

## Introduction

Transport is the second-largest source of greenhouse gas (GHG) emissions and accounts for more than 30% of total energy consumption in the EU [1]. A series of global crises highlights the need for a significant shift from conventional vehicles to well-integrated, energy efficient, connected and automated passenger and freight services that meet the ambitious EU goals [2].

The metaCCAZE project, co-funded by the European Union via Horizon Europe, and accounting with the partnership of the 2ZERO, CCAM and Cities Mission, aims to revolutionise mobility 10 Living Labs are being developed in 10 Mission cities across Europe, serving both passengers and freight, with innovative electric, automated, and connected solutions designed to make transportation smarter, net zero, and more efficient for all [3–6].

## Research Gap & Objective

Empirical insights generated within the metaCCAZE project revealed a persistent gap: the lack of structured methodologies that effectively translate innovative mobility concepts into deployment-ready solutions.

While cities are actively piloting innovative solutions, many initiatives remain at the prototype stage and face challenges in scaling, governance alignment, and real-world implementation. This paper addresses this challenge by proposing and validating a structured Use Case Definition Framework (UCDF) designed to enhance deployment readiness and replicability of zero-emission mobility solutions. The research is guided by the following questions:

- How can zero-emission mobility use cases be structured to enhance deployment readiness?
- How can co-design methodologies support replicability across different urban contexts?

## Methodology

The UCDF is grounded in the CEN-CENELEC CWA 17381:2019 standard for Urban Innovation Use Cases, with tailored adaptations for the metaCCAZE project. The structured use case format is defined in DIN SPEC 91387, ensuring consistency in how cities conceptualise, evaluate, and scale smart city and urban solutions. The UCDF's underlying logic is based on a structure:

### • Why: Context and Justification

This section provides the background needed to understand the need for the Use Case and its relevance to the city's broader goals. The use of SMART Objectives (Specific, Measurable, Achievable, Relevant, and Time-Bound) ensures clear and measurable benchmarks.

### • What: Definition and Implementation Requirements

This section defines the Use Case in detail, including scope, location infrastructure requirements, operational dependencies, and risks. It provides a clear definition of the solution and its differentiation from existing approaches, ensuring clarity in purpose.

### • How: Operational and Financial Aspects

This section describes how the service operates (also under anomalous scenarios), how users interact with it, and the financial requirements for implementation including incentive structures support user adoption and behavioural change.

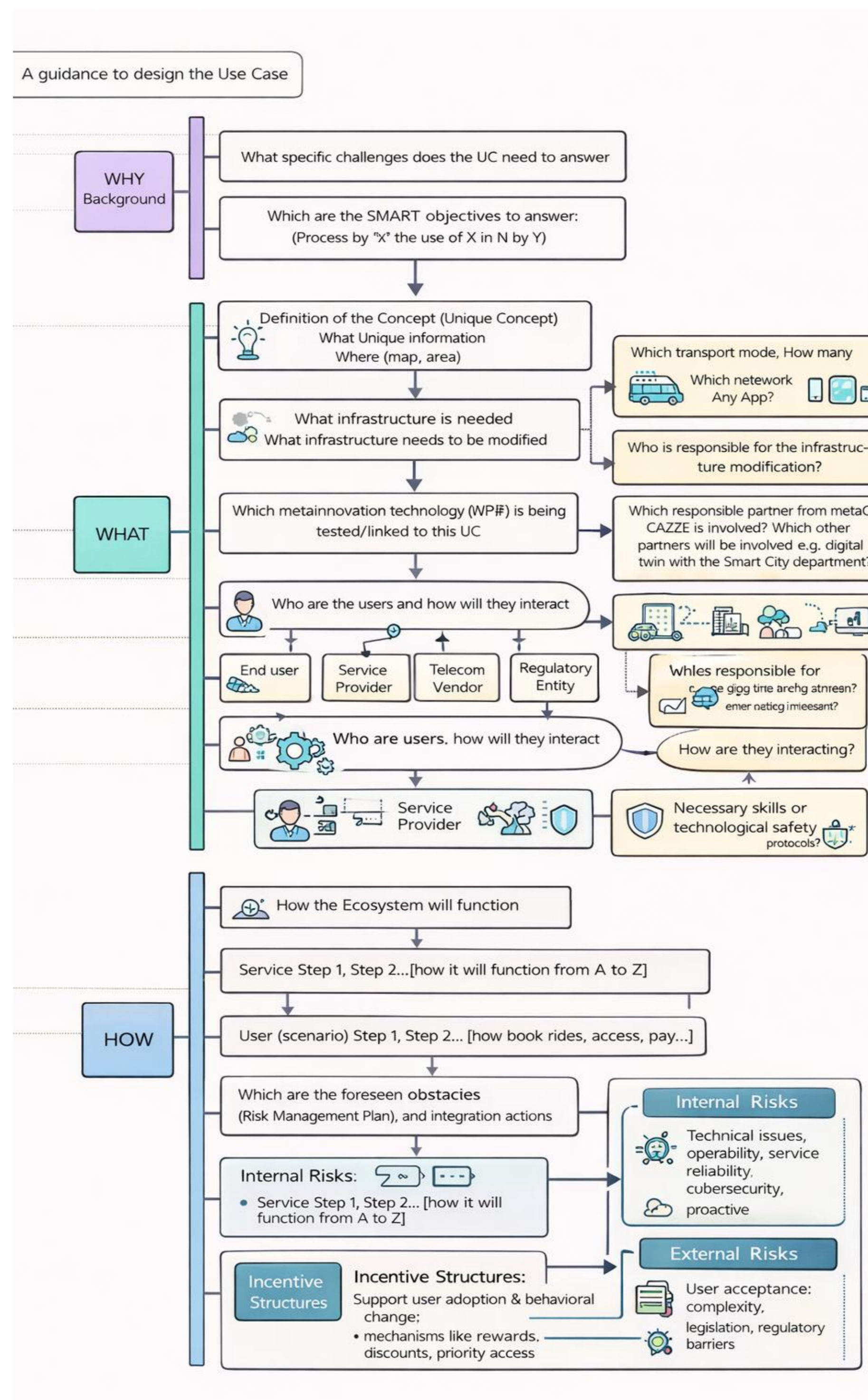


Figure 1: Why-What-How Structure in the UCDF

## Results

- **Munich** used the Template to define Dynamic Curbside Management and Multimodal Logistics Hubs. UCDF enabled the city to specify how digital mapping, enforcement mechanisms, and last-mile logistics with cargo bikes could be integrated into a coherent governance and operational framework, ensuring both regulatory feasibility and scalability.
- **Amsterdam** structured four Use Cases through UCDF: Autonomous Sailing, Adaptive Speed Governance, Waste Logistics, and Tradable Mobility Credits. Applying the Template helped transform diverse innovations into clearly defined prototypes by identifying implementation barriers, aligning with regulatory requirements, and embedding citizen acceptance considerations.
- **Limassol** defined On-Demand Mini-Bus Services, Shared E-Bikes, a Multimodal Passenger Hub, and Transport-Energy Integration. The Template allowed the city to link electrification and multimodality under a single structured definition, mapping infrastructure requirements and clarifying governance roles between municipal and national authorities.
- **Tampere** articulated two Use Cases: Autonomous E-Shuttles and Tram-Feeder Services. Through the Template, Tampere captured the operational dependencies, such as weather resilience and charging infrastructure, while also incorporating accessibility and user experience aspects to ensure social embracement alongside technical feasibility.
- **Athens's** advanced in their large-scale electric bus integration by deploying 240 e-buses and installing high-capacity depot chargers. In parallel, optimisation models for electric vehicle line planning, multi-depot scheduling, and charging infrastructure location.
- **Kraków** utilised UCDF on validating the feasibility of a container-based multimodal logistics hub. Through workshops and stakeholder consultations with logistics operators and infrastructure providers, key spatial, regulatory, and operational constraints were identified. The process clarified staffing needs, cargo e-bike access conditions, site limitations, and the infeasibility of shared storage under existing regulations.

- **Malta-Gozo** benefitted from UCDF on regulatory preparation for the demonstration of on-demand autonomous e-bus services. Legislative groundwork enabling autonomous vehicle operation during the pilot phase was advanced, and the leasing contract for the autonomous e-bus was finalised.
- **Milan** progressed thanks to UCDF in the identification of a pilot area with a quantitative methodology combining mobility and socio-economic data to support demand estimation. A dynamic DRT simulator was developed to evaluate vehicle utilisation, service quality, and real-time management of ride requests.
- **Miskolc** advanced in definitions of functional specifications for the multimodal passenger hub with local transport operators to inform procurement processes.
- **Poissy** took advantage of UCDF for a V2X-enabled smart mobility architecture to support real-time traffic supervision and shared vehicle services. The technical design included V2X gateway architecture, identification of roadside unit locations, and integration of sensor-based data streams.

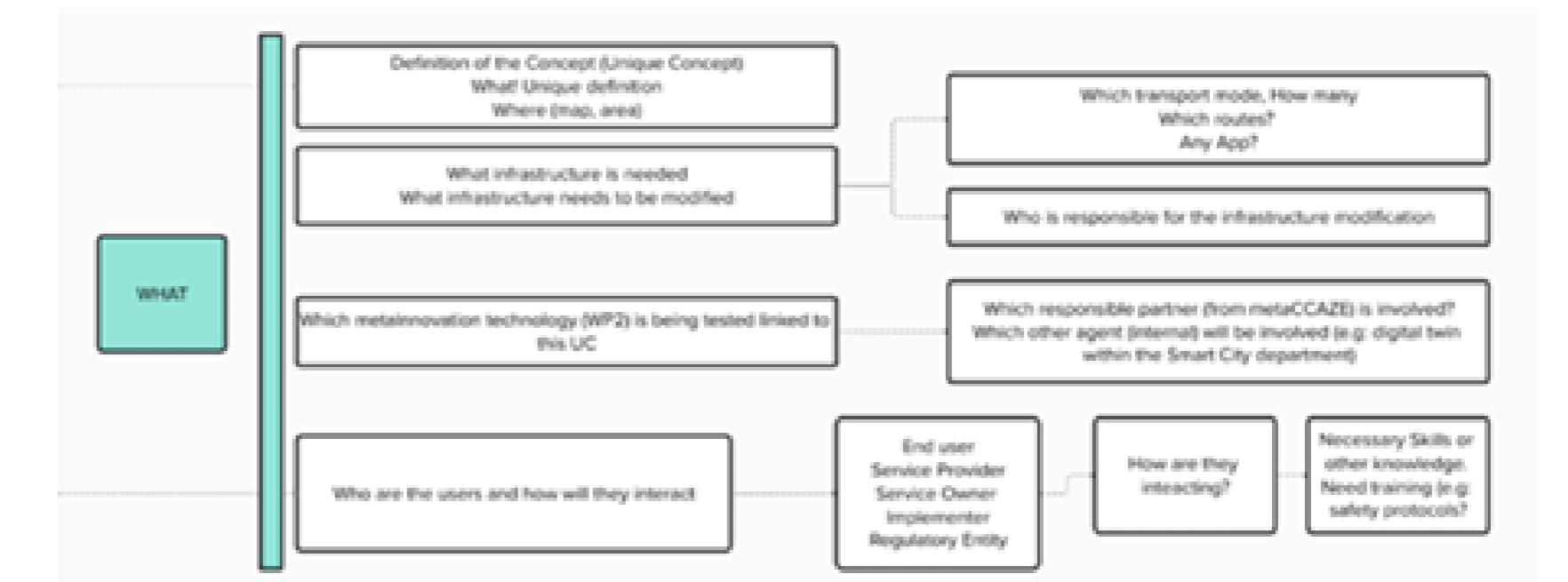
### First Stage of Why – What – How Framework



### Why: Challenges and Objectives

Questions
What specific challenges faced by the city will this Use Case address? <i>Including environmental concerns and related climate goals, logistics concerns, traffic issues, safety concerns, and any other problems that the Use Case will help mitigate – e.g. The city aims at decreasing the dependency of car use to achieve the climate neutrality goals</i>
Which (at least 5) objectives does the city aim to achieve through this Use Case? <i>Use SMART objectives – Specific, Measurable, Achievable, Relevant, Time-Bound – giving example: increase by % the use of X in N by Y?</i>
Feel free to consider the data or evidence supports these challenges (e.g., surveys, reports, or statistics)?

### What: The Concept, Location, and Infrastructure



Use Case Code
Use Case Title
Use Case Concept Definition <i>Unique Concept, Unique Definition – Explain why this UC is unique to other solutions</i>
Location (and its influence area) <i>Please describe the location of the solution and its area of influence, including a clear outline of the routes, and the scope of the project's influence. Additionally, please list any advantages the location provides and/or reasons for its selection (such as connection to current public transportation systems, economic influence, etc...)</i>

Figure 2: Snapshot of UCDF Framework

## Discussions & Conclusions

The Framework should be understood as an empirically grounded methodological approach rather than a universal replication model. Its validation is limited to structured pre-deployment phases within the metaCCAZE project context. Nevertheless, the results demonstrate that a structured Use Case definition can support cities in aligning governance, operational planning, and impact evaluation before deployment.

Ultimately, the Use Case Definition Framework demonstrates how structured methodologies can move beyond single projects to become replicable frameworks that empower cities across Europe to accelerate their transition towards climate neutrality.

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DETAILS AND  
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USE CASE  
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FRAMEWORK!