Sources	Replicability Potential	Potential Target Value
Parking Policy & Emission Management	Air Pollutant Emissions Reduction	6 months before, 12 months after	Air quality monitoring stations, vehicle emissions data	High	Reduce PM10 by 10%
Parking Policy & Emission Management	Greenhouse Gas Emissions Reduction	6 months before, 12 months after	Emission inventories, vehicle fleet data	High	Reduce CO2 emissions by 15%
Parking Policy & Emission Management	Reduction in Traffic Incidents	6 months before, 12 months after	Police reports, AI-based traffic monitoring	Medium	Reduce incidents by 10%
Parking Policy & Emission Management	Parking Policy Efficiency	6 months before, 12 months after	Parking policy assessments, emission analysis	Medium	Improve efficiency by 20%
Parking Policy & Emission Management	Digital Twin Simulation Accuracy	6 months before, 12 months after	Digital twin model validation, traffic pattern analysis	High	Model accuracy above 85%

Pilot Name	KPI Category	Data Collection Duration	Data Sources	Replicability Potential	Potential Target Value
Active Mobility & Public Realm Enhancement	Active Mobility Infrastructure Quality	3 months before & after	Field assessments, GIS-based tracking	High	Improve infrastructure rating by 10%
Active Mobility & Public Realm Enhancement	Active Mobility Usage	3 months before & after	Pedestrian and cyclist counters, mobility surveys	High	Increase usage by 20%
Active Mobility & Public Realm Enhancement	Traffic Calming Effectiveness	3 months before & after	Speed cameras, traffic flow measurements	Medium	Reduce speeds by 10%
Active Mobility & Public Realm Enhancement	Parking Conversion to Bike-Sharing Docks	3 months before & after	GIS mapping, urban space monitoring	Medium	Convert 20 parking spaces
Active Mobility & Public Realm Enhancement	User Satisfaction with Active Mobility	3 months before & after	User perception surveys, feedback reports	Medium	Improve satisfaction rating by 15%
Parking Policy & Emission Management	Traffic Safety Hazard Reduction	6 months before & after	AI-based hazard detection, safety audits	High	Reduce hazards by 15%
Parking Policy & Emission Management	Real-Time Warning Effectiveness	6 months before & after	VRU response logs, real-time monitoring	Medium	85% compliance with warnings
Parking Policy & Emission Management	Parking Policy Impact on Safety	6 months before & after	Incident reports, road safety audits	Medium	Reduce safety incidents by 10%
Parking Policy & Emission Management	Perceived Safety Improvements	6 months before & after	Resident and pedestrian surveys	Medium	Improve perception score by 10%
Active Mobility & Public Realm Enhancement	Public Space Utilization	3 months before & after	Land-use surveys, GIS analysis	High	Increase utilization by 10%
Active Mobility & Public Realm Enhancement	Green Area Expansion	3 months before & after	Satellite imagery, environmental monitoring	High	Expand green spaces by 5%

Pilot Name	KPI Category	Data Collection Duration	Data Sources	Replicability Potential	Potential Target Value
Active Mobility & Public Realm Enhancement	Car-Free Zone Area	3 months before & after	Traffic restriction mapping, pedestrian zone tracking	High	Expand car-free zones by 10%
Active Mobility & Public Realm Enhancement	Pedestrian and Cyclist Count	3 months before & after	Automated and manual pedestrian counters	High	Increase count by 15%
Parking Policy & Emission Management	Public Acceptance Index	3 months before & after	Stakeholder feedback, survey analysis	Medium	Achieve 75% public acceptance
Parking Policy & Emission Management	Replicability Potential	3 months before & after	Feasibility assessments, expert reviews	High	85% replicability rating
Parking Policy & Emission Management	Emission Reduction Percentage	6 months before & after	Emission monitoring stations, vehicle compliance checks	High	Reduce emissions by 12%
Parking Policy & Emission Management	Mode Shift Percentage	6 months before & after	Public transport ridership data, modal share analysis	High	Increase sustainable modes by 10%
Parking Policy & Emission Management	Compliance Rate with Policy	6 months before & after	Parking compliance logs, enforcement reports	Medium	Achieve 90% compliance
Active Mobility & Public Realm Enhancement	Pedestrian Comfort & Accessibility	3 months before & after	Accessibility audits, perception surveys	Medium	Improve accessibility rating by 15%
Active Mobility & Public Realm Enhancement	Cycling Infrastructure Utilization	3 months before & after	GPS tracking of cyclists, infrastructure surveys	Medium	Increase cycling facility use by 10%
Active Mobility & Public Realm Enhancement	Public Transport Ridership	6 months before & after	Public transport operator records, modal shift surveys	High	Increase ridership by 8%
Active Mobility & Public Realm Enhancement	Public Transport Passenger Satisfaction	6 months before & after	Commuter satisfaction surveys, sentiment analysis	Medium	Improve satisfaction by 10%

Pilot Name	KPI Category	Data Collection Duration	Data Sources	Replicability Potential	Potential Target Value
Parking Policy & Emission Management	Urban Functional Diversity	3 months before & after	Land use surveys, GIS mapping, accessibility audits	Medium	Improve functional diversity index by 10%
Parking Policy & Emission Management	Public Transport Accessibility Enhancement	3 months before & after	Transit network analysis, accessibility mapping	Medium	Increase accessibility coverage by 10%
Parking Policy & Emission Management	Reduction in Noise Pollution	6 months before & after	Noise level monitoring, urban environmental assessments	Medium	Reduce noise by 2 dB
Parking Policy & Emission Management	Perceived Walkability Improvement	6 months before & after	Resident perception surveys, pedestrian movement tracking	Medium	Increase perceived walkability by 15%
Parking Policy & Emission Management	Public Acceptance of Low-Traffic Areas	3 months before & after	Structured interviews, feedback sessions, surveys	Medium	Achieve 75% public support

Table 37. Barcelona SSML data with Indicators

Pilot Name	KPI Category	Data Collection Duration	Data Sources	Replicability Potential	Potential Target Value
Pedestrians, Cyclists & MMV in Shared Spaces	Conflict Resolution	6 months before, 12 months after	Surveys, observational data	High	25% reduction in incidents
Pedestrians, Cyclists & MMV in Shared Spaces	Pedestrian Comfort Index	6 months before, 12 months after	Walk audits, environmental sensors	Medium	4.2/5 improvement
Pedestrians, Cyclists & MMV in Shared Spaces	Public Acceptance	6 months before, 12 months after	Surveys, feedback forms	High	65% approval rate
Pedestrians, Cyclists & MMV in Shared Spaces	Reduction in Motorized Transport	6 months before, 12 months after	Traffic monitoring system	Medium	20% reduction in vehicle trips

Pilot Name	KPI Category	Data Collection Duration	Data Sources	Replicability Potential	Potential Target Value
Pedestrians, Cyclists & MMV in Shared Spaces	Safety Perception	6 months before, 12 months after	Surveys, accident reports	Medium	3.5/5 perception rating
Pedestrians, Cyclists & MMV in Shared Spaces	Identified Conflicts	6 months before, 12 months after	Workshop records	High	25 barriers identified
Pedestrians, Cyclists & MMV in Shared Spaces	Conflicts Removed or Mitigated	6 months before, 12 months after	Municipal records	High	15 barriers removed
Pedestrians, Cyclists & MMV in Shared Spaces	Satisfaction with Public Spaces	6 months before, 12 months after	Survey data, feedback forms	High	70% satisfaction
Increased & Integrated Public Transport Accessibility	Accessibility Rating	6 months before, 12 months after	Surveys	High	75% compliance with accessibility standards
Increased & Integrated Public Transport Accessibility	DRT Service Efficiency	6 months before, 12 months after	Operational data, user feedback	Medium	15% reduction in wait time
Increased & Integrated Public Transport Accessibility	Stakeholder Engagement	6 months before, 12 months after	Meeting records, stakeholder surveys	High	8 stakeholder meetings
Increased & Integrated Public Transport Accessibility	Passenger Satisfaction	6 months before, 12 months after	User satisfaction surveys	High	3.5/5 satisfaction rating
Increased & Integrated Public Transport Accessibility	Accessibility Information Availability	6 months before, 12 months after	Municipal records	High	12 new facilities

Pilot Name	KPI Category	Data Collection Duration	Data Sources	Replicability Potential	Potential Target Value
Increased & Integrated Public Transport Accessibility	Usage of DRT Services	6 months before, 12 months after	Surveys, traffic counts	Medium	15% increase
Increased & Integrated Public Transport Accessibility	Reduction in Pedestrian Risks	6 months before, 12 months after	Traffic and incident reports	Medium	15% reduction
Increased & Integrated Public Transport Accessibility	Walkable Conditions Rating	6 months before, 12 months after	Surveys	Medium	3.8/5 rating
Increased & Integrated Public Transport Accessibility	Public Perception of Climate Targets	6 months before, 12 months after	Surveys, feedback forms	Medium	3.5/5 rating
Increased & Integrated Public Transport Accessibility	Policy Compliance	6 months before, 12 months after	Policy compliance reports	Medium	3.5/5 compliance
Increased & Integrated Public Transport Accessibility	Cooperation Between Local Authorities & Operators	6 months before, 12 months after	Meeting records	High	8 stakeholder meetings
Increased & Integrated Public Transport Accessibility	Participatory Workshops Involvement	6 months before, 12 months after	Workshop records	High	45% PwD participation

Table 38. Tampere SSML data with Indicators

Measure Category	KPI Category	Data Collection Duration	Data Sources	Replicability Potential	Potential Target Value
Opportunity for Active Mobility	Active Mobility Mode Share	6 months before, 12 months after	Survey data	High	Increase by 8%
Opportunity for Active Mobility	School Route Safety Index	6 months before, 12 months after	Traffic & safety data	High	Improve by 15%
Opportunity for Active Mobility	Community Participation Rate	6 months before, 12 months after	Participation records	High	Achieve 40% participation
Opportunity for Active Mobility	Visualization Tool Effectiveness	6 months before, 12 months after	Feedback surveys	High	Achieve 75% positive feedback
Opportunity for Active Mobility	Pedestrian & Cyclist Comfort Index	6 months before, 12 months after	Comfort surveys	High	Improve comfort by 15%
Quality of Public Spaces	Public Space Utilization Rate	6 months before, 12 months after	Usage surveys	High	Increase by 15%
Quality of Public Spaces	Community Satisfaction with Public Spaces	6 months before, 12 months after	User satisfaction surveys	High	Achieve 75% satisfaction
Quality of Public Spaces	Safety Perception Index	6 months before, 12 months after	Safety evaluations	High	Improve safety by 12%
Quality of Public Spaces	Accessibility and Inclusivity Assessment	6 months before, 12 months after	Accessibility assessments	High	Achieve rating of at least 3.5
Quality of Public Spaces	Green Space Enhancement	6 months before, 12 months after	Green space records	High	Increase by 400 sqm
Security	Near-Miss Incidents	6 months before, 12 months after	Incident reports	Medium	Reduce by 25%

Measure Category	KPI Category	Data Collection Duration	Data Sources	Replicability Potential	Potential Target Value
Security	Safety Violations	6 months before, 12 months after	AI-camera data	High	Reduce by 35%
Security	Interaction Safety Index	6 months before, 12 months after	AI safety analysis	High	Improve index by 15 points
Security	Response Time to Incidents	6 months before, 12 months after	Response logs	Medium	Reduce response time to 6 min
Security	User Perception of Security	6 months before, 12 months after	User surveys	High	Achieve 75% positive responses
Increases in Pedestrians & Cyclists	Pedestrian Count	6 months before, 12 months after	Pedestrian sensors	High	Increase by 12%
Increases in Pedestrians & Cyclists	Cyclist Count	6 months before, 12 months after	Cyclist counters	High	Increase by 15%
Increases in Pedestrians & Cyclists	School Travel Mode Share	6 months before, 12 months after	School travel surveys	High	Achieve 20% mode share
Increases in Pedestrians & Cyclists	Safety Perception (Survey)	6 months before, 12 months after	Safety surveys	High	Achieve 65% positive perception
Increases in Pedestrians & Cyclists	Active Mobility Usage Growth Rate	6 months before, 12 months after	Mobility sensors	High	Increase by 8%
Pedestrian & Disabled Comfort	Risk Reduction	6 months before, 12 months after	Traffic safety reports	High	Reduce by 20%
Pedestrian & Disabled Comfort	Walking Distance/Time	6 months before, 12 months after	Pedestrian surveys	High	Decrease by 15%

Measure Category	KPI Category	Data Collection Duration	Data Sources	Replicability Potential	Potential Target Value
Pedestrian & Disabled Comfort	Shade Provision	6 months before, 12 months after	Urban planning records	High	Increase by 25%
Pedestrian & Disabled Comfort	Walkability Index	6 months before, 12 months after	Walkability assessments	High	Improve by 12%
Pedestrian & Disabled Comfort	Accessibility Rating	6 months before, 12 months after	Accessibility surveys	High	Improve accessibility by 15%
Cycling & E-Bike Comfort	Cycle Waiting Time	6 months before, 12 months after	Traffic signal data	High	Reduce waiting time by 15%
Cycling & E-Bike Comfort	Bike Parking Availability	6 months before, 12 months after	Urban planning records	High	Increase by 5 spaces
Cycling & E-Bike Comfort	Bike Lane Length & Connectivity	6 months before, 12 months after	Infrastructure records	High	Add 48 km of bike lanes
Cycling & E-Bike Comfort	Bike Lane Quality	6 months before, 12 months after	User surveys	High	Achieve 75% good/excellent rating
Cycling & E-Bike Comfort	Citizen Satisfaction	6 months before, 12 months after	Citizen feedback	High	Achieve 70% satisfaction
Reallocation of Public Space	Public Space Reallocation	6 months before, 12 months after	Urban planning records	Medium	Reallocate 8,000 sqm
Reallocation of Public Space	Number of Car-Free Zones	6 months before, 12 months after	City records	Medium	Create 4 car-free zones
Reallocation of Public Space	Green Space Area	6 months before, 12 months after	Environmental records	High	Increase 10% in sqm

Measure Category	KPI Category	Data Collection Duration	Data Sources	Replicability Potential	Potential Target Value
Reallocation of Public Space	Safety Enhancements	6 months before, 12 months after	Traffic safety records	High	Implement 5 enhancements
Reallocation of Public Space	Citizen Satisfaction	6 months before, 12 months after	Citizen feedback	High	Achieve 75% satisfaction
Public Acceptance of Interventions	Public Perception (Survey)	6 months before, 12 months after	Survey data	High	Achieve 65% positive perception
Public Acceptance of Interventions	Stakeholder Feedback	6 months before, 12 months after	Feedback records	High	Collect 30 stakeholder feedback
Public Acceptance of Interventions	Community Support	6 months before, 12 months after	Participation records	High	Engage 55% of the community
Public Acceptance of Interventions	Number of Endorsements	6 months before, 12 months after	Endorsement records	High	Gather 15 endorsements
Extendibility & Replicability	Scalability	6 months before, 12 months after	Feasibility studies	High	Ensure moderate replicability

Table 39. Budapest SSML data with Indicators

Pilot Name	KPI Category	Data Collection Duration	Data Sources	Replicability Potential	Potential Target Value
Pilot 1 - Traffic Safety in Budapest's Periurban Areas	Air and Noise Pollution Levels	7 months before / 11 months after	Environmental monitoring data	High	Reduction by 15%
Pilot 1 - Traffic Safety in Budapest's Periurban Areas	Adapted Street Profiles	7 months before / 11 months after	Traffic infrastructure data	Medium	2 km of adapted streets
Pilot 1 - Traffic Safety in Budapest's Periurban Areas	Smart Crosswalks & Traffic Control	7 months before / 11 months after	Traffic safety infrastructure data	Medium	5 devices

Pilot Name	KPI Category	Data Collection Duration	Data Sources	Replicability Potential	Potential Target Value
Pilot 2 - Healthy Superblocks	Effectiveness of Nudges	7 months before / 11 months after	Road user behaviour data	High	Increase by 25%
Pilot 1 - Traffic Safety in Budapest's Periurban Areas	Congestion and delays	6 months before / 20 months after	Traffic monitoring data	High	15 conflict points
Pilot 2 - Healthy Superblocks	Targeted Intervention Package	7 months before / 11 months after	Urban planning data	Medium	3 intervention packages
Pilot 2 - Healthy Superblocks	Air and Noise Pollution	7 months before / 11 months after	Environmental data	High	Baseline measurements
Pilot 1 - Traffic Safety in Budapest's Periurban Areas	Speed Limit Compliance	7 months before / 11 months after	Traffic monitoring data	Medium	50% compliance
Pilot 1 - Traffic Safety in Budapest's Periurban Areas	Traffic safety active modes	7 months before / 11 months after	Traffic monitoring data	High	5 low-traffic streets
Pilot 2 - Healthy Superblocks	Parking Restrictions	7 months before / 11 months after	Urban planning data	Medium	10 zones
Pilot 2 - Healthy Superblocks	Sidewalk Width Expansion	7 months before / 11 months after	Infrastructure data	High	500 meters
Pilot 2 - Healthy Superblocks	Car-Free Spaces	7 months before / 11 months after	Urban planning data	High	3 spaces
Pilot 2 - Healthy Superblocks	Increase in Pedestrians & Cyclists	7 months before / 11 months after	City Surveys	High	20% increase
Pilot 2 - Healthy Superblocks	Mode Share Shift	7 months before / 11 months after	Traffic Surveys	High	15% increase

Pilot Name	KPI Category	Data Collection Duration	Data Sources	Replicability Potential	Potential Target Value
Pilot 1 - Traffic Safety in Budapest's Periurban Areas	Car-Free Space Utilization	7 months before / 11 months after	City Surveys	High	30% utilization
Pilot 2 - Healthy Superblocks	Reallocation of Public Space	7 months before / 11 months after	GIS mapping, Field Surveys	Medium	20% increase
Pilot 2 - Healthy Superblocks	Extension of Cycle Lanes	7 months before / 11 months after	GIS mapping, Field Surveys	Medium	25% increase
Pilot 2 - Healthy Superblocks	Conversion to Permeable Surfaces	7 months before / 11 months after	GIS mapping, Field Surveys	High	5000 sqm
Pilot 2 - Healthy Superblocks	Tree Planting	7 months before / 11 months after	Field Surveys	High	50 trees
Pilot 2 - Healthy Superblocks	Replicability Potential	7 months before / 11 months after	Surveys, Interviews	Medium	3 areas
Pilot 2 - Healthy Superblocks	Climate Targets Achievement	7 months before / 11 months after	Air quality monitoring	High	10% emission reduction

Table 40. Utrecht SSML data with Indicators

KPI Category	Data Collection Duration	Data Sources	Replicability Potential	Potential Target Value
Safety Perception	3 months before, 6 months after	Surveys, school walks, mapping exercises	High	25% increase in perceived safety around schools
Traffic Speed Reduction	3 months before, 6 months after	Speed cameras, AI-based traffic monitoring	Medium	15% reduction in average vehicle speed

KPI Category	Data Collection Duration	Data Sources	Replicability Potential	Potential Target Value
Illegal Parking Reduction	3 months before, 6 months after	Field observations, citizen reports, enforcement data	High	30% reduction in illegal parking incidents
Pedestrian & Cyclist Volume	3 months before, 6 months after	Infrared counters, manual counting, school travel surveys	High	20% increase in active mobility
Modal Shift Towards Active Mobility	3 months before, 6 months after	Household travel surveys, school transport records	High	15% decrease in car trips for school commutes
Air & Noise Pollution	3 months before, 6 months after	Sensor-based air quality and noise monitoring	Medium	10% reduction in noise levels
Effectiveness of School Streets	3 months before, 6 months after	Observational studies, compliance monitoring	Medium	75% compliance with new street regulations
Parental & Community Engagement	3 months before, 6 months after	Participation logs, meeting attendance	High	80% engagement rate in workshops and surveys

Table 41. Warsaw SSML data with indicators

Pilot Name	KPI Category	Data Collection Duration	Data Sources	Replicability Potential	Potential Target Value
SSML 1 – Safer School Zones	Road Safety	4 months before / 7 months after	Pedestrian crossing audits, traffic analysis, citizen reports	High	30% reduction in pedestrian accidents
SSML 1 – Safer School Zones	Traffic Calming	4 months before / 7 months after	Vehicle speed monitoring, compliance reports	High	20% decrease in speeding violations
SSML 1 – Safer School Zones	Active Mobility Share	4 months before / 7 months after	Walking interviews, school mobility surveys	High	25% increase in walking/cycling trips

Pilot Name	KPI Category	Data Collection Duration	Data Sources	Replicability Potential	Potential Target Value
SSML 1 – Safer School Zones	Environmental Impact	4 months before / 7 months after	Air and noise pollution sensors	Medium	10% reduction in air pollutants
SSML 1 – Safer School Zones	Community Perception	4 months before / 7 months after	Stakeholder interviews, public surveys	Medium	75% satisfaction with safety improvements
SSML 2 – Street Reallocation & Active Mobility	Space Reallocation	4 months before / 7 months after	Urban design assessments, digital mapping	High	15% increase in pedestrian space
SSML 2 – Street Reallocation & Active Mobility	Public Transport Accessibility	4 months before / 7 months after	Transit ridership surveys, GPS tracking	Medium	10% increase in school-area transit usage
SSML 2 – Street Reallocation & Active Mobility	Citizen Engagement	4 months before / 7 months after	Focus groups, participatory workshops	High	80% stakeholder engagement in planning
SSML 2 – Street Reallocation & Active Mobility	Cycling Infrastructure	4 months before / 7 months after	Bike lane monitoring, cyclist flow analysis	Medium	20% increase in cycling usage
SSML 2 – Street Reallocation & Active Mobility	School Zone Safety	4 months before / 7 months after	AI-based traffic monitoring, observational studies	High	40% reduction in unsafe parking and drop-offs

Table 42. Zagreb SSML data with Indicators

KPI Category	Data Collection Duration	Data Sources	Replicability Potential	Potential Target Value
Traffic Safety	4 months before / 7 months after	UAV video analysis, AI-assisted traffic monitoring, accident reports	High	15% reduction in near-miss incidents
Intersection Efficiency	4 months before / 7 months after	AI-based traffic flow analysis, PT priority tracking	High	15% reduction in intersection congestion
Pedestrian & Cyclist Accessibility	4 months before / 7 months after	Video analytics, pedestrian and cyclist volume counts	High	25% increase in pedestrian and cycling flow
Public Transport Efficiency	4 months before / 7 months after	GPS tracking of public transport, PT ridership data	High	10% improvement in PT travel time
Air & Noise Pollution	4 months before / 7 months after	Environmental sensors, air quality reports	Medium	10% reduction in CO_2 emissions
Public Perception	4 months before / 7 months after	Public and stakeholder surveys, participatory workshops	Medium	80% satisfaction rate
Pedestrian & Cyclist Comfort	4 months before / 7 months after	Street audits, user experience surveys	High	20% improvement in comfort rating
Traffic Flow Optimization	4 months before / 7 months after	AI-assisted vehicle speed analysis, congestion data	Medium	10% reduction in vehicle delays
Intersection Redesign Impact	4 months before / 7 months after	Before/after comparative design audits, safety evaluations	High	20% reduction in pedestrian waiting time
Green Infrastructure Impact	4 months before / 7 months after	Urban vegetation analysis, heat island effect measurements	Medium	15% increase in shaded pedestrian areas

KPI Category	Data Collection Duration	Data Sources	Replicability Potential	Potential Target Value
Stakeholder Engagement	4 months before / 7 months after	Workshop participation records, community feedback forms	High	70% positive community engagement

Table 43. Bologna SSML data with Indicators

KPI Category	Data Collection Duration	Data Sources	Replicability Potential	Potential Target Value
Road Safety	4 months before, 7 months after	Traffic flow analysis, pedestrian surveys, speed monitoring	High	30% reduction in vehicle speed near school zones
Active Mobility	4 months before, 7 months after	Surveys, pedestrian and cycling flow analysis	High	40% increase in walking and cycling
Public Perception	4 months before, 7 months after	Stakeholder workshops, citizen feedback surveys	Medium	75% satisfaction with school mobility improvements
Green Space Enhancement	4 months before, 7 months after	Satellite imagery, environmental impact assessments	Medium	25% increase in green space within the intervention area
Traffic Calming Effectiveness	4 months before, 7 months after	Speed monitoring, compliance assessments	High	50% reduction in speeding violations
School Area Accessibility	4 months before, 7 months after	Walkability audits, accessibility surveys	High	30% increase in accessibility scores
Community Engagement	4 months before, 7 months after	Participation rates in co-creation activities	Medium	60% participation in workshops

Annex B: Checklist for Ensuring Data Quality

Use this checklist to ensure all aspects of data quality are addressed during the pilots:

- ◻ **Data Collection Preparation**
  - Define clear data quality standards and criteria.
  - Develop a comprehensive data quality plan.
  - Create standardised data collection protocols.
  - Train all data collectors in standardized protocols.
  - Ensure data collection tools and instruments are calibrated and functioning correctly.
- ◻ **During Data Collection**
  - Follow standardised data collection protocols strictly.
  - Validate data regularly for accuracy, completeness, and consistency.
  - Use automated validation tools to check for errors.
  - Monitor data in real-time and set up alerts for anomalies.
  - Ensure data is securely stored and access is restricted to authorized personnel only.
- ◻ **Post Data Collection**
  - Conduct regular data quality audits.
  - Review validation reports and address any identified issues.
  - Ensure data is backed up regularly and securely.
  - Compile and review feedback from data collectors.
- ◻ **Continuous Improvement**
  - Update data collection protocols based on audit findings.
  - Provide additional training to data collectors if needed.
  - Implement improvements based on feedback and best practices.
  - Review and refine data quality standards periodically.
- ◻ **Data Security and Privacy**
  - Ensure data privacy regulations are adhered to.
  - Obtain necessary consents from participants.
  - Implement data security measures to protect data integrity and confidentiality.
  - Regularly review data security protocols

Annex C: Common measures, indicators, data characteristics per SSML and Thematic Cluster

This table organizes various measures, indicators, and data sources associated with thematic clusters across SSMLs. The table includes details such as measure IDs, descriptions, indicator names and definitions, pilot cities involved, baseline data sources, data collection frequencies, and units of measurement. The thematic clusters covered include Safe & Sustainable Schools, Concepts for Space Reallocation, Data Safety Digital Integration, Central Areas Traffic Reorganization, and Integrated Traffic Reorganization, providing a comprehensive overview of the urban interventions and their evaluation metrics.

Table 44. Common measures, indicators, data characteristics per SSML and Thematic Cluster

Thematic Cluster	Measure IDs	Measure Descriptions	Indicator Names	Indicator Definitions	Pilot Cities	Baseline Data Sources	Data Sources	Data Collection Frequencies	Units
Safe & Sustainable Schools	UTR_MS26, BO_MS14, LYS_MS23, LYS_MS28, WAW_MS13	Engagement (no. of people engaged in co-creation), Quality of public spaces, Reallocation of public space (sqm/year), Extendibility - Replicability of intervention, Traffic safety active modes	Participation Rate, Incident Reduction, Bike Parking Capacity, Stakeholder Feedback, Road Space Reallocation	Engagement in co-creation activities, Track number of accidents, Increase in bike parking spaces, Feedback from stakeholders, Percentage of road space reallocated	Lyon, Utrecht, Zagreb, Warsaw	User surveys, workshops, focus groups conducted, Police traffic incident reports, City infrastructure records, Surveys, focus groups	User surveys, workshops, focus groups conducted, Police traffic incident reports, City infrastructure records, Surveys, focus groups	Monthly, Quarterly, Annually, semi-annually	Number of participants, Number of incidents, Number of bike parking spaces, Qualitative feedback, Percentage of road space reallocated

Thematic Cluster	Measure IDs	Measure Descriptions	Indicator Names	Indicator Definitions	Pilot Cities	Baseline Data Sources	Data Sources	Data Collection Frequencies	Units
Concepts for Space Reallocation	HD_MS21, BUD_MS17, BUD_MS24, UTR_MS26, LYS_MS23	Cycling & e-bike comfort (reduced cycle waiting time), Mobility space usage, Conversion from impermeable to permeable/vegetated surfaces	Increased Bike Parking Spaces, Addressing Conflicts Between Cyclists and Pedestrians, Vegetated Surface Area Increase	Percentage increase in bike parking spaces, Percentage of road space reallocated for cyclists and pedestrians, Total area of newly added vegetated surfaces	Budapest, Lyon, Utrecht	Traffic and spatial analysis, safety audits, User surveys, city records	Traffic and spatial analysis, safety audits, User surveys, city records	Quarterly, Monthly, Semi-annually, annually	Percentage (%) from baseline, Percentage (%), Square meters (sqm)
Data Safety Digital Integration	UTR_MS26, LYS_MS27, TMP_MS20, BCN_MS24, TMP_MS10	Engagement (no. of people engaged in co-creation), Data security measures, Digital integration for traffic management	Participation Rate, Stakeholder Engagement Level, Digital System Performance	Engagement in co-creation activities, Stakeholder feedback on data safety, Performance of integrated digital systems	Tampere, Barcelona, Lyon, Warsaw	Workshop attendance records, citizen engagement logs, digital system performance data	Workshop attendance records, citizen engagement logs, digital system performance data	Monthly, Semi-annually, annually	Number of participants, Qualitative assessments, System performance metrics
Central Areas Traffic Reorganization	GOT_MS20, ZG_MS28, ZG_MS20, ZG_MS23, UTR_MS26	Pedestrian & disabled comfort (reduced risks; improved access), Traffic reorganization in central areas	Improved Walkable Conditions, Adaptability Rate, Traffic Flow Efficiency	Percentage increase in the quality of walkable areas, Adaptability of traffic management strategies, Efficiency of	Gothenburg, Zagreb, Lyon	Current urban redesign adaptability, Initial number of pedestrian and disabled	Expert assessments, stakeholder feedback	Annually, Quarterly, semi-annually	Percentage (%), Number of zones, Traffic flow efficiency rate

Thematic Cluster	Measure IDs	Measure Descriptions	Indicator Names	Indicator Definitions	Pilot Cities	Baseline Data Sources	Data Sources	Data Collection Frequencies	Units
				traffic flow in reorganized areas		comfort zones			
Integrated Traffic Reorganization	GOT_MS19, HD_MS13, BUD_MS19, GOT_MS22, GOT_MS27	Increases in pedestrians + cyclists (numbers), Integrated approaches for traffic reorganization	Cyclist Count, Active Mobility Mode Share, Commuter Satisfaction	Total count of cyclists observed in designated areas, Mode share of active mobility (cycling, walking), Satisfaction levels of commuters with traffic reorganization	Gothenburg, Budapest, Lyon	Initial cyclist count data, Baseline mode share survey results	Camera image, manual counts, Traffic surveys, observational data	Monthly, Quarterly, semi-annually	Total count of cyclists observed in designated areas, Mode share of active mobility (cycling, walking), Satisfaction levels of commuters with traffic reorganization

Annex D: Data collection protocol template

Table 45. Data collection protocol template

1. SSML Information	Title: [SSML pilot title] Researcher(s): [Name(s) and Affiliation(s)] Objective: Brief description of the purpose and goals of the data collection.
2. Condition	Baseline or Intervention
3. Horizontal partner(s)	Involved horizontal partners and/or instruments
4. Data Collection Method	**Sources:** Identify where the data will be collected from (e.g., surveys, direct measurements, interviews). **Type/format:** Specify whether the data is quantitative (numerical) or qualitative (descriptive)/ format (e.g. .csv).
5. Procedures	**Tools:** List the tools or instruments you will use (e.g., survey forms, measurement devices). **Process:** Describe the step-by-step process for collecting the data.
6. Data Management	**Storage:** Outline how the data will be stored and secured. **Handling:** Describe the procedure for processing and managing the collected data.
7. Related indicators:	Add MS and Indicator numbers
8. Ethical Considerations	**Consent:** Explain how consent will be obtained from participants (if applicable). **Privacy:** Describe measures to protect the privacy and confidentiality of any participants.
9. Timeline	**Schedule:** Provide an estimated timeline for the data collection activities.
10. Other	Other information, descriptions, links, read.me files. etc.

Annex E: Transformative Governance interview

Operationalization of goals

Likert scale questions

1. Alignment of SSML plan with the city's strategic goals as expressed in its mission, SUMP activities, and strategy?
2. Different criteria for alignment (e.g. Completeness & Level of alignment…)
3. OR look at the dimensions (sustainable mobility, safety, inclusion etc.) separately.

Open questions

Please explain your answers to the Likert questions

1. Which dimensions of the REALLOCATE goals (sustainable mobility; inclusion; safety) are currently seen as important to your activities?
2. How well does the SSML connect with the strategic goals/programs of the city?

Alignment of goals and outcomes

Likert questions

1. How well are the outcomes, until today, of your city's REALLOCATE activities with your city's strategic goals in general (as expressed in its strategy document and key priorities in decision making)?
2. Specifically, how are the outcomes aligned with the sustainable mobility goals of your city?
3. How are the outcomes aligned with the traffic safety goals of your city?
4. How are the outcomes aligned with the inclusion goals of your city?

Open questions

Please explain your answers to the Likert questions

1. How has the SSML contributed to learnings which can inform long-term approach and strategy?
2. How has the SSML generated awareness among different stakeholders of the importance of sustainable mobility, and the approaches / solutions available?

Learnings and opportunities for generalization

Likert questions

1. Has your city developed its capacities as reflected by the learning needs of D4.1?
2. Have you seen increased collaboration between city departments as part of the SSML?
3. Are reports of the SSML used as input for long-term policy development or other sustained change efforts in the city?

Open questions

1. Broadening the interested stakeholders during the project (links with the Stakeholder Map?)?
2. Spreading lessons learned across the city.
3. Are reports of the SSML used as input for long-term policy development or other sustained change efforts in the city?