Fleet and traffic management systems
for conducting future cooperative mobility

Impact Evaluation Framework and Dedicated KPIs

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1 EXECUTIVE SUMMARY

The deliverable D5.2 “Impact Evaluation Framework and Dedicated KPIs” is part of Task 5.5 “Impact Assessment” within the CONDUCTOR project. It outlines a structured approach for evaluating the impacts of the CONDUCTOR solutions across various Use Cases (UCs) and confirming that the expected impacts from the project proposal are achievable through the validation and measurement framework established here.

The framework builds on the Key Performance Indicators (KPIs) selected during Task 5.4 “Validation Plan and Results” and reported within D5.1 Validation Strategy and Plan, while extending the assessment beyond technical performance to include economic, environmental, and societal dimensions (

Figure 1). This approach ensures that the impacts of CONDUCTOR's innovations are quantified, using recognised valuations to assign economic value to KPIs. Through this, the deliverable supports the real-world validation of improvements such as reduced CO_2 emissions, enhanced traffic management efficiency, cost savings, and improved passenger experience.

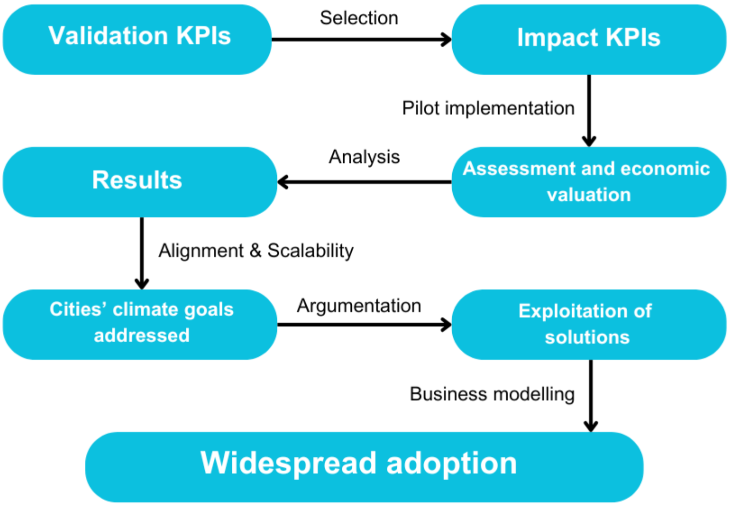

Figure 1: Pathway towards impact: from validation plans to widespread adoption (Source: own elaboration combining different sources)

Each UC is assessed based on the Key Performance Areas (KPAs) defined within the project, including technical, social, environmental, and economic metrics. Success criteria and valuation methods are linked to these KPIs, ensuring a comprehensive evaluation of the solutions deployed in each UC.

Additionally, the framework aligns with broader city climate goals and Horizon Europe’s Key Impact Pathways (KIPs), aiming to deliver impacts such as reducing delays by over 10%, improving travel times by more than 10%, and cutting emissions by at least 5%. The goal is to confirm that these impacts, which were outlined in the initial project proposal, are realised and provide a solid basis for scaling CONDUCTOR solutions across Europe.

This framework will be applied in **D5.4 “Report on impact assessment”**, due Month 36 of the project, where the final assessment of impacts across all UCs will be based on real-world data and pilot simulations results. By linking the validation KPIs with their respective economic valuations, this framework provides solid data that can substantiate the broader deployment of CONDUCTOR’s solutions.

Keywords: CCAM, Impact evaluation, Key Performance Indicators, External costs, Traffic management, Economic valuation, Environmental impacts.

2 INTRODUCTION

2.1 Background

The CONDUCTOR project is specifically designed to address the growing complexity in fleet and traffic management by integrating Connected and Cooperative Automated Mobility (CCAM) services. CONDUCTOR focuses on the seamless coordination of both conventional and automated vehicles within a multimodal transportation system. The goal is to provide innovative, real-time decision-making tools powered by data fusion and machine learning technologies, aimed at improving urban mobility, reducing traffic congestion, and cutting emissions.

With urbanisation and automation on the rise and traffic systems becoming more congested, the need for a smarter, more coordinated approach to traffic management has become critical. CONDUCTOR responds directly to this need by proposing advanced solutions that optimise traffic flow while enhancing efficiency of both passenger and freight transportation. CONDUCTOR's vision is to create a flexible, responsive transportation ecosystem where public transport services, logistics, and private vehicles interact seamlessly. This is achieved through dynamic balancing and priority-based management, so that vehicles can move more efficiently through urban and peri-urban environments.

CONDUCTOR focuses on creating and testing an open, interoperable platform that integrates CCAM services with existing fleet and traffic management systems. Through its three use cases, CONDUCTOR will demonstrate the viability of this platform in real-world conditions, showing how CCAM can improve both the operational efficiency and environmental performance of transport systems across Europe. Project partners such as Nommon, AIMSUN, TUM, and Deusto will employ next-generation simulation models and machine-learning-based predictive tools to help authorities manage traffic dynamically and effectively.

In terms of solutions developed, CONDUCTOR is structured around three main UCs, divided in 5 pilots, each of which serves as demonstration for testing the project's solutions in different real-world and simulation conditions:

1. **Use Case 1 (Integrated Traffic Management with Inter-Modality)**: This use case focuses on pilot demonstrations in Athens (Greece), Almelo (Netherlands), and Madrid (Spain), where the integration of traffic management systems with various modes of transport will be tested.

   In Athens, the pilot will focus on synchronising bus, tram, metro, and trolley-bus services to reduce door-to-door travel times and improve the reliability of multi-modal journeys. In Almelo, the focus is on freight traffic management, with the goal of reducing stops at traffic lights and improving circulation through a major logistics corridor. In Madrid, traffic management will be tested in the context of a shift towards greater adoption of connected and automated vehicles.

2. **Use Case 2 (Demand-Responsive Transport)**: Pilots connecting Slovenia with Italy, Croatia, and Austria will explore how DRT systems can be optimised over time to provide more efficient and flexible shuttle operations. This use case's focus is on refining route plans and managing fleet operations to meet the evolving needs of passengers while minimising costs and environmental impact.

3. **Use Case 3 (Urban Logistics)**: In Madrid, the focus will shift to urban logistics, with the aim of improving last-mile parcel delivery by integrating goods transport with demand-responsive transport services. This use case will explore how the combined transport of passengers and goods can optimise the use of underutilised vehicles, particularly during off-peak hours.

These pilots are designed to validate the scalability and adaptability of *CONDUCTOR* solutions across different geographic, operational, and regulatory contexts.

In terms of impact, CONDUCTOR directly aligns with the call topic *HORIZON-CL5-2022-D6-01-04*, which seeks to integrate CCAM services into traffic and fleet management systems to improve efficiency and promote interoperability. The expected outcomes of the project align with the KIPs defined by Horizon Europe, which include generating innovation-based growth, creating more efficient transport systems, and reducing greenhouse gas emissions through better traffic management and vehicle optimisation.

At this stage, it is important to highlight the expected impacts that were outlined in the project proposal and confirm that the objectives remain aligned with those initial projections. This deliverable serves as a tool to ensure that the expected results, as proposed, are being validated through ongoing use case evaluations and KPI assessments.

The anticipated impacts, as listed in the impact section, include:

- **Reduction in delays at traffic lights**: By more than 10%, as part of optimising traffic management systems in pilot sites.
- **Improvement in door-to-door travel times**: Targeting an improvement of over 10%, contributing to better multimodal transport coordination and efficiency.
- **Reduction in waiting times between CAVs (Connected and Automated Vehicles) and fixed-route transit**: Expected decrease of over 5%, with a focus on improving the passenger experience when integrating connected and autonomous vehicles(CAVs) into public transport systems.
- **Shortening of integration times between systems**: By more than 10%, improving the speed and efficiency of data sharing and system interoperability between traffic and fleet management solutions.
- **Reduction in traffic queue lengths and empty kilometres travelled by vehicles**: At least a 10% reduction, with expectations of up to 20-25% in certain use cases, particularly where ride-parcel pooling and cooperative fleet management strategies are implemented.
- **Governance models for CCAM services**: Tested and accepted by at least 70% of stakeholders, ensuring that the proposed operational models for CCAM systems are viable and aligned with real-world needs.

One of the objectives of this deliverable is to ensure that the impacts presented in the original proposal—such as those linked to traffic efficiency, operational integration, and governance structures—are on track to be achieved. These results are being measured using the KPIs selected from the validation plans (D5.1 Validation Strategy and Plan), which aim to provide quantitative evidence measuring the project's success. This evaluation will confirm whether the objectives sold in the proposal are being met and demonstrate the potential for wider adoption of the CONDUCTOR solutions.

2.2 Objective of this deliverable

The primary objective of this deliverable, D5.2, is to establish a robust impact evaluation framework that will assess the effects of the applications of the CONDUCTOR solutions across multiple UCs and scenarios. The framework will provide a comprehensive structure for evaluating both the quantitative and qualitative impacts of the project, focusing on various stakeholders involved in the CCAM ecosystem, including traffic operators, city authorities, and users. Quantifying the impact of the project's innovations with this framework should provide a clear idea of the extent to which the solutions being tested are contributing to local climate objectives, while providing tangible arguments for the exploitations of all project-developed solutions.

The deliverable will select key metrics and indicators from the initial validation plans, that are used to measure success across the different use cases, going one step forward by translating these validation KPIs, upon pilot completion, into tangible economic valuations. These include specific KPIs that will track achievements across different KPAs, further specified within the following Scope section (Section 2.4). This deliverable will serve as a methodological base towards the application of its impact framework (D5.4: Report on impact assessment of Use cases) after full implementation of the different use cases.

This framework is related to several tasks of WP5 and WP6, including:

- Use cases: Where the impact assessment will evaluate the solutions implemented in each UC.
- Validation plan and results: To ensure the accurate quantification of benefits retrieved from a selection of Validation KPIs across use cases.
- Impact assessment: To quantify the expected benefits for stakeholders.

In addition, this deliverable will support the exploitation tasks of the project, particularly:

- Exploitation strategy and business models: To feed into the development of business models based on validated impacts.
- Exploitation roadmap and activities: Ensuring that the quantified impacts are aligned with the long-term scalability and adoption of the CONDUCTOR solutions.

2.3 Intended readership

This document is intended for a wide range of stakeholders involved in the CCAM ecosystem, with a specific focus on those participating in or affected by the Horizon Europe Programme. Key audiences include:

- **CONDUCTOR consortium members**, who are responsible for implementing and overseeing the validation framework and ensuring alignment with the project’s goals.
- **Policy makers and CCAM programme management**, particularly those managing or supervising projects under the Horizon Europe framework, who require insights into the methods and impacts of the validation strategies applied in CONDUCTOR.
- **Other Horizon Europe CCAM projects**, looking for comparable methodologies and impact evaluation strategies that could be shared or adopted across similar initiatives.
- **Academic and industry researchers**, interested in understanding the design, execution, and impact evaluation of the CONDUCTOR solutions, with a view to contributing to or building upon these validation activities.
- **Local and city authorities**, who may benefit from the project's findings to improve urban mobility management, reduce emissions, and enhance public transport efficiency through CCAM technologies.

2.4 Scope

This impact evaluation framework will apply to the different solutions tested across the three UCs of the CONDUCTOR project. The framework will consider quantitative and qualitative impacts on various stakeholders, focusing on the four key performance areas (KPAs):

- **Economic impact**: This will be evaluated through selected KPIs such as cost savings per trip, fleet operational costs, and reduction in traffic congestion. For example, economic KPIs

within UC1 Athens will track reduction in delays across multimodal transport, while KPIs related to UC3 Madrid will touch upon cost reductions in last-mile delivery operations due to integrated logistics solutions.
- **Environmental impact**: Environmental KPIs will measure reductions in greenhouse gas emissions and improvements in fuel and energy consumption. For instance, in UC1 Almelo, the KPIs will assess the decrease in vehicle stops for freight transport, contributing to reduced emissions. Similarly, in UC2 Slovenia/Italy, the focus will be on fuel savings achieved through the optimisation of demand-responsive transport systems.
- **Societal Impact**: Societal KPIs will evaluate user satisfaction and improvements in transport accessibility. In UC1 Madrid, these KPIs will measure the effectiveness of network recovery after disruptions, reflecting user experience, while in UC2, they will track improvements in accessibility for underserved areas through optimised shuttle services.
- **Technical Impact**: Technical KPIs will gauge system reliability, scalability, and interoperability. For UC1 Athens, KPIs will assess how well the traffic management system integrates various modes of transport, while for UC3 Madrid, they will measure, among others, the effectiveness of combining passenger and goods transport solutions within an interoperable framework.

The results from these KPIs will be compiled at the pilot, use case, and project levels through context-specific economic and societal valuations. By translating the observed impacts—such as CO_2 reductions, time savings, and efficiency gains—into common economic units, these valuations will enable meaningful cross-pilot comparisons. This approach helps unify diverse impact metrics that would otherwise be difficult to aggregate, ensuring that varied KPIs, like environmental and operational benefits, are assessed on a comparable scale. The compilation of these impacts at the project level will offer a consolidated view of the overall effectiveness and value of the CONDUCTOR solutions, facilitating a clear understanding of their scalability and broader applicability.

2.5 Structure of the document

The document is structured into seven sections, outlined as follows:

- **Section 1** provides the **executive summary**, summarising the key objectives and scope of the deliverable, including a brief overview of the impact evaluation framework and its connection to the project's overall goals.
- **Section 2** introduces the **background** and **objectives** of the deliverable, along with the intended readership, scope, and structure of the document.
- **Section 3** discusses the **methodological considerations**, including a review of best practices, alignment with existing frameworks such as the **CCAM-CEM** policy evaluation framework.
- **Section 4** presents the **CONDUCTOR impact framework**, detailing the rationale behind the evaluation approach and the comparison of baseline, business-as-usual, and post-pilot results.
- **Section 5** outlines the **use cases' evaluation strategy**, covering the alignment with validation plans and the connection between local impact results and broader climate city goals. It also provides a detailed assessment of KPIs for each UC, including UC1 Athens, UC1 Almelo, UC1 Madrid, UC2 Slovenia, and UC3 Madrid.
- **Section 6** focuses on the **analysis and insights** expected in D5.4, including a comparative analysis of the results and their contribution to cities' climate goals.
- **Section 7** covers aspects of **dissemination, exploitation, and standardisation**, ensuring the findings of this deliverable are communicated and used effectively in further project tasks.

3 METHODOLOGICAL CONSIDERATIONS

3.1 State-of-the-art methodologies: best practices review, going beyond SotA

At proposal stage, the CIVITAS evaluation framework was preferred to ensure compliance and comparability with current standards. However, with the recent development of the Common Evaluation Methodology (CEM) for CCAM, CONDUCTOR identified an opportunity to enrich its own approach by following their guidelines on setting up the evaluation framework, as well as complying with specific areas and wordings of their taxonomy. A review of recent projects impact practices has also been undertaken to ensure compliance with state-of-the-art methodologies, summarised in Table 1.

Table 1: Current impact practices within European CCAM & Traffic Management projects (Source: CORDIS)

Methodology	Description	Applied HE Project Example	Category
Common Evaluation Methodology (CEM)	A framework for assessing the impacts of CCAM solutions on a large scale, facilitating data sharing and collaboration.	FAME	Quantitative
Multi-Criteria Decision Making (MCDM)	A 6-step process that evaluates KPIs across living labs, including grouping KPIs by impact areas, creating templates, applying MCDM to weight KPIs, identifying necessary applications for data collection, and conducting surveys for feedback.	IN2CCAM	Quantitative
System Dynamics	Models feedback loops between mobility, land use, and infrastructure to forecast long-term impacts of automation.	LEVITATE	Quantitative
Dose-Response Curves	Quantifies the relationship between levels of automation and impacts like road capacity, fuel consumption, and safety.	LEVITATE	Quantitative
Meta-Analysis and Retrospective Studies	Leverages past research to forecast the impacts of CAVs, enabling better decision-making by utilizing existing data.	LEVITATE	Quantitative
Willingness-to-Pay Studies	Assesses market demand by measuring how much individuals are willing to pay for varying levels of vehicle automation.	LEVITATE	Qualitative & quantitative
FESTA Framework	Provides a structured, stepwise approach for conducting field operational tests through systematic data gathering across various test sites.	SHOW	Quantitative
KPI-Driven Framework	Measures success across social, economic, environmental, and governance dimensions, emphasizing real-time data collection and cross-project benchmarking.	ULTIMO	Quantitative
Impact-First Approach	Focuses on real-time data collection and emphasizes user-centric evaluation to monitor public acceptance of automated vehicles.	ULTIMO	Quantitative

Theory-Driven Evaluation	Assesses how multimodal traffic management influences specific impacts, accounting for contextual and causal factors.	ORCHESTRA	Qualitative
Program Theory Development	Creates a logic model explaining how project interventions contribute to outcomes, identifying key performance areas for effective evaluation.	ORCHESTRA	Qualitative
Technology Readiness Assessment	Evaluates the maturity of technologies, assessing the transition from concept to operational readiness in multimodal traffic management ecosystems.	ORCHESTRA	Quantitative
CIVITAS Impact and Process Evaluation Framework	Evaluates the effectiveness of interventions and analyzes the implementation process in public transport systems.	SPINE	Quantitative

FAME, which is currently in its third and final year, is on track to provide the next common methodology for evaluating CCAM projects. The EU-CEM offers guidance on establishing a strong foundation for a successful evaluation during the project preparation phase and developing a practical evaluation plan. Its goal is to ensure high-quality evaluations that deliver reliable input for decision-making and policy development, benefiting both industry and authorities.

The CEM aligns closely with CONDUCTOR's goals in impact assessment by providing a structured framework for evaluating the impacts across CCAM pilot projects, aiming to make them comparable and transferable across different European contexts. Although the CEM is still at a draft stage, we have aligned with their guidelines on the phrasing of our Key Performance Areas, as well as their evaluation recommendation. As we anticipate that the CEM will become the leading method for evaluating CCAM projects across Europe, including it in our process should ensure that CONDUCTOR remains aligned with future standards.

IN2CCAM, CONDUCTOR’s sister project, pivots around developing and implementing CCAM technologies to improve traffic flow and mobility services in urban and peri-urban areas. It leverages living labs in six cities to integrate CCAM services into real-world traffic systems, including last-mile mobility, dynamic traffic management, and the use of autonomous vehicles (AVs) in public transportation. IN2CCAM's impact assessment centers on using **Multi-Criteria Decision Making (MCDM)** through a 6-step process to evaluate selected KPIs across their living labs. The process starts by grouping KPIs into impact areas and creating specific templates for each living lab. MCDM is then applied to determine the appropriate weighting for each KPI. Next, necessary applications are identified for KPI measurement to guarantee accurate data collection. The final step involves preparing and distributing surveys to gather feedback from each living lab, providing a comprehensive evaluation of the project's impact.

Both projects share a common focus on improving traffic flow and urban mobility through CCAM technologies, while measuring their impact through a KPI-driven impact assessment. Their approach to impact assessment differs from our own, as they integrate both validation and impact assessment into a single process. That said, CONDUCTOR can draw lessons on incorporating more detailed weighting of KPIs based on stakeholder priorities and enhancing the role of user feedback in validating results.

LEVITATE centres on assessing the potential societal impacts of CAVs by developing an evaluation framework to guide decision-making and maximize benefits. Key methodologies include **System Dynamics**, which models feedback loops between mobility, land use, and infrastructure over time, and **Dose-Response Curves**, used to quantify the relationship between automation levels and impacts like road capacity, fuel consumption, and safety. Additionally, **Meta-Analysis and Retrospective Studies** leverage past research to forecast impacts, while **Willingness-to-Pay**

Studies assess market demand by measuring how much individuals are willing to pay for varying levels of vehicle automation.

The LEVITATE project provides an in-depth impact assessment focusing on forecasting the societal impacts of CAVs, with a detailed approach to quantifying both direct and systemic impacts. Similar to CONDUCTOR, LEVITATE uses a combination of KPIs like travel time reduction, road safety, and emissions to measure the impact of automated mobility solutions. However, LEVITATE's methodology differs by integrating system dynamics modelling which is a more holistic approach than CONDUCTOR's focus on immediate impacts. Moreover, its selection of secondary impacts such as cyber risks, safety margins, and travel demand could give a greater depth to CONDUCTOR's approach.

SHOW revolves around advancing CAV deployment through large-scale demonstrations, aiming to enhance shared mobility services in urban settings. Its methodology is based on a two-step framework approach. The **FESTA Framework** offers a structured, stepwise approach for conducting field operational tests through systematic data gathering and comparability across various test sites. Specific impact aspects included in their assessment include road safety, traffic efficiency and logistics.

Both projects emphasize system-level analyses, and they share key similarities with CONDUCTOR's approach, especially in its use of KPIs to measure impacts such as traffic efficiency, environmental performance, and societal acceptance. However, one area where CONDUCTOR might find it challenging to apply lessons from SHOW is the depth of simulation-based impact evaluations that SHOW incorporates, including city-level simulations and long-term scalability assessments. SHOW's methodology also places a strong emphasis on pre-demonstration rehearsals, where the KPIs and tools are validated across multiple iterations before final deployment.

ULTIMO focuses on advancing automated mobility by integrating shared services and connected vehicles. Its methodology is KPI-driven, using a detailed framework across social, economic, environmental, technical, and governance dimensions to measure success and quantify mobility impacts. The **Impact-First Approach** emphasizes user-centric, real-time data collection to monitor public acceptance and preferences. **Cross-Project Benchmarking** leverages KPIs from previous projects like AVENUE and SHOW, allowing for comparison with existing data.

The ULTIMO project impact assessment, like CONDUCTOR's, is structured around a KPI framework to measure outcomes. Another similarity is their shared focus on the integration of AVs into public transport, where KPIs such as trust, vehicle performance, and operational costs play a central role in assessing success. What CONDUCTOR can learn from ULTIMO is from its impact-first strategy by incorporating more forward-looking impact analysis tools to assess the broader public acceptance and scalability of its solutions. However, ULTIMO's focus on other aspects such as digital impact monitoring and real-time data collection through continuous online search monitoring is less applicable to CONDUCTOR.

ORCHESTRA focuses on improving multimodal traffic management by developing and implementing an advanced Multimodal Traffic Management Ecosystem (MTME). In its approach to the impact assessment the project heavily relies on three main aspects. First, **Theory-Driven Evaluation** provides a structured method for assessing how MTME influences specific impacts, taking into account contextual and causal factors. The **Technology Readiness Assessment** evaluates the maturity of MTME technologies, moving from concept development to operational readiness. Additionally, **Program Theory Development** creates a logic model that explains how MTME components contribute to project outcomes, helping identify key performance areas for effective evaluation.

The impact assessment frameworks of ORCHESTRA and CONDUCTOR both focus on evaluating multimodal traffic management systems, but ORCHESTRA's use of the program theory model stands out in mapping out how key interventions lead to specific long-term outcomes. ORCHESTRA also incorporates Technology Readiness Levels into its impact assessment, offering CONDUCTOR a more structured way to measure the maturity of its solutions. While both projects emphasize KPIs in areas like environmental and economic impact, ORCHESTRA's evaluation highlights the importance of contextual factors like policy and data governance.

SPINE aims to integrate innovative solutions into public transport systems to advance climate neutrality. It employs the **CIVITAS Impact and Process Evaluation Framework**, adapted to the SPINE methodology. Their **Impact Evaluation Process** assesses the effectiveness of interventions by measuring outcomes across multiple dimensions, and their **Process Evaluation Activity** analyses the implementation process to understand how various factors contribute to project success.

The SPINE and CONDUCTOR impact assessments both draw from the CIVITAS framework, using KPIs to measure the success of multimodal transport solutions and their environmental and societal impacts. Both projects share a focus on KPIs related to traffic flow, emissions reductions, and user satisfaction, ensuring a robust comparison of economic and societal impacts. Despite these similarities, SPINE’s emphasis on equity-centred design and real-time digital simulations presents unique learning opportunities that may be harder to apply retroactively in CONDUCTOR’s case.

Figure 2

Figure 1 below provides a visual breakdown of the hierarchies, best practices, and methodologies we referenced in this section, serving as a foundation for the evaluation presented here.

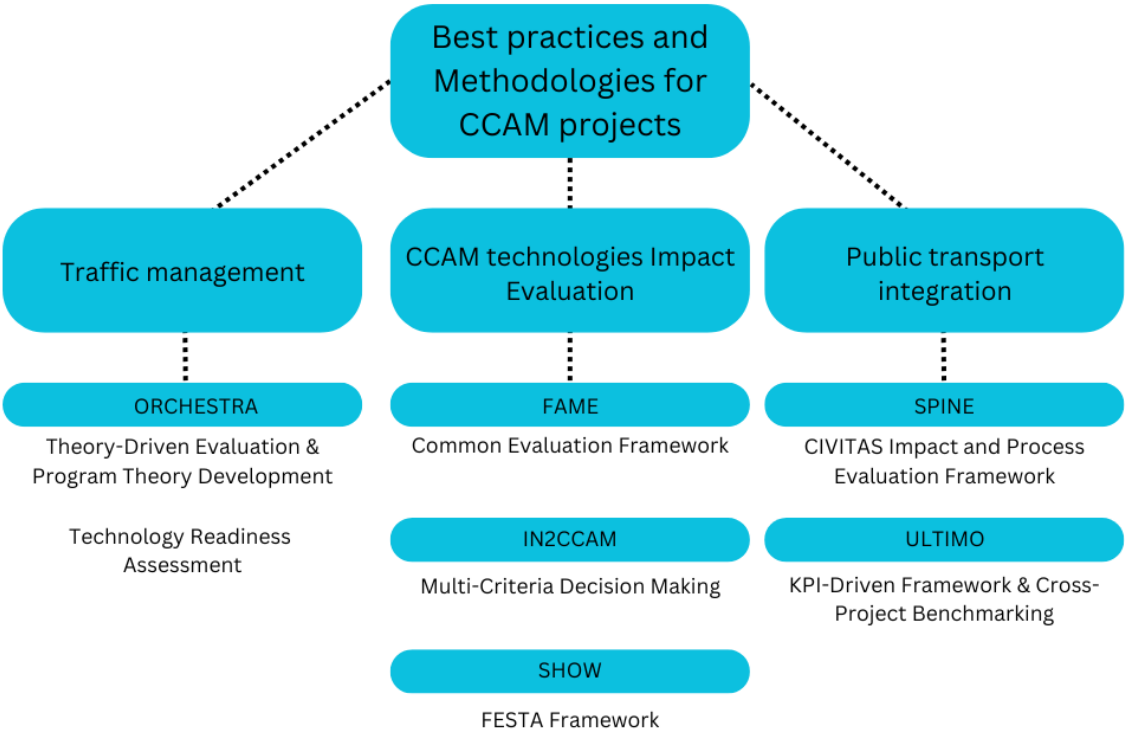

Figure 2: Best practices and methodologies for CCAM Projects (Source: own elaboration)

3.2 Alignment with EU-CEM for CCAM policy evaluation framework:

The EU-CEM for CCAM provides structured guidelines to support high-quality, standardised evaluation of CCAM systems across Europe. The methodology covers both technical and societal impact assessments, ensuring that project evaluations can be harmonised, compared, and utilised across different contexts. It supports decision-making and policy formation by offering a robust framework for evaluating CCAM's large-scale deployment. Still at a draft stage, this framework will be used to inform and shape the approach of CONDUCTOR’s impact methodology. This alignment is key to ensuring that project results contribute to broader CCAM research and policy development.

The EU-CEM framework is directly applied to the impact assessment within CONDUCTOR’s use cases, aligning on its key impact areas such as technical performance, user interaction, and environmental impact. This should ensure that project results are robust, transferrable, and aligned with EU-wide CCAM deployment goals.

For example, in UC1 and UC3, the project applies EU-CEM’s focus on technical performance and traffic flow efficiency to assess the effectiveness of traffic management systems. Key indicators, such as vehicle kilometres travelled (VKT), congestion metrics, and travel time reductions, are measured and phrased in alignment with the guidelines. In UC1, these metrics help quantify the improvements in traffic flow in complex urban environments. In UC3, they assess the logistics operations, ensuring the reduction of delivery times and optimised routing efficiency, as prescribed by EU-CEM’s traffic flow efficiency indicators.

Moreover, in UC2 and UC3, we follow the CEM’ guidelines for user-centric evaluation, focusing on user satisfaction and quality of life impacts. In UC2, DRT systems are evaluated using indicators such as user satisfaction rates and system usability scores, reflecting EU-CEM's emphasis on user interaction and mobility impacts. Similarly, in UC3, user feedback on urban logistics services is collected to assess how well the system meets user needs, providing valuable insights into the service's operational success.

Additionally, within UC1 and UC3, this framework evaluates environmental impact, particularly emissions reduction and energy efficiency, as outlined by EU-CEM. In UC1, the focus is on measuring CO_2 emissions reduction through improved traffic flow and reduced congestion. In UC3, logistics operations are evaluated in terms of reduced emissions from optimised fleet operations and efficient routing. These evaluations follow EU-CEM's environmental impact guidelines, ensuring that sustainability is a core part of the assessment.

By following the EU-CEM framework, the evaluation results from CONDUCTOR are structured to be comparable with other CCAM projects across Europe. This will allow transferability of the findings to future CCAM research, ensuring that CONDUCTOR's outcomes provide tangible inputs for future policy and decision-making. The use of standardised KPIs, aligned with EU-CEM's requirements, ensures that CONDUCTOR's impact can be assessed against a consistent set of criteria.

3.3 Relation to KIPs / UMIs

The CONDUCTOR project integrates multiple evaluation frameworks to ensure a proper assessment of its impact on future mobility systems. Two of the main frameworks used to guarantee broader alignment with the European Union are Urban Mobility Indicators (UMIs) and Key Impact Pathways (KIPs).

UMIs are tools currently under development as part of broader urban mobility planning initiatives, including the revised TEN-T regulations. Their purpose is to assess accessibility, safety, efficiency, and sustainability within transport systems across cities. As urbanization accelerates, cities face increasing challenges such as congestion, pollution, and social inequality. UMIs are expected to provide a consistent framework for benchmarking urban mobility systems, enabling cities to compare performance, identify areas for improvement, and align their investments with sustainable development goals.

The UMI framework, once fully developed, will categorize indicators into key areas similar to their UMIs for Walking and Public Transportation counterparts. These categories will help cities evaluate key aspects of their mobility systems, including safety, service quality, and accessibility to key destinations. That said, it is important to note that these indicators are still in the development phase and are evolving under the Trans-European Transport Network (TEN-T) regulations.

The revised TEN-T Regulation, which came into force in July 2024, introduces significant changes to urban mobility planning by enhancing the role of cities as hubs within the trans-European transport network. It designates 431 cities as urban nodes and mandates the adoption of Sustainable Urban Mobility Plans (SUMPs), along with the collection and submission of data on UMIs to the European Commission. These indicators, focusing on sustainability, safety, and accessibility, will play an even bigger role in monitoring the implementation of SUMPs and ensuring the effective interaction of urban mobility systems with the broader TEN-T network.

Although the UMIs are still under development, the CONDUCTOR project demonstrates strong alignment with the broader objectives they aim to achieve. As the UMI framework continues to evolve under the revised TEN-T regulations, CONDUCTOR's approach will likely fall in line with many of the anticipated indicators and goals that TENT-T expert group on urban mobility are working towards.

Key Impact Pathways (KIPs), meanwhile, are an instrument used by the EC under the Horizon Europe framework to measure the impact of research and innovation activities. These pathways help track progress across three main areas: scientific, societal, and economic impacts. They capture both short-term result, medium-term effects, and long-term impacts. By focusing on nine specific pathways, the EU can assess how well projects are meeting their goals and contributing to broader societal challenges, including climate change and digital transformation

The connection between KIPs and UMIs is their common goal of advancing societal and environmental improvements. For example, research and innovation projects tracked through KIPs might develop new technologies or policies that enhance urban mobility, and their success could be measured through UMIs. Both tools, though different in focus, will support CONDUCTOR to assess the impact of the pilot projects.

CONDUCTOR is strongly aligned with the KIPs by directly addressing scientific, societal, and economic impacts through its innovation in fleet and traffic management. By reducing emissions, improving travel efficiency, and supporting urban mobility transformation, the project’s outcomes directly contribute to the KIPs’ objectives.

4 CONDUCTOR IMPACT FRAMEWORK

4.1 Rationale

4.1.1 Baseline, business-as-usual, and post-pilot results comparison

As recommended by the CIVITAS policy evaluation framework, the impact evaluation approach for the CONDUCTOR project is built on comparing baseline conditions, business-as-usual (BaU) scenarios, and post-pilot results (Figure 3). These comparisons are necessary to assess the real-world benefits of the solutions being tested within the project's use cases. By establishing and refining these scenarios, we ensure that the impact of the interventions is accurately measured, free from external influences that might affect the results.

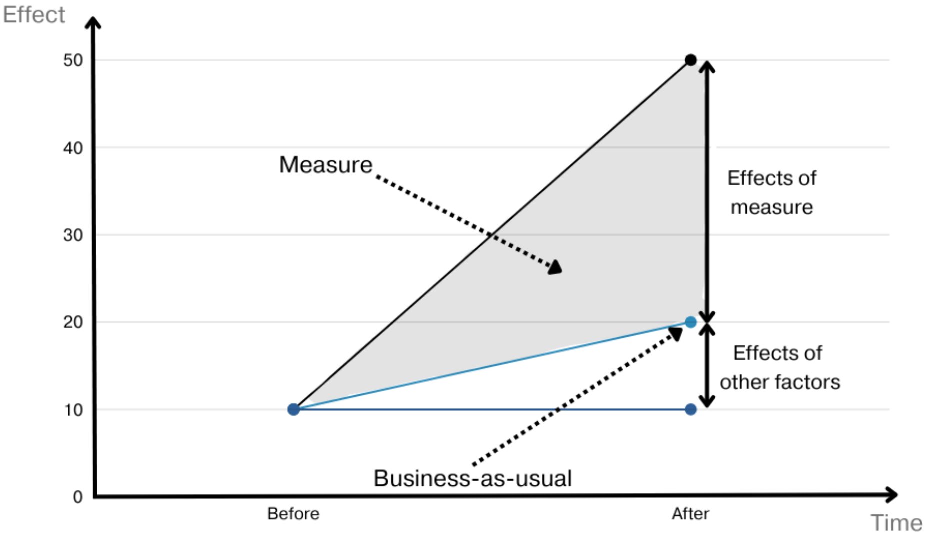

Figure 3: Scenario comparisons (Source: CIVITAS)

Baseline scenario

The baseline refers to the pre-existing conditions in the traffic and fleet management systems, before the CONDUCTOR solutions were introduced. This serves as the reference point for measuring the changes brought by the project. Historical data from sensors, local transportation networks, and other relevant sources can be used to describe the baseline conditions. For example, in the UC1 Almelo pilot, baseline traffic data can be collected through existing roadside infrastructure, measuring vehicle stops, emissions, and traffic flow before the solution is applied.

According to CIVITAS guidelines, establishing a robust baseline is crucial. It should be sufficiently broad to embrace all key indicators that may be influenced by the intervention, including unintended impacts. In addition, the baseline should be statistically sound to enable credible evaluations.

Business-as-Usual scenario

The BaU scenario simulates what would happen if the CONDUCTOR interventions were not implemented. This scenario, based on predictive models or historical data aims is key to isolating the project's impact by providing a counterfactual. CIVITAS outlines that establishing a credible BaU scenario often involves forecasting based on past trends or monitoring a control site with similar characteristics.

In CONDUCTOR, BaU scenarios might incorporate forecasted increases in vehicle numbers, congestion, and expected environmental impact in the absence of new traffic management systems. In the case of UC2, the BaU might consider the continued use of conventional DRT systems without optimisation. In some instances, where full BaU data may not be available, medium scenarios might be employed, where only part of the solutions is applied.

Post-pilot scenario

The pilot results reflect the performance and outcomes during the implementation of CONDUCTOR's solutions, and they serve as the basis for post-intervention evaluations. Following CIVITAS's approach, this scenario requires a final set of measurements, taken after the intervention has been deployed. These measurements directly assess the effectiveness of the solutions and are compared with both the baseline and BaU to highlight the changes induced by the project.

Scenario comparisons and societal impacts

The CONDUCTOR evaluation framework, aligned with CIVITAS principles, depends on before-and-after comparisons, as well as counterfactual analysis using BaU. These comparisons help capture the direct effects of the interventions while controlling for other influencing factors. The impact of these comparisons will be then translated into societal impacts using economic valuation methods, such as monetary savings per reduced minute of travel time and avoided health costs thanks to emission reduction. This step is essential for quantifying and compiling the benefits of the CONDUCTOR solutions. For instance, reductions in travel time will be evaluated in terms of € saved per minute, helping to provide a clearer picture of how CONDUCTOR interventions contribute to societal well-being and operational efficiency. Similarly, reductions in CO_2 emissions will be monetised to reflect the environmental savings achieved by the project, to be then compiled and compared with the results of other use cases.

5 USE CASES EVALUATION STRATEGY

5.1 Alignment with validation plans

The impact evaluation framework is directly tied to the validation strategy defined in D5.1: Validation Strategy and Plan. To avoid overlap and leverage the extensive work undertaken in T5.4, we selected key KPIs that can be economically quantified. These KPIs measure the technical, social, environmental, and economic performance across all use cases, ensuring that the evaluation reflects the real-world effectiveness of CONDUCTOR solutions.

Through a structured approach, the validation plans provide the criteria and hypotheses that serve as a foundation for both evaluation and exploitation. The selected KPIs form the backbone of this process, translating technical achievements into tangible results that can be used to advocate for wider adoption.

The impact evaluation also serves as a bridge between validation and exploitation by offering detailed insights into the performance of the solutions, as depicted in Figure 4. By transforming the KPI results into quantifiable societal, economic, and environmental impacts, this framework provides strong evidence for stakeholders to support the scalability and broader deployment of CONDUCTOR's solutions. The framework's ability to demonstrate reductions in travel time, operational costs, and emissions should support making a compelling case for adoption across different urban and transport systems.

In this way, the evaluation will be able to confirm or not the success of the solutions in specific pilot scenarios but also provides transferable, evidence-based arguments to promote their wider application across European cities.

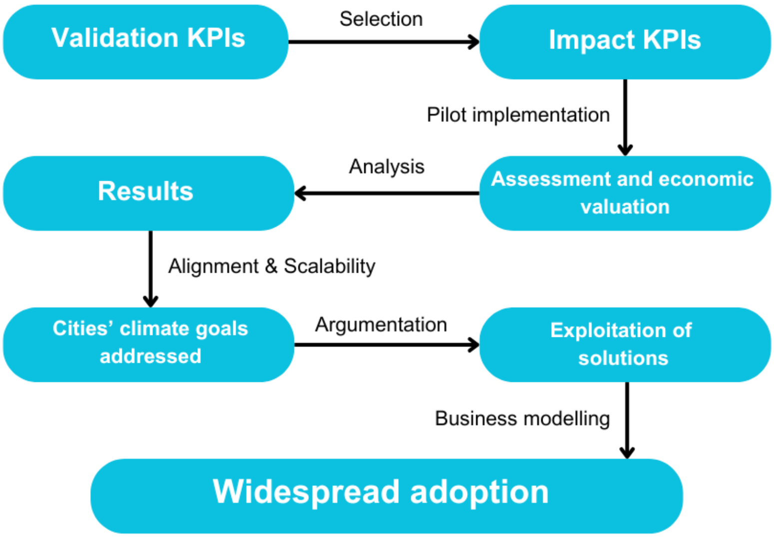

Figure 4: Pathway towards impact: from validation plans to widespread adoption (Source: own elaboration combining different sources)

5.2 Use cases' KPI assessment

The assessment of KPIs for each use case within the CONDUCTOR project goes beyond tracking quantitative technical performance; it aims to translate these KPIs into tangible economic and societal impacts. We rely on the Handbook on the External Costs of Transport (2019) as the primary reference to estimate transport-related external costs, such as air pollution, noise, congestion, and accidents. This allows us to assign monetary values to each KPI, translating improvements—such as reduced CO_2 emissions or shortened travel times—into economic savings. The external cost figures provided in the handbook are widely recognised by EU institutions and transport experts, making them reliable for benchmarking our estimates.

For example, in UC1 Athens, validation KPIs such as reduced travel time and improved punctuality have immediate economic benefits, such as time savings for passengers and reduced operational costs. The value of time (€/hour) and emission costs (€/tonne) are translated into euros, providing a concrete perspective on the potential returns on investment.

In order to comprehensively link the various Key Performance Areas (KPAs) to the KPIs and the core questions they aim to answer within the impact assessment, Figure 5 summarises how the KPIs for technical, environmental, social, and economic impacts are tied to specific inquiries. These questions span all UCs and ensure a holistic approach when assessing the socio-economic implications of CONDUCTOR's solutions.

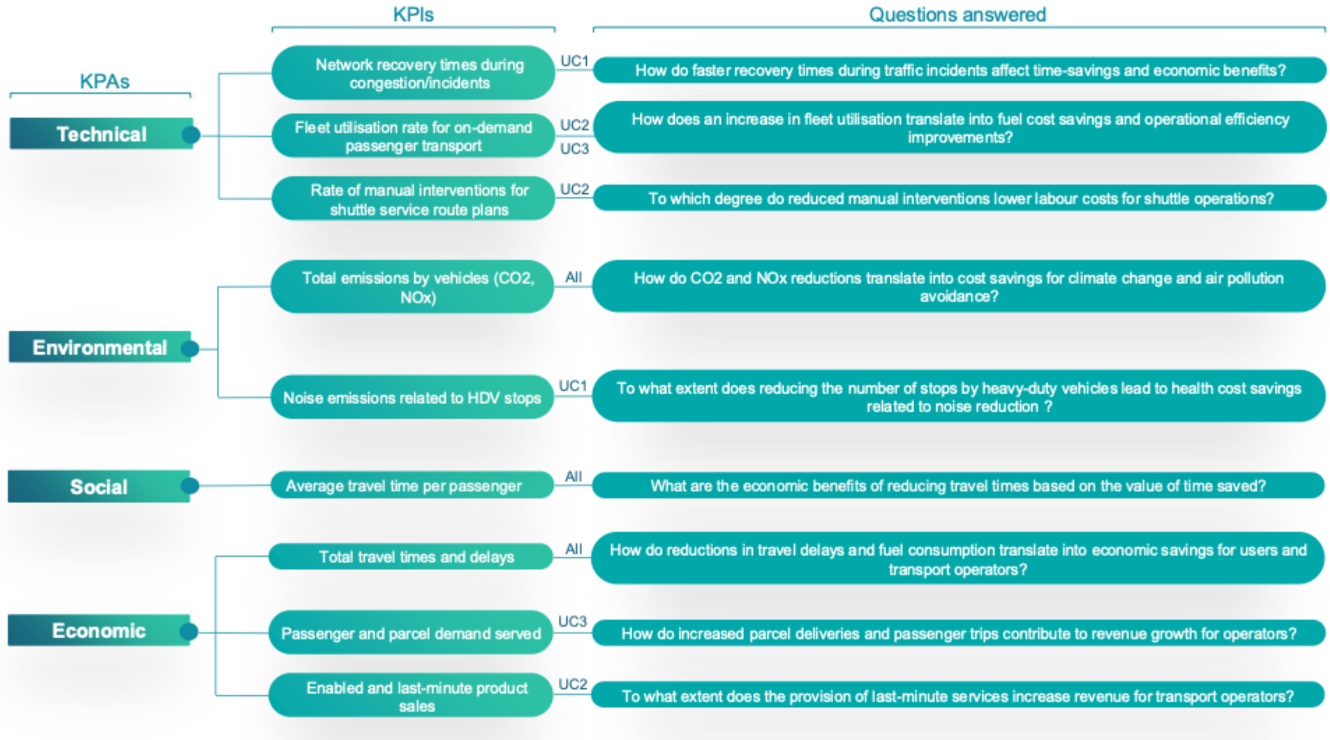

Figure 5: Overview of KPAs, KPIs, and their related socio-economic impact questions

5.2.1 UC1 Athens

The Athens pilot focuses on integrating public transportation modes to reduce door-to-door travel times and improve journey reliability. For this pilot, we have selected the following KPIs (Table 2) based on validation plan, alongside their related valuation method, references values when available, as well as the calculation formula:

Table 2: UC1 Athens KPIs evaluation

KPA	KPIs	Economic valuation method	Reference value	Formula
Technical	Average travel time per passenger, Waiting time of passengers	Value of time (€/hour/person) for passenger travel in urban settings	9€ / hour / person (Greece - Handbook of external costs)	Average travel time reduction per trip (hours) * total number of trips (units) affected by solution * 9 (€) * average vehicle occupancy
	Punctuality of scheduled arrival/departure time	Value of time (€/hour/person) for passenger travel in urban settings	9€ / hour / person (Greece - Handbook of external costs)	Delay reduction per passenger (hours) * total number of passengers affected * 9 (€)
	Travel time and speed of vehicles	Time savings (€/hour) for vehicle operation	9€ / hour / person (Greece - Handbook of external costs).	Reduction in fuel consumption (litres) * cost of fuel (€/litre) + time saved (hours) * cost of time (€/hour)
Social	Travel times	Value of time (€/hour/person)	9€ / hour / person (Greece - Handbook of external costs)	Reduction in travel time per trip (hours) * number of passengers affected * 9 (€)
Environmental	Total emissions by all the vehicles in the network who have completed their trip (CO2, NOx)	Climate change avoidance costs for CO2, air pollution costs for NOx	Climate change avoidance cost of CO2 emissions avoided: 100 €/tonne CO2[1], Air pollution cost of NOx emissions avoided: 5.1 €/kg NOx	Reduction in CO2 emissions (tonnes) * climate change avoidance cost of CO2 emissions (€/tonne) + reduction in NOx emissions (kg) * air pollution cost of NOx (€/kg)
Economic	Running costs per passenger (fuel / energy consumption)	Fuel cost savings (€/litre), energy consumption reduction (€/kWh)	Fuel and energy costs in Greece, 2024-average[2].	Reduction in fuel consumption (litres) * cost of fuel (€/litre) + energy consumption reduction (kWh) * cost of energy (€/kWh)

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[1] EU-28 estimation (scenario : central) of climate change avoidance costs in €/tCO2 equivalent (€2016)

[2] As fuel and energy prices can be subject to high volatility, estimated values will be computed upon pilot completion based on observed averages fuel and energy prices for the pilot period.

5.2.2 UC1 Almelo

The Almelo pilot is centred around improving freight traffic management by minimising stops at traffic lights and enhancing flow along key logistics routes. The selected KPIs for this pilot are outlined below in Table 3, together with their valuation methods, reference values when available, and calculation formulas:

Table 3: UC1 Almelo KPIs evaluation

KPA	KPIs	Economic valuation method	Reference values	Formula
Environmental	Total emissions by all vehicles in the network under consideration	Climate change avoidance costs for CO2, air pollution costs for NOx	Climate change avoidance cost of CO2 emissions avoided: 100 €/tonne CO2[3], Air pollution cost of NOx emissions avoided: 26.5 €/kg NOx	Reduction in CO2 emissions (tonnes) * €100 + Reduction in NOx emissions (kg) * €26.5
	Reduction in fuel consumption	Fuel cost savings (€/litre)	Fuel costs in Netherlands for HDVs, 2024-average[4]	Reduction in fuel consumption (litres) * cost of fuel (€/litre)
	The number of stops made by trucks/Heavy-duty vehicles (HDVs)	Noise reduction cost savings (€/dB)	Tbd	Total number of stops avoided (units) * dB/stop * noise reduction factor (€/dB)
Economic	The number of stops made by trucks/HDVs	Fuel cost savings (€/litre)	Fuel costs in Netherlands for HDVs, 2024-average[3]	Reduction in fuel consumption (litres) * cost of fuel (€/litre)
	Delay by trucks/HDVs: additional travel time compared to an uninterrupted pass	Value of time for freight road long distance trips – Netherlands (€2016/Hour/HGV)	22.5€ / Hour / HGV	Reduction in delays (hours) * number of vehicles affected * €22.5/hour

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[3] EU-28 estimation (scenario: central) of climate change avoidance costs in €/tCO2 equivalent (€2016)

[4] As fuel and energy prices can be subject to high volatility, estimated values will be computed upon pilot completion based on observed averages of fuel and energy prices for the pilot period.

5.2.3 UC1 Madrid

The Madrid pilot focuses on advancing traffic management systems with the introduction of connected and automated vehicles to boost overall traffic efficiency. Table 4 lists the KPIs chosen for this pilot, including their valuation methods, reference values, and relevant calculation formulas:

Table 4: UC1 Madrid KPIs evaluation

KPA	KPIs	Economic valuation method	Reference value	Formula
Technical	Average travel times and delays per connected and conventional vehicles	Value of time (€/hour/person) for passenger travel in urban settings	12.1€ / Hour / Person (Spain-Urban – Handbook of external costs)	Reduction in travel time per trip (hours) * total number of trips (units) affected * 12.1 (€) * average vehicle occupancy
	Different traffic measurements will be analysed to capture the recovery time, in terms of reducing congestion and bringing the network back to normal conditions.	Value of time (€/hour/person) for passenger travel in urban settings	12.1€ / Hour / Person (Spain - Handbook on the external costs of transport)	Reduction in travel time per trip (hours) * total number of trips (units) affected * 12.1 (€) * average vehicle occupancy
Environmental	Total emissions by all the vehicles in the network who have completed their trip (CO2, NOx)	Climate change avoidance costs for CO2, air pollution costs for NOx	100 €/tonne CO2, 26.5 €/kg NOx (Spain - Handbook of external costs)	Reduction in CO2 emissions (tonnes) * 100 €/tonne + Reduction in NOx emissions (kg) * 26.5 €/kg
Economic	Total travel times and delays	Value of time (€/hour/person) and fuel cost savings	12.1€ / Hour / Person (Spain) + Fuel cost 2024 average (Spain)	Reduction in delay time (hours) * total number of passengers affected * 12.1€ + fuel consumption reduction (litres) * cost of fuel (€/litre)

5.2.4 UC2 Slovenia

The Slovenia/Italy pilot seeks to optimise DRT services by refining route plans and improving fleet management to meet evolving passenger needs. The following KPIs have been identified and listen in Table 5, alongside their valuation methods, reference values where applicable, and calculation formulas:

Table 5: UC2 Slovenia/Italy KPIs evaluation

KPA	KPIs	Economic valuation method	Reference value	Formula
Technical	Rate of manual interventions for shuttle service route plans	Labour cost savings from reduced interventions	Average labour cost per hour for GoOpti	Reduction in manual interventions (hours) * labour cost per hour
	Fleet kilometres per daily plan	Fleet fuel cost savings (€/daily plan)	Fuel costs in Italy, Austria, Slovenia, Croatia, for passenger vehicles (2024-average)	Average reduction in km driven (per daily plan) * fuel consumption (litres/km) * cost of fuel (€/litre)
Social	Ratio of accepted and rejected requests	Value of time (€/hour)	Value of time (€/hour/person) for shuttle service users in Slovenia/Italy, Slovenia/Croatia and Slovenia/Austria: 5.5€	Increase in accepted requests (units) * average time saved per passenger (hours) * 5.5 (€)
Environmental	Reduction in GHG emissions (CO2, NOx)	Climate change avoidance costs for CO2, air pollution costs for NOx	100 €/tonne CO2 (EU-28 estimation), 26.9 €/kg NOx for Italy, Slovenia Austria, Croatia (Average)	Reduction in CO2 (tonnes) * 100 €/tonne + Reduction in NOx (kg) * 23.85 €/kg
Economic	Average costs per kilometre per passenger dropped off	Fuel cost savings per kilometre reduced	Fuel costs in Italy, Slovenia, Austria, Croatia for passenger vehicles (2024-average) Average reduced kilometres per passenger dropped off	Average reduced kilometres per passenger dropped off * fuel consumption (litres/km) * cost of fuel (€/litre)
	Average planning costs per route plan	Labour cost savings from reduced planning time	Labour costs for GoOpti planners	Reduction in planning time (hours) * labour cost per hour
	Enabled and number of last-minute product sales	Revenue increase from new services	Revenue per service based on real-world data	Increased last-minute services provided (units) * average revenue per service (€)

5.2.5 UC3 Madrid

The Madrid pilot aims to develop coordination strategies for DRT-CCAM (i.e., DRT enabled by CCAM) and parcel delivery services. The KPIs selected for this use case, along with their economic valuation methods, reference values, and calculation formulas, are outlined below in Table 6:

Table 6: UC3 Madrid KPIs evaluation

KPA	KPIs	Economic valuation method	Reference value	Formula
Technical	On-demand passenger's transport fleet utilisation rate	Fuel cost savings (€/litre), vehicle utilisation increase (€)	Fuel costs in Spain for DRT vehicles (2024-average)	Number of avoided idle trips (units) * average fuel consumption per trip (litres) * cost of fuel (€/litre)
	Total distance of the DRT and delivery vehicles	Fuel cost savings (€/litre)	Fuel costs in Spain for DRT vehicles (2024-average)	Reduction in distance travelled (km) * fuel consumption (litres/km) * cost of fuel (€/litre)
	Number of vehicles used for goods delivery	Reduction in operational costs (€)	Labour cost savings per vehicle (€/hour)	Reduction in the number of delivery vehicles (units) * labour cost per vehicle (€)
	Average travel times of road traffic	Value of time (€/hour/person) for passenger travel in urban settings	12.1€ / Hour / Person (Spain-Urban)	Reduction in average travel time (hours) * total number of passengers * 12.1 (€)
Economic	Passenger demand served	Increase in revenue from additional passenger trips served.	Revenue per trip served (€)	Increase in passengers trips (units) * revenue per trip (€)
	Parcel demand served	Increase in revenue from parcel delivery (€)	Revenue per parcel delivery (€)	Increase in parcel deliveries (units) * revenue per parcel (€)
	Total vehicle emissions (CO2 and NOx) of delivery vehicles	Climate change avoidance costs for CO2, air pollution costs for NOx	100 €/tonne CO2, 26.5 €/kg NOx (Spain)	Reduction in CO2 emissions (tonnes) * 100 €/tonne + Reduction in NOx emissions (kg) * 26.5 €/kg
	Average costs per parcel delivered & passenger	Fuel cost savings (€/litre) from reduced trips, labour cost savings (€)	Fuel costs in Spain (2024-average) Average operational cost for a delivery/passenger DRT trip	Reduction in delivery trips * average operational cost per delivery trip (€) + Reduction in passenger trips * average operational cost per passenger trip (€)
	Total fuel consumed by the DRT and delivery vehicles	Fuel cost savings (€/litre)	Fuel costs in Spain for DRT and delivery vehicles (2024-average)	Total reduction in fuel consumption (litres) * cost of fuel (€/litre)

6 ANALYSIS & INSIGHTS EXPECTED IN D5.4

6.1 Comparative analysis

The comparative analysis in **D5.4** will focus on aggregating and contrasting the economic valuations derived from the selected KPIs across different scales: pilot level, city level, and project level. By applying the impact evaluation framework established in this deliverable, we will compile the results from each UC to provide a comprehensive overview of the benefits and costs associated with the CONDUCTOR solutions.

At the **pilot level**, we will assess the localised impacts of the solutions, taking into account the specific context of each UC. This includes evaluating reductions in travel times, fuel consumption, and emissions for both passengers and logistics operations. Each KPI is assigned a monetary value through the methodologies defined in this deliverable, allowing for a consistent economic comparison despite the varying thematic areas of the KPIs. This ensures that KPIs, whether related to technical performance, social impact, or environmental benefits, can be evaluated on a common economic scale.

At the **city level**, we will compile the impacts of pilots that share geographical or operational similarities to assess the broader implications of deploying CONDUCTOR solutions at an urban scale. This will focus on the city-wide benefits, such as traffic efficiency improvements and reduced emissions, and how these contribute to meeting city-level goals like climate targets and sustainable mobility.

At the **project level**, we will synthesise the results from all pilots to provide an overall assessment of the economic, environmental, and social benefits generated by the project. The ability to convert KPIs from different thematic into monetary values allows us to offer a holistic evaluation of the project's impact, quantifying cost savings in areas such as fuel consumption, time savings, and operational efficiency. This also supports the analysis of scalability, offering insights into how the solutions validated in the pilots can be transferred and applied across other European cities and contexts.

6.2 Alignment with cities’ ambitions and targets on climate neutrality

UC1-ATHENS

Athens has committed to climate goals under the framework of both local and EU-wide initiatives. The Athens City Council approved a Climate Action Plan to reduce its greenhouse gas emissions by 61% by 2030 compared to 2018 levels. This target is part of Athens' broader strategy to combat climate change and aligns with the requirements of the Paris Agreement, striving to limit global warming to 1.5°C. Additionally, the city aims to ensure 70% of residents have access to green spaces within a 15-minute walk by 2030, with 30% of its surface covered by green or permeable areas to enhance climate adaptation and quality of life.

Athens is actively involved in several major international networks and initiatives aimed at tackling climate change, such as C40 Cities and Resilient Cities Network. Similarly, it has been selected as one of the 100 Climate-Neutral and Smart Cities by 2030, an EU initiative that helps cities implement their climate goals by offering funding, technical support, and collaboration opportunities.

By integrating public transport modes and improving real-time traffic management CONDUCTOR offers a measurable approach to reducing travel times and optimizing vehicle flow. Through its impact evaluation framework, CONDUCTOR quantifies the reductions in CO2 emissions by comparing baseline traffic conditions with post-pilot scenarios. Furthermore, the framework assesses how enhanced public transport efficiency reduces private car reliance, with metrics tied to emission reductions and energy savings. The framework could demonstrate the degree to which the solutions developed in CONDUCTOR contributes to Athens' climate goals.

UC1-, UC3- MADRID

Through the Madrid Roadmap, the city laid out its mission to reduce greenhouse gas (GHG) emissions by 65% by 2030 (compared to 1990 levels) and aiming for full climate neutrality by 2050. The city has also seen progress in recent years, with direct emissions dropping by 11.9% in the residential, commercial, and institutional sector, and by 34% in road transport from 2000 to 2019. The roadmap emphasizes the importance of an inclusive urban transformation, focusing on technical, social, and economic feasibility. Key sectors and actions identified to achieve these reductions include residential, services, and transport sectors, which contribute up to 90% of total emissions reductions.

The city has similarly been selected as part of the European Union's 100 Climate-Neutral and Smart Cities by 2030 initiative, which aims to make Madrid climate-neutral by 2030—two decades ahead of the EU's broader 2050 target. In addition, Madrid is a participant in the NetZeroCities project, which supports cities in overcoming structural and financial barriers to meet climate goals by 2030.

CONDUCTOR's impact assessment framework directly aligns with this roadmap by providing a structured approach to measure the contributions from the transport sector, particularly through the UC1 and UC3 pilots in Madrid. The UC1 pilot seeks to optimize transport network operations after the incidents that may disrupt the flow of people or goods, and may result in economic losses. Meanwhile, the UC3 pilot aims to optimize last-mile delivery by integrating freight and passenger transport. Through its framework, CONDUCTOR quantifies reductions in emissions, energy consumption, and travel times in these UCs, translating these improvements into economic and societal impacts. This will offer a concrete evaluation of how CONDUCTOR's solutions contribute to the emissions reductions outlined in the roadmap.

UC1-ALMELO

The city of Almelo, like other municipalities in the Netherlands, follows national and EU climate targets aimed at reducing greenhouse gas emissions. Almelo's climate goals align with national commitments to the Paris Agreement, targeting a 49% emissions reduction by 2030 and supporting energy efficiency to meet the EU goal of a 90% reduction by 2040. At the local level, Almelo has implemented measures focused on climate adaptation, such as improving green infrastructure and water management to combat increasing heat, drought, and heavy rainfall.

The CONDUCTOR UC1 pilot in Almelo focuses on improving freight traffic management, reducing vehicle stops, and optimizing circulation, which may lead to lower fuel consumption and emissions. Through its impact evaluation framework, CONDUCTOR provides measurable insights into how the optimized freight traffic s ystem helps Almelo meet its climate goals. The framework also evaluates other societal impacts, such as noise reduction and improved air quality, ensuring that the solutions tested in Almelo are aligned with both national and local climate objectives.

UC2-SLOVENIA

This use case involves multiple cities and regions, each with distinct climate goals and sustainable mobility targets tailored to their local priorities. Despite their unique approaches, they share overarching objectives, striving toward climate neutrality, reduced emissions, and enhanced urban mobility through innovations in sustainable transport.

Ljubljana has set a series of goals to reduce greenhouse gas emissions and improve mobility as part of its climate action strategy. The city is focused on achieving climate neutrality by 2030. Ljubljana is also a member of the NetZeroCities initiative, part of the broader EU Mission: 100 Climate-Neutral and Smart Cities by 2030. The City has also established goals to promote sustainable mobility by reducing private vehicle use and increasing walking, cycling, and public transport. Their target is for two-thirds of all trips to be completed using sustainable methods by 2027 by enhancing public transport, developing cycling infrastructure, and encouraging electromobility.

Maribor, Slovenia's second biggest city population-wise, has committed to reach climate neutrality by 2040. The city has similarly been selected as part of the EU's "100 Climate-Neutral and Smart Cities by 2030. The city is tackling these goals through increased investment in energy efficiency, public transportation, and emissions-reducing measures. The city's transport policy prioritizes sustainable mobility solutions, aiming to curb private vehicle use and improve the distribution across various modes of transit. The goal is a more balanced and efficient modal split, reducing reliance on individual motorized transport.

Zagreb was the first city in Slovenia to implement a Sustainable Energy and Climate Action Plan, setting a 40% reduction in greenhouse gas emissions by 2030. As a member of the C40 Cities Climate Leadership Group, Zagreb has prioritized sustainable energy, enhanced mobility infrastructure, and reduced dependency on private vehicles. The city's strategic mobility initiatives emphasize modernizing public transit, optimizing intersections for transit prioritization, and expanding bicycle and light rail infrastructure. Through its City Office for Strategic Planning and Development, Zagreb collaborates on EU projects and coordinates regional development, actively engaging stakeholders in creating a sustainable urban mobility vision.

Vienna's climate targets and ambitions for combating climate change are laid out in its The Smart City Wien framework: sustainability strategy updated in 2022 with the ambitious target of achieving climate neutrality by 2040. This framework prioritizes integrated urban planning, low-emission public transportation, and extensive public participation in shaping Vienna's mobility landscape, all backed by the Vienna Climate Budget and Vienna Climate Check to ensure each project's environmental impact is measurable and impactful. Lastly, like its counterparts, Vienna is part of the EU Mission for 100 Climate-Neutral and Smart Cities by 2030 and the C40 Cities Climate Leadership Group. They leverage these partnerships to advance ambitious climate goals through shared innovation and funding.

The Friuli-Venezia Giulia region, where the Trieste airport is located, has a set goals in climate action, focusing on energy transition, sustainable mobility, and GHG emissions reduction. Their 2021-2027 regional development plan emphasizes promoting energy efficiency to reduce emissions. The region aligns its goals with the EU's broader objectives of reducing emissions by 55% by 2030, and ultimately achieving carbon neutrality by 2050. Friuli-Venezia Giulia is also a participant in the Covenant of Mayors for Climate and Energy, where members commit to reducing CO2 emissions by at least 40% by 2030.

By optimizing DRT systems, the UC2 pilot has a goal of reducing fuel consumption and emissions through more efficient route planning and fleet operations. The framework translates these operational improvements into measurable environmental impacts, such as reductions in CO2 and NOx emissions. This allows the cities and regions involved to understand the exact contribution of the pilot toward achieving their climate neutrality and emissions reduction targets from passenger routes to the airport.

7 CONCLUSIONS

This deliverable, D5.2, has established the Impact Evaluation Framework to assess the quantifiable effects of the solutions implemented within the CONDUCTOR project across its various UCs. This framework builds directly on the validation strategies outlined in D5.1, ensuring alignment between validation activities and the impact assessments. The primary aim is to move beyond technical measurements and focus on translating Key Performance Indicators (KPIs) into tangible economic, environmental, and societal impacts.

The framework relies on KPIs chosen from Task 5.4, focusing on their monetisation using the Handbook on the External Costs of Transport (2019), which provides widely accepted reference values for transport-related externalities such as air pollution, noise, and emissions. This approach allows the project to assign monetary value to the technical improvements measured in each UC. For example, reductions in CO_2 emissions, improvements in travel times, and fuel savings are translated into direct economic benefits, making the case for the solutions' real-world impact.

Each UC is evaluated within four Key Performance Areas (KPAs): technical, environmental, social, and economic. These areas are carefully selected to ensure a comprehensive evaluation that reflects the real-world effects of CONDUCTOR's solutions on both the operational efficiency and broader societal goals. In particular, environmental KPIs are linked to climate change avoidance costs and reductions in air pollution, which offer measurable benefits to local and regional climate objectives.

The use of these KPIs is essential for not only providing a technical evaluation but also a socio-economic one, demonstrating how technical performance translates into measurable cost savings and environmental benefits. For instance, time savings from improved traffic management systems are valued using the €/hour method, while emission reductions are calculated based on €/tonne CO_2 avoided. These valuations provide stakeholders with a concrete understanding of how CONDUCTOR's innovations contribute to cost reductions, operational efficiency, and climate action.

Additionally, the framework is structured to ensure that the assessment goes beyond the specific pilot settings to offer insights into the scalability of the solutions across different European cities. By linking KPIs to broader urban and regional goals, such as climate neutrality or emissions reductions, the framework ensures that the results from each use case can be extrapolated and used as evidence for further deployment of CONDUCTOR’s solutions.

In the next phase, D5.4, the framework will be applied to provide a detailed comparative analysis across the pilot, city, and project levels. This will enable the project to demonstrate the aggregated effects of its solutions, providing insights into both localised impacts and broader systemic benefits. By comparing baseline conditions, business-as-usual scenarios, and post-pilot results, the framework will ensure that the project's interventions are accurately assessed, and the benefits clearly documented and quantified.

Ultimately, the Impact Evaluation Framework outlined in this deliverable offers a rigorous, monetised assessment of how CONDUCTOR’s solutions impact transport efficiency, environmental performance, and societal outcomes. By aligning these results with city-level goals — such as emission reductions, travel times, and operational costs — the project provides a data-driven foundation for scaling and exploiting these solutions across Europe.

In conclusion, D5.2 ensures that the expected benefits, as projected in the initial proposal, can be validated and quantified. With the application of this framework in D5.4, CONDUCTOR will be able to provide clear, evidence-based recommendations for the scaling and widespread adoption of its solutions, supporting European cities in their pursuit of more efficient, sustainable, and cooperative mobility systems.

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A. ABBREVIATIONS AND DEFINITIONS

Term	Definition
AV	Autonomous Vehicles
BaU	Business-as-Usual
CAV	Connected Autonomous Vehicles
CCAM	Connected, Cooperative and Automated Mobility
CEM	Common Evaluation Framework
CO_2	Carbon Dioxide
DRT	Demand-Responsive Transport
EU	European Union
HGV	Heavy Goods Vehicle
KPI	Key Performance Indicator
KIP	Key Impact Pathways
MTME	Multimodal Traffic Management
NOx	Nitrogen Oxide
SUMP	Sustainable Urban Mobility Plan
TEN-T	Trans-European Transport Network
UC	Use Case
UMI	Urban Mobility Indicator
VKT	Vehicle Kilometres Travelled
WP	Work Package