D2.1: Validation report of Lighthouse LLs Implementation

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Executive summary

The URBANE project provides support for the European Union's efforts to achieve safe and sustainable last mile delivery operations. The efforts conducted within the URBANE project to achieve safe and sustainable last mile delivery operations are driven by six key objectives:

- Analyse the Physical, Digital, Social and Business dimensions of complex last mile logistics delivery systems to define target strategic innovations of significant potential impact and develop a new framework to facilitate the co-creation of innovative last mile delivery solutions, accounting for environmental and energy efficiency.
- To setup, prototype, test and demonstrate last mile innovative solutions in four Lighthouse LLs [Wave 1], seen as commodities for all actors in an open, neutral and cooperation-based community.
- Provide the infrastructural Enablers for Innovation Transferability including consensus protocols to support collaborative services in local logistics networks governed by smart contracts, Digital Twinning capabilities and data driven decision making tools to enable replicability of most performing practices.
- Model, deploy and demonstrate smart solutions in two Twining Living Labs (Wave 2), clearly evidencing level of adaptation of models and efficient replicability of solutions demonstrated in Wave 1 LLs.
- Develop Business Plans and design a Commercialization Path for key project outcomes.
- Disseminate, promote scale-up, enable effective policymaking, and support relevant LL initiatives at EU level.

Deliverable 2.1 contributes in particular to the achievement of objective 2. It documents the work performed in Task 2.1 LLs Management and Validation that foresees the definition of the management process and a qualitative and quantitative assessment of the implemented solutions to evaluate and validate the operational effectiveness, as well as the environmental, economic and societal sustainability of the innovative measures within the LLs. It also contributes to identify the barriers to uptake and means to maximize the transferability potential of the developed last mile solutions. Based on their unique visions and challenges, each Lighthouse Living Lab defined specific goals and real-world use cases to foster collaboration among diverse stakeholders in developing innovative solutions. During their implementation a validation methodology based on the impact assessment methodology developed in task 3.2 has been identified. After that, the final qualitative and quantitative values of the impact and process evaluation at pilot sites were reported in a dedicated sub-chapter for each Living Lab. Additionally, findings and evaluation results across LLs were analysed and compared through SEAMLESS framework providing an overview of the barriers to and possibilities for the implementation of the innovations. Finally, the key lessons learned and recommendations for the replication of the solutions and Living Lab experience were reported in the last chapter to transfer them to Wave 2 LLs and Follower cities.

The innovation introduced in this deliverable is the methodological evaluation and validation of the interventions demonstrated by URBANE from a broader ecosystem perspective. This approach considers not only the direct impacts on last-mile delivery operations but also indirect effects on physical, natural, and human resources involved in distribution. Beyond traditional KPIs for last-mile delivery research,

additional metrics were developed to evaluate alignment with Sustainable Development Goals (SDGs) and compliance with the Do No Significant Harm (DNSH) principle. To assess their sustainability, triangulation methodology was employed, evaluating social, environmental, and economic dimensions.

To conclude, the 4 Lighthouse Living Labs generated valuable insights into these dimensions and elaborated several interesting lessons learned on the social, environmental and economic dimension, demonstrating high transferability potential for improving urban logistics in similar contexts.

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Glossary of Terms and Acronyms

TABLE 1 GLOSSARY OF TERMS AND ACRONYMS

TERM/ACRONYM	MEANING
ABM	Agent-based model
ADV	Autonomous Driving Vehicle
AI	Artificial Intelligence
ALN	Alliance Locker Network
AT	ATECO (Italian Classification of Economic Activity)
B2B	Business to Business
B2C	Business to Consumer
BPMN	Business Process Model and Notation
CCAM	Connected, Cooperative and Automated Mobility
CBA	Cost Benefit Analysis
CCTV	Closed-Circuit Television
CDM	Collaborative Delivery Model
CO2	Carbon Dioxide
dBA	A-weighted decibel
DNSH (principle)	Do Not Significant Harm (principle)
DT	Digital Twin
EC	European Commission
ECJ	European Court of Justice
EDV	Electric Delivery Vehicle
eLCVs	electric Light Commercial Vehicles
EU	European Union
F	Female
FaaS	Freight as a Service
GA	Grant Agreement
GDPR	General Data Protection Regulation
GHG	Green House Gas
GLS	General Logistics Systems (courier)

GPS	Global Positioning System
ICE	Internal Combustion Engine
ICT	Information and Communication Technology
ILN	Individual Locker Network
KPI	Key Performance Index
L/U	Loading/Unloading
LEM	Local Evaluation Managers
LEZ	Low Emission Zone
LTZ	Low Traffic Zone
LL	Living Lab
LMD	Last Mile Delivery
LSP	Logistics Service Provider
M	Male
MX	Month X
NDA	Nearby Delivery Area
NO2	Nitrogen Dioxide
NOx	Collective term for the gases nitric oxide (NO) and nitrogen dioxide (NO2)
NPS	Net Promoter Score
NVR	Net Video Recorder
PESTLE analysis	Political Economic Social Technological Legal and Environmental analysis
PM10	Particulate Matter <10
PuDo	Pick-up Drop-off point
PV	Photovoltaic
Q	Question
ROIs	Regions Of Interest
SDG	Sustainable Development Goal
SIM	Subscriber Identity Module
SULP	Sustainable Urban Logistics Plan
SUMP	Sustainable Urban Mobility Plan
TEN-T	Trans-European Transport Network
UCC	Urban Consolidation Center

UPS	United Parcel Service (courier)
UCCLN	Urban Consolidation Centre Locker Networ
VRP	Vehicle Routing Problem

1. Introduction

URBANE, *or Upscaling Innovative Green Urban Logistics Solutions Through Multi-Actor Collaboration and PI-inspired Last Mile Deliveries*, supports the transition path towards effective, resilient, safe and sustainable last-mile transport, through four Lighthouse Living Labs (LL) in Helsinki, Bologna, Valladolid and Thessaloniki implemented in Work Package 2.

This report validates the qualitative and quantitative assessment of the Wave 1 LLs solutions to be replicated in other contexts and transferred to Wave 2 LLs and Follower cities taking into consideration social, environmental and economic criteria.

The proposed measures are evaluated with respect to effectiveness in achieving the local policy objectives, (including those contributing to project ones) as well as stakeholders and consumers needs by consolidating stakeholder clustering in each Lighthouse LL city. The purposes are to: I) perform a mapping of stakeholders in the different LLs, generating an overview of their perspectives on the LL innovations, ii) to assess the effectiveness and the sustainability impact of the URBANE LL innovations, iii) identify the potential or actual barriers/enablers to uptake, iii) assess the transferability potential of the last mile solutions.

The adopted evaluation methodology is described in Chapter 3, developed on the basis of the internal Task 3.2 deliverable "Impact Assessment methodology and KPIs" and is supported by the **SEAMLESS** framework, an analytical framework developed by NORCE for planning and evaluating sustainable last mile logistics. It is a generic and scalable tool – tested in the four LLs and easily adaptable to the subsequent Twinning LLs, Follower cities and cities outside of the project consortium. This framework's principal aim is to enable a seamless transition from data collection and collaboration with LLs, to modelling, and back to decision-makers and researchers for analysis.

SEAMLESS has been developed based on the following combination of methods in collaboration with LLs:

1. **Stakeholder mapping –** the creation of an overview of sectors and stakeholders affected by innovations in each LL through individual workshops and the compilation of LL context data in a *scoping document* on each LL. These scoping documents form the basis of the deliverables of each LL demonstrator. They include contextual data on each LL, the goals in each, the use cases through which these were addressed and some results from each LL use case.
2. **Qualitative governance analysis –** analysis of LL context data from the *scoping documents* in to understand how decisions are made in each LL context, who is responsible for those decisions and which regulations at different levels of governance are relevant to LL innovations.
3. **Design Thinking and Sustainable Business Model canvases –** the gathering of LL partners in workshops (described below) designed to reflect on the impact of LL innovations and how these may influence implementation.
4. **Public perception surveys –** surveys targeted primarily at a general public to determine the perceived challenges created by existing freight systems and the acceptability of LL innovations.

In Wave 1, WP3 – Task 3.4 did not incorporate inputs from the SEAMLESS tool in their ABM due to delays in survey data collection, as such, ABM data has only been collected from the Thessaloniki Living Lab. Following the experiences in Wave 1, it is recommended that inputs from SEAMLESS are integrated in the ABM in Wave 2. More information on ABM can be found in *D3.2 Modelling Framework and Agent-Based Models* and how the lack of data has been addressed by making the model more generic.

Sustainable business models became a phenomenon of global interest and design thinking has been increasingly used as a strategy to support this process.

Design Thinking for sustainability is a process to develop solutions, products, or services that are sustainable, desirable for the user, economically viable from a business perspective, and technologically feasible. Design thinking is a suite of practitioner-based, problem-solving approaches that typically emphasizes a user-centred, empathetic process (Buhl et al., 2019). The design thinking approach was well received and provided a useful framework to prompt the LLs to think about sustainability, their users, how to meet user needs, and to develop a business model for their LL.

Sustainable Business Model Canvas is a template that was created almost a decade ago (see Joyce and Paquin, 2016) to support the development of an idea into a viable business model. It follows a holistic approach regarding the relationships within and outside the business. In addition to economic criteria, the canvas considers ecological and social consequences of the innovation. The canvas is designed to help maximize positive outcomes and avoid negative impacts on society and nature. In that way, sustainability becomes integrated into the core business innovation.

By outlining the concepts on the canvas, the business concept gains coherence and clarity among the LL team members. Further, it supports communication with third parties and prepares for a solid business plan beyond URBANE.

Freight transport is undergoing rapid changes and has received more research and policy attention in recent years (European Commission, 2013). This increased attention has provided new perspectives on the sustainability of urban freight and its consequences (Aifandopoulou & Xenou, 2019). Sustainability is increasingly recognized as a key driver of innovation in business and public sectors, and environmental and social criteria have been incorporated into default design criteria, in addition to traditional criteria such as profitability, aesthetics, etc. (Gaziulusoy 2015). At the same time, expanding the scope of considerations around urban freight can greatly increase the complexity that needs to be addressed and the number of relevant stakeholders who need to be considered. Urban sustainability problems can be difficult to tackle because of their inherent complexity.

The environmental, social and economic aspects of sustainability have in urban research been described as a triangle where progress towards one can come at the expense of another (Campbell, 1996), and freight is one sector where economic and environmental sustainability have received the most focus (Haarstad, Rosales and Shrestha, 2024). Freight's complexity can be addressed by involving relevant stakeholder early and by anchoring freight policy within a regional and national context (Bjørgen and Ryghaug, 2021; Kin et al., 2023).

1.1. URBANE Outputs Mapping to GA Commitments

TABLE 2 DELIVERABLE ADHERENCE TO GRANT AGREEMENT DELIVERABLE AND WORK DESCRIPTION.

URBANE GA Item	URBANE GA Item Description	Document Chapter(s)	Justification
		DELIVERABLE	
D2.1 Validation report of Lighthouse LLs Implementation	*Report on the assessment of solutions, user acceptance tests, KPI measurements across LLs, learning conclusions and reusable results (models). The report will consolidate stakeholder clustering in each Lighthouse LL city, based on agent-based scenario modelling, considering social, environmental and economic criteria.*	Chapters 1 - 7	The report validates the qualitative and quantitative assessment value of the Wave 1 LLs solutions to be replicated in other contexts and transferred to Wave 2 LLs and Twinning cities taking into consideration social, environmental and economic criteria. It includes KPI measurements across LLs, along with key learnings and transferable outcomes.
		TASK	
Task 2.1 LLs Management and Validation (M1-M24)	*Within this task, ITL will define the management process for Wave 1 LLs. The baseline KPIs for each LL will be defined to validate the efficiencies of the new models and services. The lessons learned and evaluation results will be consolidated in the report and in replicable models to enable replication in wave 2 LLs where relevant.*	Chapters 2 (Sections 2.1, 2.2, 2.3, 2.4), 3, 4 (Sections 4.1.1, 4.2.1, 4.3.1, 4.4.1), 5 and 6	Chapter 2 otulines Wave 1 LLs management process and objectives giving an overview of each LL use case and objectives (Sections 2.1, 2.2, 2.3 amd 2.4). Chapter 3 includes the validation methodology and tools providing a context for the LL use cases that informed solution development and URBANE models design. Baseline KPIs, defined in collaboration with Task 3.2, are detailed in sections 4.1.1, 4.2.1, 4.3.1, and 4.4.1. Findings and evaluation results across LLs within the SEAMLESS framework are presented in chapter 5. Finally, chapter 6 offers lessons learned and recommendations for replicating the solutions in Wave 2 LLs and Follower cities.
ST2.1.1 LLs Communities Setup & baseline KPIs in each city (ITL)	*NORCE will provide the LLs with recommendations for data collection routines for the evaluation procedure outlined above. This subtask, taking into account the methodology developed under T3.2, will be responsible for the local evaluation impact assessment by the LLs.*	Sections 4.1, 4.2, 4.3, 4.4	The indicated sub-chapters include the final assessment and validation at pilot sites for each LL based on the methodology developed by FIT in Task 3.2 and data collection routines provided by NORCE, illustrated in section 3.1.2.
ST2.1.2: Stakeholder Mapping/Clustering (Social Innovation) in each city (NORCE)	*Stakeholder Mapping/Clustering (Social Innovation) in each city (NORCE), including desk research, qualitative governance analysis, interest mapping through interviews*	Sections 4.1.1.3, 4.2.1.3, 4.3.1.3, 4.4.1.3; Chapter 5	The sections in chapter 4 outline workshop and survey data collected for subtask 2.1.2, which are combined with the other qualitative data to summarise findings in chapter 5. Here, the cumulative results of the desk research, qualitative governance analysis and

	and Q-methodology, and survey-based public perception feedback data with integrated webGIS components. Exploring the agent-based models and performing stakeholder mapping, and public perception data analysis are time consuming activities, and this subtask will ensure cooperation between project partners in the LLs.		interest mapping are summarised for each city. Survey data for Valladolid is available in 4.3.1.3 and for Thessaloniki in 4.4.1.3. The Thessaloniki survey is further detailed in D3.2 (Modelling Framework and Agent-Based Models)
ST2.1.3: Ex ante Sustainability triangulation (NORCE)	*Based on the agent-based scenario modelling (from WP3, task 3.4 input) and stakeholder mapping, incorporating sustainability impact analysis based on social, environmental and economic criteria in line with SDG targets (NORCE). By categorising SDGs into tangible evaluation criteria on social, economic and environmental objectives, ABM results will be analysed according to sustainability impact.*	Chapter 4	KPIs outlined sections 4.1.1, 4.2.1, 4.3.1 and 4.4.1 are combined with results from ST 2.1.2 and with process evaluation results in 4.1.2, 4.2.2, 4.3.2 and 4.4.2 to outline the sustainability contribution of each LL. These contributions are outlined in 4.1.3, 4.2.3, 4.3.3 and 4.4.3.
ST2.1.4: Evaluation and validation of sustainability impact and lessons learned in all LL cities (ITL, with contribution of NORCE)	*The identification of potential or actual barriers to uptake that are common to several LLs and external projects will be an extension of ST2.1.2 and will assist with maximising transferability potential of the last mile solutions developed. Together, subtasks 2.1.2-2.1.4 will comprise the SEAMLESS planning and evaluation tool, mixing agent-based modelling, stakeholder mapping, governance analysis and public perception data analysis, enabling the consolidation of proof-of-concepts in reusable models (input to WP3 open models' library). An early report on LL requirements (Technical Specification and Use Case Scenarios) will provide input to WP3.*	Sections 4.1.1.3, 4.2.1.3, 4.3.1.3, 4.4.1.3, 4.1.2, 4.2.2, 4.3.2, 4.4.2 and chapter 5	Sections 4.1.1.3, 4.2.1.3, 4.3.1.3, and 4.4.1.3 present the social impact evaluation for each Living Lab, focusing on KPI alignment with SDGs, DNSH principle compliance, and sustainability triangulation. Sustainability impact results for each LL are detailed within their respective concluding sub-chapters. Specifically, barriers and drivers for solution uptake are identified in the process evaluation sections (4.1.2, 4.2.2, 4.3.2, and 4.4.2). The final comparable results across LLs, integrated with quantitative and qualitative data in the SEAMLESS tool, are presented in Chapter 5 providing a final overview of the barriers to and possibilities for the implementation of the innovations. The early report on LL requirements is the scoping document (basis of each deliverable on LL demonstrator – D2.2, D2.3, D2.4, D2.5).

1.2. Deliverable overview and Report Structure

The deliverable is structured as follows:

- Chapter 1 includes the introduction, URBANE Outputs mapping to GA commitment and the deliverable structure.
- Chapter 2 focuses on Wave 1 LLs Management process and objectives, providing an overview of the use cases developed by each Living Lab, which served as the foundation for subsequent solution development.
- Chapter 3 presents the validation methodology based on the impact assessment methodology developed in task 3.2. After a general explanation, it focuses on the description of the tools for impact evaluation, including the social dimension, and the process evaluation.
- Chapter 4 analyses the final assessment and validation at pilot sites for each LL.
- Chapter 5 outlines the findings and results across Living Labs collected through the different data collection methods that compose the SEAMLESS framework,the impact and process evaluation providing an overview of the barriers to and possibilities for the implementation of the innovations.
- Chapter 6 presents lessons learned and recommendations for replicating the solutions in Wave 2 LLs and Follower cities.
- Chapter 7 outlines the conclusions on the work conducted in the deliverable.

2. Wave 1 LL Management process and objectives

Throughout WP2, Wave 1 Living Labs (LLs) collaborated closely, despite operating locally. The process conducted by ITL Foundation (WP2 leader) began with regular meetings to understand challenges, guide pilot implementation, and foster knowledge sharing. LLs were supported in defining their vision and specific challenges, preparing a scoping document for each LL to outline activities and goals. The scoping document outlined the framework for LL activities under WP2, aligning with the project's overall goals. It also served as the foundation for the LL demonstrator deliverables (D2.2, D2.3, D2.4, and D2.5). The WP2 leader established a process for gradually updating the document based on the information available throughout the pilot preparation and implementation. The document aimed to provide a detailed analysis of the four LLs, comparing the situation before (AS-IS) and during (TO-BE) the pilot implementation. It defined specific use cases, milestones, model description and KPIs to measure progress. The WP2 leader developed this document with support from NORCE, FIT Consulting (WP3 leader) and the project coordinator. NORCE provided guidelines for data collection routines to support the evaluation of stakeholder mapping, qualitative governance analysis, and sustainability triangulation. FIT Consulting guided partners in creating BPMN diagrams for the AS-IS and TO-BE situations, defining KPIs, and developing WP3 models tailored to the specific characteristics and needs of each Living Lab.

In parallel with the completion of the scoping document, ITL, in collaboration with WP3 and NORCE, organized specific meetings and workshops to gather information for solution development, sustainability, and transferability. The meetings held in collaboration with WP3 focused on the following:

- Data Request Templates: Guiding LLs in completing WP3 data request templates to collect necessary data and information for model and service development;
- KPI Data Sheets: Identifying KPIs for each LL use case, collecting required data, and establishing baseline values;
- BPMN Diagrams: Assisting LLs in creating AS-IS and TO-BE BPMN diagrams to describe current and future processes.

LLs also completed a process evaluation survey using a modified PESTLE analysis to identify drivers and barriers (the results can be found in the process evaluation sections dedicated to each LL in Chapter 4). They had periodical exchanges with digital model owners to develop tailored solutions. This work culminated in a physical workshop in Bologna, where participants refined digital model features, completed data collection, and identified the needs and expectations of Living Lab end-users for the Digital Twin and Impact Assessment Radar.

In parallel, NORCE assisted partners in collecting data for the social impact evaluation, which included stakeholder mapping, qualitative governance analysis, and sustainability triangulation aligned with SDG targets and the DSNH principle. This provided a clearer understanding of all LLs and their potential for replicating and transferring the URBANE solutions.

As part of stakeholder mapping, Living Lab partners identified relevant stakeholders in their context, assessed their potential impact on LL innovation implementation, and considered strategies for collaboration. This involved self-collection of data through questionnaires and meetings with LL partners, with responses included in the scoping documents. These responses were later analysed alongside findings from the prioritization step of the Design Thinking workshops.

NORCE conducted two workshops with each Living Lab, focusing on sustainability. The first workshop covered the initial four steps of Design Thinking, and the second focused on testing through the Flourishing Business Model canvas (a variation of the sustainable business model canvas). The workshops revealed that many of the challenges facing the LL regions are shared by society more broadly: creating new opportunities and livelihoods without harming the environment while maintaining economic performance. More information on these workshops is provided in Section 3.1.2.

Following the completion of the LL Scoping Documents and workshops, NORCE conducted a qualitative governance analysis of the four LL contexts. This analysis considered the legislative and social factors influencing each LL, highlighting potential barriers to innovation implementation. Together, this data was used in a sustainability triangulation based on each LL. Additionally, NORCE assisted LLs in developing questionnaires to gather information about people's perceptions on their innovations. Chapter 5 presents the findings and results of the entire process, summarising the SEAMLESS framework. This framework provides an overview of potential or actual barriers to adoption and strategies for maximizing the transferability of the developed last-mile solutions.

In the final weeks of the pilot implementation, Lighthouse LLs held preliminary meetings with Wave 2 LLs and Follower Cities to share results and discuss transferability. These meetings were valuable for finalizing lessons learned, results, and transferability potential. To provide a clear overview of the Living Labs, their specific objectives and real-world use cases are outlined in Table 3 below. This provides a brief overview of the use cases, with more detailed explanations in the following sections.

TABLE 3 WAVE 1 LLS USE CASES

	Use case 1	Use case 2	Use case 3
Bologna LL	Micro-hubs networks and light EDVS – PI last mile deliveries	N/A	N/A
Helsinki LL	Delivering tools from the Würth Center Sörnäinen to nearby construction sites in Kalasatama region	Delivering B2B and B2C e-commerce parcels in the Ruoholahti and Jätkäsaari region using the ADV	Delivering B2B and B2C e-commerce parcels in the Ruoholahti and Jätkäsaari region using ADVs and a microhub
Valladolid LL	Monitoring of loading and unloading areas using AI through the implementation of a CCTV system	Implementation of an innovative and sustainable solution of contactless parcel delivery: the trunk delivery service	Techno-economic comparison of the use of combustion vehicles, commercial electric vehicles and IFEVS prototype vehicles in different delivery services
Thessaloniki LL	Operation of Hub and Spoke delivery model (Parcel Lockers) supported by Digital Twins	Ideal composition of new fleet (EVs) and services	N/A

2.1 Bologna Living Lab

The Bologna Living Lab objective is to realize a measure listed in the SUMP (Sustainable Urban Mobility Plan), namely the implementation of the Nearby Delivery Area, combined with a collaborative approach between logistics operators and with the utilisation of zero emission vehicles. The final objective of the LL is to define a guideline on how to implement sustainable, low-impact and innovative micro-logistics hubs to be used for innovative delivery methods in urban areas by applying also the Freight as a Service (FaaS) and the physical internet approach. The guidelines aim to have a great impact in terms of replicability in other contexts, thanks to the modular approach which allows to activate several services or only some of them.

To achieve these objectives a use case has been defined:

- **Use case 1 Micro-hubs networks and light EDVS – PI last mile deliveries**: installation of 3 automated micro-hubs used by logistics operators in a collaborative way and implementing zero emission vehicles in the last-mile delivery in the LTZ within the historic centre of Bologna. The innovation provided by this use case is that two potential competitors, i.e. the two transport operators, collaborate in the distribution of the parcel and use the same micro-hub. This part of the business model also represents a concrete step towards the Physical Internet concept.

2.2 Helsinki Living Lab

The objectives of Helsinki Living Lab are various ranging from piloting sustainable modes of delivery to increasing collaboration between different stakeholders. Helsinki piloted if the number of routes driven by conventional urban delivery vehicles could be decreased in densely populated areas and replaced by innovative and sustainable modes of delivery. Simultaneously, Helsinki tested the concept of a micro hub in the city with a range of innovative last-mile delivery options for the B2B and B2C deliveries in densely populated areas. Helsinki Living Lab executed 3 piloting sprints/use cases in an iterative manner, developing the next sprint based on the lessons they learned during the last sprint. The developed use cases are the following:

- **Use case 1 Delivering tools from the Würth Center Sörnäinen to nearby construction sites in Kalasatama region** (May – August 2023): delivering Würth's and DB Schenker's B2B parcels, mostly tools, from Würth Center Sörnäinen to nearby construction sites using an ADV, manufactured by TwinswHeel/Soben and operated by LMAD, and a cargo bike, provided by DB Schenker.
- **Use case 2 Delivering B2B and B2C e-commerce parcels in the Ruoholahti and Jätkäsaari region using the ADV** (November – December 2023): delivering DB Schenker's B2B and B2C e-commerce parcels in Ruoholahti using the same ADV with an integrated modular parcel locker system. The ADV was placed into a heated parking hall where it could be recharged and stored securely before the installation of the container to Würth Center Jätkäsaari's private backyard.
- **Use case 3 Delivering B2B and B2C e-commerce parcels in the Ruoholahti and Jätkäsaari region using ADVs and a microhub** (May – July 2024): it was designed iteratively based on the feedback gathered from previous use cases/sprints to add more ADVs and a micro hub acting as an urban consolidation centre. URBANE joined forces with DISCO to utilize a pre-existing micro hub as a homebase for the ADVs, cargo bikes and a service point for the residents in Helsinki. As explained

in D2.2 Helsinki demonstrator, after some difficulties in finding the suitable location for ADVs and in dealing with the permit process at city level, a private real estate company Antilooppi rented their premises inside the shopping centre in Ruoholahti for the DISCO project. This led to the implementation of use case 3 in collaboration with DISCO project.

2.3 Valladolid Living Lab

Among the objectives to be achieved with the development of URBANE, the city of Valladolid has prioritized the following: (1) to make L/U zones more efficient, with view to achieving a more sustainable, orderly and efficient urban goods distribution; (2) to promote sustainable and environmentally friendly delivery practices; and (3) to build a safer city for pedestrians.
To achieve these objectives a set of use cases have been defined in accordance with the city's strategy, specifically the following:

- **Use case 1 Monitoring of loading and unloading areas using AI through the implementation of a CCTV system**: this use case helps to understand the behaviour of delivery services and to design policies adapted to their needs.
- **Use case 2 Implementation of an innovative and sustainable solution of contactless parcel delivery: the trunk delivery service**: through this service, customers have the possibility to receive their parcels in the trunk of their cars, rather than at the recipient address. This use case intends to go further and transfer this concept to deterrent parking. On the entry into force of the restrictions associated with the LEZ, this use case attracted much interest, as it aims to help to reduce delivery times, costs and emissions.
- **Use case 3: Techno-economic comparison of the use of combustion vehicles, commercial electric vehicles and IFEVS prototype vehicles in different delivery services**: several prototype vehicles have been put into circulation, partly powered by photovoltaic energy, to study their effect on the improvement of the city's air quality, the emissions of the different electric and non-electric vehicles currently used by (1) the internal delivery service of the municipality and (2) the postal service. IFEVS electric cargo bikes, with and without photovoltaic panels, equipped with monitoring devices, have been tested in Valladolid by postal workers. Due to complexities in delivering IFEVS vans from Italy to Spain, Valladolid LL partners in collaboration with WP2 leader and the project coordinator decided to initiate vans testing on Italian roads open to general traffic to obtain data on its real consumption and to conclude pilot activities for Use Case 3. Concurrent testing of the vans' pedestrian detection system has been completed.

2.4 Thessaloniki Living Lab

The primary aim of Thessaloniki LL is to explore the effectiveness and potential of micro-hubs and micro-consolidation centres in transforming urban logistics into a decarbonized and sustainable business model. This initiative focuses on implementing innovative strategies to identify and apply the most effective combination of new processes, thereby promoting zero-emission operations in the last mile of delivery.
The developed use cases are the following:

- **Use case 1 Operation of Hub and Spoke delivery model (Parcel Lockers) supported by Digital Twins:** the Hub and Spoke model is a logistics and distribution strategy that involves the use of central hubs and peripheral spokes to optimize the movement of goods. In this model, a central hub serves as a consolidation point where goods from various sources are gathered and sorted. The installation of parcel lockers is an integral part of implementing the Hub and Spoke model in the city of Thessaloniki. The aim of installing parcel lockers in the city of Thessaloniki is to enhance the effectiveness of the operational planning process and improve the customer experience in the last mile delivery.

- **Use case 2 Ideal composition of new fleet (EVs) and services under a shared shared urban consolidation center:** it includes the simulation of new services and vehicles, specifically focusing on zero-emission and modular options, to improve last mile operations. By simulating their use in the urban environment, stakeholders can assess their performance, energy efficiency, and impact on reducing carbon emissions. This evaluation helps in understanding the benefits and challenges associated with integrating zero-emission vehicles into the logistics operations of Thessaloniki.

3. Validation methodology

The validation methodology is based on the impact assessment methodology developed in task 3.2 by FIT that relies on the methodology defined in **CIVITAS 2020 impact and process evaluation methodology**[1] for the evaluation of mobility related measures implemented in European urban environments. This choice was made also to contribute to the European knowledge base of evidence-based solutions for urban mobility.

However, to guarantee a commonly agreed and effective impact evaluation and measurement system in line with URBANE's purposes, some key approaches of other European projects dealing with urban mobility and city logistics have been used:

- STRAIGHTSOL assessment framework to identify KPIs and methodologies to gather data from stakeholders;
- NOVELOG evaluation framework for city logistics measures to assess the complexity of UFT systems, through selected performance indicators, divergent stakeholders' interests, conflicting business models and operations;
- SULPiTER set of data, clustered in five Impact Areas (namely: Environment, Energy, Transport, Economy, Society-People) to be gathered from different stakeholders to provide a complete description of urban logistics;
- ULaaDS methodology for the impact assessment framework based on the principles of topical application, multi-criteria, multi-actor views, co-production and an iterative process, and comparability. This framework identifies areas of impact, objectives and indicators for the trials.

CIVITAS evaluation focuses on the measures implemented in cities. The goal is to assess the impact of these measures across various categories, using both quantitative data against pre-established targets and qualitative observations.

Given the real-world context of the project, evaluation must strike a balance between rigorous scientific analysis and insightful interpretation of urban mobility and logistics changes. This is crucial for ensuring that evaluation is feasible, efficient, and valuable for informing policy decisions.

The evaluation framework designed for URBANE (Figure 1) seeks to conduct impact and process evaluation of the project's innovations, comparing the measured outputs and outcomes of URBANE innovations implemented in the Living Labs.

The **impact evaluation** carries out a quantified assessment of direct effects (technical, social, economic and environmental) of URBANE interventions implemented in the Living Labs against the overall project objectives. The **process evaluation** complements the findings of the impact evaluation trying to gain insight in the processes of URBANE solutions implementation and to assess results and outcomes.

The impact evaluation is conducted at 3 levels:

1. Project Evaluation: while a comprehensive evaluation of project KPIs will be available at the project's conclusion, the anticipated project outcomes can serve as benchmarks for individual LLs. Specifically, as outlined in the Grant Agreement, URBANE LLs (Wave 1 and Wave 2) are expected to achieve the following key targets for demonstration activities:

[1] As described in D2.4 of the project CIVITAS SATELLITE – February 2020

- Successful demonstration of innovations in 6 real operational environments leading to improved environmental performance (>20% GHG reduction) in intervention areas
- Deliveries made with conventional vehicles in Lighthouse LLs halved thanks to the introduction of innovative technologies such as CCAM. KPI: decrease in deliveries made via traditional vehicles: 50%
- Hub operations will become less labour intensive, with new jobs created upstream in the logistics chain

The LL contribution to the above-mentioned targets is reported in the "Conclusions" section of each LL assessment and validation (Chapter 4).

2. City/Local evaluation: local evaluation, using URBANE-defined KPIs, assesses the effectiveness of tested use cases and innovations in achieving higher-level urban sustainability goals. Where applicable, Living Labs have been encouraged to link URBANE's local objectives and KPIs to those outlined in local SULPs. LL leaders have been asked the following questions to discuss with their local consortia: What are your goals for this project? What do you hope to achieve? And what specific metrics would you use to measure the project's success?

   Individual Local KPIs are detailed in the dedicated chapters on Assessment and validation at pilot sites within Chapter 4.

3. Use case evaluation: this evaluation involves a set of KPIs tailored to specific use cases and innovations to be tested in the first wave and replicated in the second wave KPIs. Given the similarities between use cases, Wave 1 LLs should serve as models for Wave 2 LLs, guiding their evaluation methodologies, approaches, and KPI identification and calculation. A preliminary list of KPIs was identified by WP3, initially focusing on the URBANE objectives outlined in the Grant Agreement. In this phase, the impact areas and KPIs were primarily drawn from the minimum set of indicators defined in SULPITER, along with KPIs designed to measure both project and local goals. The KPI list was continually updated as local use cases were defined, developed, and refined, as documented in the WP2 scoping documents (the basis for D2.2-D2.5 LL demonstrators). Additionally, KPIs were included to address relevant impact areas of the SDGs.

   Use case KPIs are presented in the dedicated chapters on Assessment and validation at pilot sites within Chapter 4 and should be considered by Wave 2 Living Labs as examples of how to apply the methodology.

4. Social impact evaluation: a key and transversal component of the impact evaluation is the social impact evaluation, aligning with a broader vision that encompasses impact assessment of the social KPIs, SDGs and the DNSH Principle. To achieve this, extensive dialogue with Living Labs was conducted to evaluate URBANE's demonstrated innovations from a holistic perspective, understanding their potential "indirect" impacts beyond operational last-mile delivery activities. The combination of methodologies applied for the Social Impact Evaluation compose the SEAMLESS Framework developed by NORCE. The SEAMLESS framework is an analytical framework designed for planning and assessing sustainable last-mile logistics developed by LLs. A more detailed explanation including methods and tools is reported in the following section.

The impact and process evaluation involves a before-and-after analysis (AS-IS and TO-BE), comparing the situation prior to URBANE's implementation of innovative last-mile solutions in Living Labs with the current state using these solutions. This approach should also be applied to monitor activities undertaken by Wave 2 within WP4.

Process evaluation focuses on identifying the factors that helped or hindered the implementation of URBANE solutions. This primarily involved a qualitative assessment using specific data collection templates. By understanding the planning and implementation process, it is possible to gain valuable insights into the project's successes and challenges.

It is crucial to distinguish between cause and effect: identify the impact directly attributable to the proposed solution and separate it from influences of external factors. When evaluating interchange performance, it is important to focus on both the outputs and outcomes resulting from the implementation of URBANE's innovative last-mile solutions.

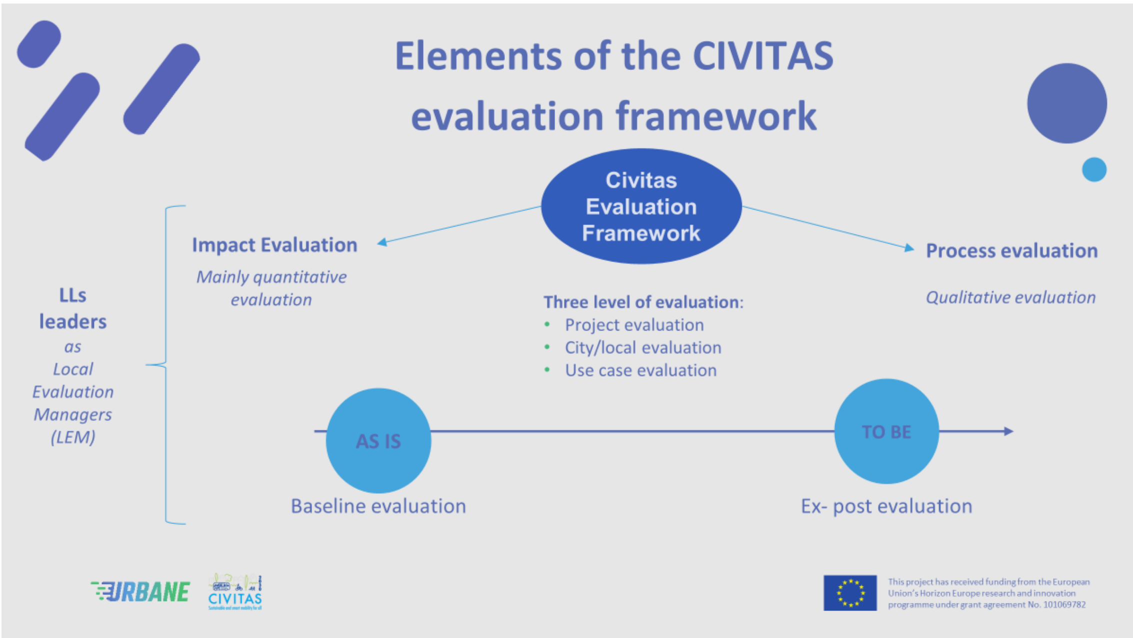


FIGURE 1 CIVITAS AND URBANE EVALUATION FRAMEWORK

3.1 URBANE Tools for the impact and process assessment

The tools that have been selected in the URBANE project to support Local Evaluation Managers (LEMs) to perform impact assessment are the following:

3.1.1 Impact Evaluation of transport, environment, energy and economic KPIs

In collaboration with Living Labs, WP3 defined KPIs based on the URBANE objectives outlined in the Grant Agreement. Impact areas and KPIs were primarily drawn from the minimum set of indicators identified in SULPITER, supplemented by KPIs designed to verify both project and local objectives. The tool for the selection and calculation of KPIs is the following:

T3.2 Structured Datasheets (xls format) for the selection and calculation of KPIs, accompanied by general guidelines on the use of sheets and by descriptions, units of measurement, target group, and calculation methodology for each KPI.
Additionally, the KPIs were aligned with the impact areas subsequently defined by CERTH for the ecosystem approach within the following tool:

T3.7 Impact Assessment Radar based on the KPIs identified in task 3.2, supports LEMs in performing more complex impact assessment analysis and considerations by interacting with various models integrated into the Innovation Transferability Platform. More information can be found in D3.5 and Annex 4.

3.1.2 Social Impact Evaluation

The social impact results collected through the T2.1 tools mentioned above have been included in the **SEAMLESS framework** developed by NORCE. The SEAMLESS framework is an analytical framework for planning and evaluating sustainable last mile logistics that consists of stakeholder mapping, qualitative governance analysis, and sustainability triangulation (SDGs). It focuses on identification of potential or actual barriers to uptake and means by which the transferability potential of the last mile solutions developed can be maximized. Through a facilitated innovation process, stakeholders with diverse disciplinary backgrounds and a common interest in urban logistics co-produced an innovation to address urban sustainability. The innovation was then further developed and operationalized for a business context. The methods in the SEAMLESS framework are as follows:

1. Stakeholder mapping developed by NORCE. This is the process of identifying the different groups of people or organizations that are affected by or have an interest in a particular project or issue. The overview includes names or organizations and groups them into categories.

2. Qualitative governance analysis developed by NORCE to study how decisions are made and how power is distributed in a particular organization or community. This was done through interviews, observations, and desk research by each LL.

3. Design Thinking and Sustainable Business Model workshops carried out by NORCE in collaboration with LLs.

NORCE carried out workshops with each LL in smart specialization that both started and ended with sustainability. The workshops with each LL were based on the design thinking process, outlined below, to find the major challenges faced by the LL regions to balance economic, social, and environmental sustainability questions. In addition to sustainability, the LLs were prompted to think about their users, how to meet user needs, and to develop a business model for their LL. To meet these needs, the LLs needed to identify and develop new ideas and opportunities within circular economy and integrated goods and production chains. Several of the major challenges facing the LL regions were found to be shared by society more broadly. That is, to create new opportunities and livelihoods without increasing our climate and environmental footprint, whilst nevertheless ensuring good economic performance.

Design Thinking for sustainability is a process to develop solutions, products, or services that are sustainable, desirable for the user, economically viable from a business perspective, and technologically feasible. Design thinking is a suite of practitioner-based, problem-solving approaches that typically emphasizes a user-centred, empathetic process (Buhl et al., 2019). The approach is loosely characterized by a blend of creative and analytic modes of reasoning and various hands-on tools and techniques (Buhl et al., 2019).

Design thinking projects typically start with an exploratory phase that seeks to empathetically understand the given problem from the user's perspective. Through observing users in real-life situations in context, the practitioner defines an adequate problem and solution space (Buhl et al., 2019; Wilkerson and Trellevik, 2021). This focus on immediate users can infuse the design process with empathy and realism, providing valuable insights into what people do, value, and desire (Hoolohan & Browne, 2020).

As a practice, design thinking is typically defined as having five steps that are iteratively applied. The five steps are divided into diverging and converging phases, where diverging phases widen perspectives and converging phases increase focus: (1) **Empathy**: the point of view of the user is elicited. (2) **Define**: Knowledge about the user is distilled and formulated as specific needs, wants or requirements (problem definition). (3) **Ideation**: ideas for solutions are formulated based on the specific needs and requirements one is aiming to satisfy. (4) **Prototyping**: ideas are implemented in first stage products or services. (5) **Testing**: potential users and other relevant stakeholders test and provide feedback on the prototypes. These five steps are iterative, and the process may be partially or completely revisited several times.

For URBANE, the Design Thinking approach incorporated the Sustainable Business Canvas as a way of ensuring that sustainability is well rooted in both the starting point and final product of the process. Each LL was therefore involved in an individual workshop on the first four steps of Design Thinking and later all four LLs were invited to a workshop on the Testing step using the Flourishing Business Model canvas (a variation of the Sustainable Business Model canvas)

The **Sustainable Business Model canvas** is a tool to help practitioners develop a business model that incorporates key sustainability factors in their value chain. The aim is to be as close as possible to an implementable business plan based on the LL innovations. By outlining the concepts on the canvas, the business concept gains coherence and clarity among the LL team members. Further, it supports communication with third parties and prepares for a solid business plan beyond URBANE. For URBANE, the business models of each LL are an important aspect of transferability to the Wave 2 LLs.

Design Thinking workshop

The workshop started with the Sustainable Development Goals as they have been represented in the KPIs and considered their context in the innovations and use cases for each LL city, region, and country in collaboration with WP3. Then each LL moved through and prioritized some possible ideas. The next section describes in a little more detail how this design thinking process was approached in the workshops. In this setting, the steps, illustrated in the Design Thinking Map (Figure 2), were classified by (1) sustainability, (2) context, (3) prioritize, (4) develop ideas and (5) model.

Step 1: Sustainability

NORCE described the context of the workshop, outlined the suggested process, and gave some insight into the distinct SDGs that are targeted through the Key Performance Indicators (KPIs) of the project. The LLs were then divided into break-out rooms.

Step 2: Context

The workshop participants were asked to assume the perspective of different personas that were important to each LL. Each LL identified a different constellation of consumers, partners, last mile companies, logistics operators, or other service providers that were important for the logistics innovations facilitated by the Living Labs. Different LLs took different approaches to setting the context. Whilst some chose to identify several personas in the form of overarching categories of actors, others took form of individual and sometimes named user/provider groups.

Step 3: Prioritize

During this stage, participants were tasked with prioritizing various personas, which was based on the preceding step. The task involved determining which stakeholders were most important to focus on in the development of their innovations. This step was important to establish the framework for the subsequent activities in the workshop, allowing for more focused attention on selected key actors.

Step 4: Develop ideas

This step identifies stakeholder needs and how to solve them. The first step is to define "point of statements", and the second is define a "how might we… statement". In the "point of statement" the participants should formulate a statement based on the perspective of the selected personas. The "point of statement"-template was a simple one; ___**need**___**because**___. An example could be as follows: *the business users of lockers for last mile delivery* ***need*** *URBANE LLs to consider sustainability for them,* ***because*** *they do not have the budget or expertise.* In other words, this step aims at making the participants aware of why the different personas might need the innovations, and in what way they meet selected SDGs through the lens of the selected persona. The "how might we" statement aims to direct attention to how the LL might meet the stakeholder needs. An example: '*how might we support small scale delivery operators,' or 'how might we train the postal service in the use of electric delivery vehicles in zero emissions zones.'*

Step 5: Model

This final step is the 'materialize' step of design thinking. The Sustainable Business Canvas is a tool to help practitioners develop a business model that incorporates key sustainability factors in their value chain. The aim is to be as close as possible to an implementable business plan based on the LL innovations.

By visualizing the concepts on the canvas, the business concept gains coherence and clarity among the LL team members. Further, it supports communication with third parties and prepares for a solid business plan beyond URBANE. For URBANE, the business models of each LL will be an important aspect of transferability to the Wave 2 LLs.

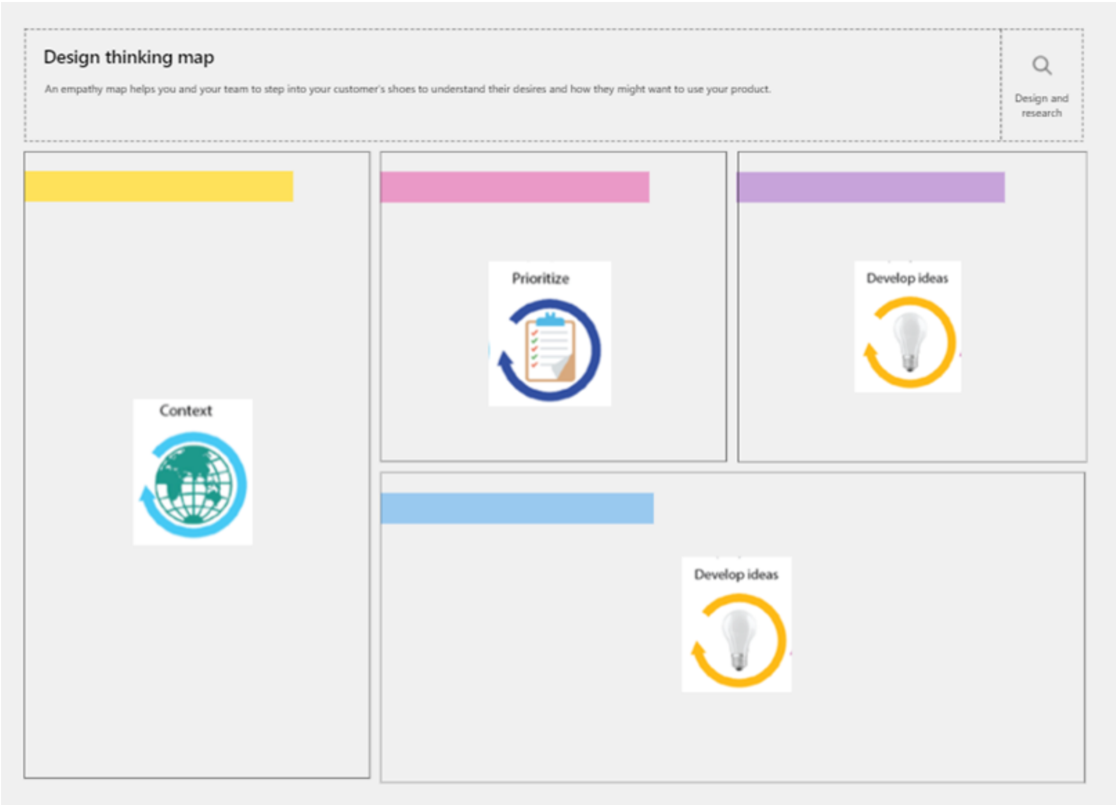


FIGURE 2 DESIGN THINKING MAP

During the Sustainable Business Canvas workshop, NORCE reiterated the activities and results from the first workshop on Design Thinking. The LLs were then divided into four break-out rooms and were guided through each box in the Flourishing Business Model canvas (Figure 3) to articulate the business plan, identifying future challenges and areas that require further development. This canvas is a version of the Sustainable Business Model canvas that is designed to focus on the three pillars of sustainability (economy, society and environment) and leads workshop participants from the larger business outcomes to the more specific values, processes, and people affected.

For each set of boxes addressed, participants first briefly brainstormed individually and then shared their ideas and insights with the other members of the LL while the information was recorded by workshop facilitators. Participants started with the Costs, Goals, and Benefits boxes that form the basis for the business canvas outcomes. Then, participants considered the Value boxes in the centre of the canvas and related the potential value co-creations and co-destructions back to the ideate phase of their design thinking work. Finally, the Process and People boxes were filled out to show the activities, resources, and relationships needed to carry out the business plan given the governance system each LL is located in.

FIGURE 3 SUSTAINABLE (FLOURISHING) BUSINESS MODEL CANVAS (JOYCE AND PAQUIN 2016)

4. Survey-based public perception feedback data developed by the LLs supported by NORCE. This is the process of gathering information about people's perceptions, attitudes, and opinions on a particular topic. This was done through surveys. Some LLs used surveys regularly performed by LL cities, while others established a survey for the purpose of URBANE individually. Thessaloniki, Valladolid and Helsinki LL targeted their surveys at a general public, whilst the Bologna LL decided to target their survey at transport operators.

5. Ex ante Sustainability triangulation. Evaluation activities included discussions with LLs to broadly assess URBANE's innovations and their indirect impacts using an ecosystem approach. In fact, sustainability triangulation involves assessing how the URBANE LL innovations take account of the social, environmental and economic dimensions of sustainability. The sub-task evaluated preliminary findings from T3.4 based on sustainability indicators. WP2 and WP3 defined how the various project KPIs align with the targets and indicators of the SDGs in compliance with the DNSH principle (Annex 2), alongside the conventional KPIs used in last mile delivery projects. Each KPI may contribute to one or more SDGs, or possibly none. Explanations regarding the link or modifications on how KPIs are calculated for SDGs compared to URBANE are detailed in the Comment column (see Annex 1).

In particular, the analysis showed that URBANE contributes to many more SDG targets than first expected. The project's attention to SDG 3 good health and wellbeing, 4 quality education, 5 gender equality, 10 reduced inequalities, and 17 partnership for the goals are important but less expected contributions. SDGs 7 on clean energy, 8 on decent work, 9 on infrastructure, 11 on sustainable cities, and 12 responsible consumption were expected goals to which URBANE is strongly contributing.

The primary gap, among other minor ones, identified between the CIVITAS Impact areas and the SDGs selected for URBANE was related to SDG 8, specifically concerning decent work. One of URBANE's objectives is to create more and better jobs by increasing job opportunities (including positions for women and other disadvantaged groups), reducing physical labour, ensuring fair working conditions/contracts and pay in the LL business models, creating safer working environments, and reducing exposure to air pollutants. Excerpts of the KPI-SDGs association were shared with the Wave 1 LL during Design Thinking workshops conducted as part of WP2 and presented in chapter 2.1.1 of this document. Moreover, to ensure compliance with the DNSH principle in urban logistics and last-mile deliveries, it is crucial to foster responsible and ethical decision-making that minimizes negative impacts on urban communities and the environment. By integrating the DNSH principle into their operations, stakeholders can align their activities with sustainable development goals while preventing or mitigating harmful consequences. To assess this alignment, the KPIs of each use case were analysed and linked with the six objectives defining a sustainable activity according to the EU Sustainable Taxonomy, as outlined in Annex 2.

The inclusion of the SDGs and the DNSH principle in the innovations demonstrated by URBANE is undergoing continuous evolution along with the awareness of LL actors on broader impacts generated by new business models demonstrated in URBANE; in particular, the evaluation of the relevance of SDGs in the LL business models was supported through the development of the SEAMLESS evaluation framework. This framework principal aim is to enable a seamless transition from data collection and collaboration with LLs, to modelling, and back to decision-makers and researchers for analysis.

3.1.3 Process evaluation

Process evaluation is a fundamental component of the URBANE evaluation, complementing the impact assessment. It focuses on understanding the processes involved in implementing URBANE solutions and evaluating their results and outcomes.

LLs conducted qualitative process evaluations using specific templates to identify facilitators and barriers encountered during solution implementation. This involved understanding the planning and implementation processes.

Given the important role of data-sharing in this project, as highlighted in early discussions between WP3 and WP2 URBANE partners, the following tools were adopted:

1. BPMN diagram of the AS-IS (description of the process as it occurs before the implementation of the solution) **and TO-BE situation** (description of the process ad it occurs during pilot execution).
To ensure consistent KPI calculation methodologies and clarify the scope and operational boundaries for KPI valorization, Living Labs received support from WP2 and WP3 in developing two BPMN diagrams for each use case. These diagrams illustrate the current process (AS IS) and the envisioned process during pilot execution (TO BE). This distinction aids Living Labs in differentiating baseline values from those collected during the demonstration.
The specific BPMN diagrams for each Living Lab can be found in the D2.2 - D2.5 LL demonstrators.

2. Process evaluation online survey to carry out process evaluation, aimed at identifying barriers and drivers, based on **PESTLE analysis**. The PESTLE analysis is a strategic management tool used to assess the external macro-environmental factors that may impact an activity. PESTLE stands for Political, Economic, Social, Technological, Legal, and Environmental factors, and the analysis involves identifying and evaluating how these factors might influence the demo implementation. Each LL partner was asked to fill in one questionnaire for each USE CASE he/she is involved in. The full questionnaire, developed by WP3 in Task 3.2 together with WP2, can be found in Annex 3.

Figure 4 provides an overview of the tools described above that assist LEMs in conducting impact and process evaluation.

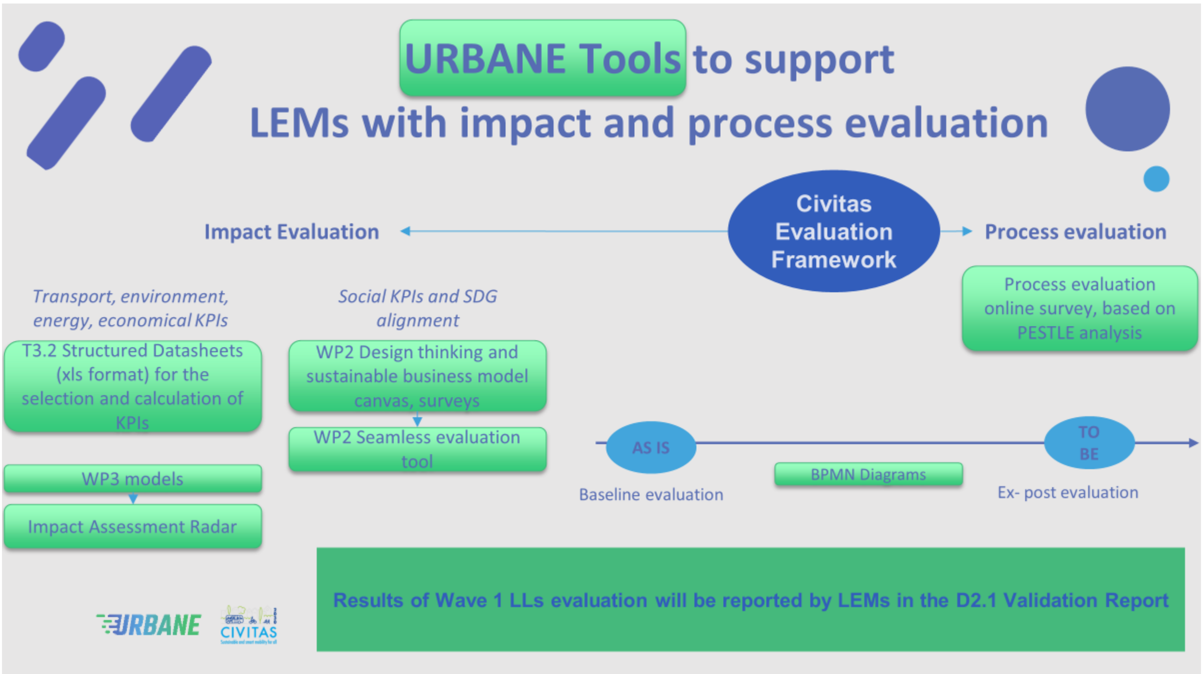


FIGURE 4 OVERVIEW OF TOOLS DEVELOPED IN URBANE TO SUPPORT LOCAL EVALUATION MANAGERS IN PERFORMING IMPACT AND PROCESS EVALUATION

4. Assessment and validation at pilot sites

This section presents the final assessment and validation at pilot sites for each LL based on the methodology outlined in Chapter 3. The goal is to provide a clear and concise evaluation that allows for easy interpretation of the results. To ensure comparability, methods, approaches, and indicators were standardized across all Living Labs, and outputs were adjusted to account for differences between cities. Living Lab leaders, in their role as Local Evaluation Managers, organized local meetings to jointly select appropriate KPIs for each use case with local partners, collect baseline data, and gather final values during the pilot phase. The evaluation includes the following four primary areas explained in detail in Chapter 3. The Project Evaluation (including a comprehensive evaluation of project KPIs) will be reported in the "Conclusions" section of each LL.

1. **City/Local evaluation**: reporting KPIs final values related to LLs objectives and ambitions, related to SULP or any other comparable. LLs have been advised to match their local objectives and KPIs with those listed in SULPs, whenever possible.
2. **Use case impact evaluation**: reporting KPIs final values specifically related to each Use Case. Use case KPIs primarily focus on operational metrics that measure the effectiveness and financial viability of new delivery methods compared to traditional ones, especially in terms of last-mile distribution.
3. **Social impact evaluation**: reporting social KPIs final values aligned with SDGs, DSNH principle and the final version of the Design Thinking Map and the Sustainable Business Model Canvas for each LL.
4. **Process evaluation insights:** summarizing points of view of local partners on possible barriers and drivers that might affect the demo implementation and innovation uptake for each use case. Local Evaluation Managers have been given a questionnaire that can be used at different stages of the project (e.g., before, during, and after the demo implementation) to track the context, analyze and summarize findings, and interpret changes in numerical KPIs by identifying political, environmental, social, technological, legal, and economic factors that may influence the project.

4.1 Bologna

4.1.1 Impact evaluation

4.1.1.1 City/Local impact evaluation

In late 2019, the Metropolitan City of Bologna approved both the Sustainable Urban Mobility Plan (SUMP) and the Sustainable Urban Logistics Plan (SULP). The Bologna use case is designed to implement one of the measures identified by the SULP, namely the Nearby Delivery Area (NDA). Due to this strong connection, the Bologna Living Lab decided to align its high-level KPIs with those already established in the SULP.

The baseline values are based on data collected in 2020 (the most recent monitoring), although the data required for these calculations is somewhat uncertain and fragmented, both in terms of sources and values. Nevertheless, despite the smaller scale of the pilot, the KPI calculations in the pilot area are aligned with the SULP objectives and can contribute to achieving them. Table 4 reports the aligned KPIs; the last column provides the SULP KPI IDs.

TABLE 4 BOLOGNA CITY/LOCAL KPIS

KPI name	Measurement unit	Data source	Baseline Value	Value at M24	Connection with URBANE platform/models/other tools	Comments
N. of deliveries with sustainable vehicles (cargo bikes, electric vehicles and carts) on the total vehicles	%	2020 SULP – Metropolitan City of Bologna and Municipality of Bologna	0	N. of deliveries with the sustainable vehicle used within URBANE (Scoobic – Light Electric Vehicle) until 2/08/2024: 379.		Link to Bologna SULP KPI code ID: AT16_100 It was not possible to calculate other deliveries done with other sustainable vehicles.
N. of total electric commercial vehicles out of the total vehicles that have access to the LTZ	n.	2020 SULP – Metropolitan City of Bologna	24	25 (Scoobic – Light Electric Vehicle used by Salerno Trasporti last miler)		Link to Bologna SULP KPI code: AT16_101

N. Access commercial vehicles/day in the LTZ	n.	2020 SULP – Metropolitan City of Bologna	3,6 (SULP) 2 (TYP and Due Torri)	1 (Scoobic – Light Electric Vehicle instead of the 2 traditional vehicles used by TYP and Due Torri)		Link to Bologna SULP KPI code: AT16_102
Number of loading/unloading spot in the city centre	n.	2020 SUMP – Metropolitan City of Bologna	36	39 (due to the implementation of the 3 Nearby Delivery Areas)		Link to Bologna SULP KPI code: AT16_103
N. of Nearby Delivery Areas	n.		0	3		No link to specific SULP KPIs but it is a measure included in the SULP

4.1.1.2 Use cases impact evaluation

The following table (Table 5) presents the remaining KPIs for Bologna, which are more focused on implementation activities related to use case 1. In addition to baseline values and the connection with URBANE models, tables 5, 6 and 7 also include information related to the category of each KPI, the TO BE benefits and the KPI values at M24 (August 2024).

TABLE 5 BOLOGNA USE CASE 1 KPIS

KPI name	Measurement unit	Data source	Baseline Value	Value at M24	% Change	Connection with URBANE platform/models/tools	Comments
L55. Number of PuDo in the demo area - Agnostic and - courier specific	n.	GEL proximity platform	17 agnostic PuDos and 265 courier specific PuDos	20 agnostic PuDos and (+3 thanks to implementation of the 3 NDAs) and 265 courier specific PuDos	+17,6% of agnostic PuDos		**Infrastructure & Policy KPIs** TO BE benefits: increase of agnostic PuDo (improvement of goods distribution and traffic congestion)
L16. Number of loading/unloading spot in the demo site (number of operators/n. L/U spots)	n.	Municipality of Bologna data source	430	433 (+3 thanks to implementation of the 3 NDAs)	+0,7% of L/U spots	CERTH Impact assessment radar for scale-up of the adoption of the solution by LSPs	**Infrastructure & Policy KPIs** AT16_103 (SULP 2020) TO BE benefits could stem from: less usage of L/U zones, less access to LTZ

L25. Investment in infrastructures/facilities included in the TO BE situation	Infrastructures/ facilities: € Vehicles: € Administrative costs: € Utilities: €	Municipality of Bologna and Salerno Trasporti database	0	**Hub investment by the Municipality of Bologna**: 3 lockers purchase 68,415 €; cameras €4,400 + NVR €3,900 + €6,000 lepida fibre adaptation; €10 per SIM card monthly renewal per each locker (maximum 4 renewals per month). Other works and excavations were included in other existent works on the same areas in the same period. Electricity consumption is not quantifiable. The total cost is **€83,135**, assuming an average of 2 SIM card monthly renewals per microhub. The actual cost may vary based on usage. **Last miler service**: the cost of the service for each delivery is €2.75; the cost of the ICT investment for technological integration is €7,686. The service includes also the Electric Delivery Vehicle rent (€480.00 per month) and the electric power top-up (€62.00).		CERTH Impact assessment radar and Digital Twin (Cost Benefit Analysis Model)	**Infrastructure & Policy KPIs**

TABLE 6 BOLOGNA USE CASE 1 KPIS (CONTINUED)

KPI name	Measurement unit	Data source	Baseline Value	Value at M24	Connection with URBANE platform/models/tools	Comments

L28. Accidents involving freight vehicles	n.	Metropolitan city of Bologna statistical data (2022)	253	This calculation should be done by the end of 2024 to collect more reliable data including also updated data on Bologna 30 zone measures		**Infrastructure & Policy KPIs** TO BE benefits could stem from: less vehicles, smaller vehicle (less occupancy of the road and sidewalk), reduction of mixture of traffic (e.g. commercial and pedestrian)
L29. People killed or seriously injured in collisions involving freight vehicles	n.	Metropolitan city of Bologna statistical data (2022)	killed: 1; injured: 45	This calculation should be done by the end of 2024 to collect more reliable data including also updated data on Bologna 30 zone measures		**Infrastructure & Policy KPIs** TO BE benefits could stem from less vehicles, smaller vehicle (less occupancy), reduction of mixture of traffic (e.g. commercial and pedestrian)
L1. CO2 emissions (per vehicle per day)	g/km	TYP database Due Torri Database Salerno database	TYP: 50km/day: 6.150 kg Due Torri: 50km/day: 6.150 kg Co2 per km: 123g/Km	TYP: 24 Km/day Co2 emissions 24 km/day: 2.952 Kg Saved km: 26 = 3.198 CO2 kg (-52%)	SKEMA Collaborative routing model	
L53. Degree of innovation of logistics companies	qualitative	TYP and Due Torri database	TYP: 5-10 % Due Torri: 5-10 %	TYP: 5-10 % Due Torri: 5-10 % Salerno: 0.72%		This has been monitored to highlight the fact that digital capabilities of LSPs is a driver; on the other hand, poor level of innovation of last miler
L36. Safety of deliveries (no damages):	%	TYP and DueTorri database	TYP: 99,5%; DUE TORRI: 98%	TYP: 100%; DUE TORRI: 100%; Salerno: 100%	Blockchain	**Operations KPIs** TO BE benefits: vehicles and micro hub monitoring through GEL parcel tracking system and cameras

TABLE 7 BOLOGNA USE CASE 1 KPIS (CONTINUED)

KPI name	Measurement unit	Data source	Baseline Value	Value at M24	Connection with URBANE platform/models/tools	Comments
L37. Security of deliveries (no losses or thefts)	%	TYP and DueTorri database	TYP: 99,7%; DUE TORRI: 98%	TYP: 100%; DUE TORRI: 100%; Salerno: 100%	Blockchain	**Operations KPIs** TO BE benefits: vehicles and micro hub monitoring through GEL parcel tracking system and cameras
L19. Quality of transport services	%	TYP and DueTorri database	TYP: 97%; DUE TORRI: 97%	TYP: 98%; DUE TORRI: 98%; Salerno: 98%	Blockchain	**Operations KPIs** TO BE benefits: vehicles and micro hub monitoring through GEL parcel tracking system and cameras. The quality level is linked to the transit time according to the geographical zone of the delivery agreed with the client. The baseline is the media of the delivery respecting the agreed service levels.
L56. Information accessibility for LSPs	qualitative		Construction site data: NO; exceptional events: NO; accessibility conditions due to weather conditions: NO	N/A	Digital Twin through the Collaborative Routing Model	**Operations KPIs** The Digital Twin can help LSPs to optimize the deliveries between depots, lockers and last milers to achieve fewer emissions and less costs. In addition, if the DT will contain also real time data on construction sites, exceptional events and accessibility due to weather conditions, could support LSPs in organizing their deliveries better.
Total delivery costs (Sustainability of the solution)	€	TYP and DueTorri database	TYP: 3 to 5 Euros; DUE TORRI: 12 Euros Labor costs (TYP: 45%; DUE TORRI: 45%) Vehicle and fuel costs (TYP: 45%; DUE TORRI: 45%)	TYP: €2 – €4; Due Torri: €11 (the saving for the transport operator is between €1 and €1.30 per delivery) without considering the last miler technological integration cost that is about €7,700 covered by ITL;	CERTH Impact assessment radar, URBANE Digital Twin Platform receiving input from SKEMA collaborative routing model and CBA model. They can help to find the Break-Even Point (i.e. which	**Delivery costs**

			Technology management costs (TYP: 2%; DUE TORRI: 2%); Insurance costs (TYP: 1%; DUE TORRI: 1%); Order management costs (TYP: 1%; DUE TORRI: 1%); Waste management costs (TYP: 1%; DUE TORRI: 1%); Marketing and promotion costs (TYP: 1%; DUE TORRI: 3%)	Salerno Trasporti: €2.75 per delivery (Labor costs 68%; Vehicle and fuel costs 27%; Technology management costs 2%; Insurance costs 1%; management costs 1%; Waste management costs 1%; Marketing and promotion costs 0%).	"factors" should we change to make this delivery model profitable)	
Average number of km per trip per vehicle	km	TYP and DueTorri database	TYP: 80 km; DUE TORRI: 80 km	Salerno: 20 km per day; TYP and Due Torri: 24km (from warehouse to the micro hub)	SKEMA Collaborative routing model	**Vehicle operations KPIs** TO BE: also, the last miler will be included
Average number of km per vehicle per day	km	TYP and DueTorri database	TYP: 80km; DUE TORRI: 160 km	Salerno: 20 km per day; TYP and Due Torri: 34km (from warehouse to the micro hub)	SKEMA Collaborative routing model	**Vehicle operations KPIs** TO BE: also, the last miler will be included
Average distance of km travelled in demo area per day	km	TYP and DueTorri database	TYP: 50 km; DUE TORRI: 50km	Salerno: 20 km per day; TYP and Due Torri: 24km (from TYP warehouse to the micro hub)	SKEMA Collaborative routing model	**Vehicle operations KPIs** TO BE: decrease of TYP and DueTorri deliveries
Time to complete a delivery route (minutes)	minutes	TYP and DueTorri database	TYP: 480 minutes; DUE TORRI: 480	Salerno: 60 minutes; TYP and Due Torri: 35/40 minutes (from warehouse to the micro hub)	SKEMA Collaborative routing model	**Vehicle operations KPIs.**
Average vehicles load factor	% in weight or	TYP and DueTorri database	TYP: 80%; DUE TORRI: 90%	Salerno: 20%; TYP: 80%		**Vehicle operations KPIs**

	volume per Km					
Average number of deliveries per trip	n.	TYP and DueTorri database	TYP: 60 to 70; DUE TORRI: 20-30 (bigger shipments than TYP)	TYP and Due Torri: 5; Salerno: 5		**Vehicle operations KPIs** TO BE: Less deliveries per trip for Due Torri and TYP (only to 3 NDAs instead to the single recipients)

4.1.1.3 Social impact evaluation

Social KPIs - Decent work KPIs

While KPIs commonly identified in European urban logistics projects and literature align well with SDGs 9 - Industry, innovation, and infrastructure, 11 - Sustainable cities and communities, 12 - Responsible consumptions, 13 - Climate action, 17 - Partnerships for the goals, the SDG 8 - Decent work and economic growth, was not sufficiently covered. To address this, specific indicators related to personnel turnover, salary, education level, gender diversity, and flexible work were collected in a dedicated data sheet. Due to the very short timeframe, data from the Bologna Living Lab indicates no significant changes in social KPIs so far, except for the inclusion of GEL Proximity and Salerno Trasporti data in the "TO-BE" scenario. Further implementation of the solution is expected to positively impact key performance indicators (KPIs) such as average salary and educational level. In the below Table 8 the expected benefits from the introduction of the solution (TO BE benefits) are detailed. Comprehensive results are presented in Section 4.1.3 Conclusions.

TABLE 8 BOLOGNA SOCIAL KPIS

KPI name	Measurement unit	Data source	Baseline Value	Value at M24	Comments
Personnel turnover	%	TYP, DueTorri and GEL database	DUE TORRI: 12%; TYP: 0%	DUE TORRI: 12%; TYP: 0%; GEL: 0%; Salerno: 7%	TO BE benefits: lower personnel turnover due to the improvement of the working conditions for transport operators and last milers. Expanding the use of agnostic microhubs could decrease the driver's need to make multiple stops and handle

					parcels individually, potentially resulting in less physical work and improved safety.
Average salary	€	TYP, DueTorri and GEL database	DUE TORRI: €2,282.36; TYP €2,500	DUE TORRI: €2,282.36; TYP €2,500; GEL: €2,500; Salerno: €2,300	TO BE benefits: Higher and more efficient delivery volumes through the automated microhubs may result in a reduction of drivers, leading to increased average salaries.
Education level	%	TYP, DueTorri and GEL database	PhD: DUE TORRI, TYP an GEL: 0%; master's degree: DUE TORRI: 35%; TYP: 20%; Bachelor's degree: DUE TORRI: 37%; TYP: 20%; High School Diploma: DUE TORRI: 100%; TYP: 53%; Lower Educational level: DUE TORRI: 0%; TYP: 6,67%;	PhD: DUE TORRI, TYP, GEL and Salerno: 0%; master's degree: DUE TORRI: 35%; TYP: 20%; GEL: 0%; Salerno: 0%. Bachelor's degree: DUE TORRI: 37%; TYP: 20%; GEL: 80%; Salerno: 0%. High School Diploma: DUE TORRI: 100%; TYP: 53%; GEL: 20%; Salerno: 80%. Lower Educational level: DUE TORRI: 0%; TYP: 6,67%; GEL: 0%; Salerno: 20%.	TO BE benefits: the solution's advanced technology will require a workforce with enhanced ICT skills, which means higher education level.
Gender diversity	%	TYP, DueTorri and GEL database	DUE TORRI: 48%; TYP: 53,33%; GEL: 0%	DUE TORRI: 48%; TYP: 53,33%; GEL: 0%; Salerno: 15%	TO BE benefits: thanks to the reduction of the physical work due to the presence of the automated and unattended microhub, the number of women working in transport operators and last milers will increase.
Percentage of self-employed workers	%	TYP, DueTorri and GEL database	DUE TORRI: 0%; TYP: 6,67%	DUE TORRI: 0%; TYP: 6,67%; GEL: 0%; Salerno: 0%	TO BE benefits: As delivery volumes increase, there will be a growing demand for last-mile delivery services. This will likely lead to more self-employed workers and small businesses participating in the solution by providing deliveries in the city center with zero emission vehicles.
Percentage of part-time workers	%	TYP, DueTorri and GEL database	DUE TORRI: 2%; TYP: 0%; GEL: 0%	DUE TORRI: 2%; TYP: 0%; GEL: 0%; Salerno: 29%	TO BE benefits: automated microhubs can help create more predictable workloads for full-time drivers, reducing the need for frequent adjustments or additional part-time staff.

Precariousness rate	%	TYP, DueTorri and GEL database	DUE TORRI: 15%; TYP: 0%	DUE TORRI: 15%; TYP: 0%; GEL: 0%; Salerno: 17%	TO BE benefits: the precariousness rate should decrease thanks to guaranteed hours and fixed wages for the last mile drivers, instead of relying on temporary or on-demand work
Flexibility of working hours	Yes/No	TYP, DueTorri and GEL database	DUE TORRI: Yes; TYP: Yes	DUE TORRI: Yes; TYP: Yes; GEL: Yes; Salerno: Yes	TO BE benefits: the flexibility of working hours is likely to increase as automated microhubs allow some staff to work remotely, coordinating orders and deliveries
Percentage of remote work	%	TYP, DueTorri and GEL database	DUE TORRI 27%; TYP 80%	DUE TORRI 27%; TYP 80%; GEL: 40%; Salerno: 40%	TO BE benefits: The percentage of remote work is likely to increase as automated microhubs allow some staff to work remotely, coordinating orders and deliveries through the dashboard.

DNSH principle compliance

Bologna LL use case KPIs are aligned with DSNH principle as they are linked with the six objectives defining a sustainable activity according to the EU Sustainable Taxonomy. The Bologna use case is compliant with objective 1 and 5 by rethinking urban distribution models with last miler light electric vehicles. Additionally, they enhance efficiency by decreasing the number of vehicles and kilometres travelled, thereby mitigating overall traffic congestion in the demo area. The Bologna use case also aligns with objective 2, "Climate Change Adaptation," by enhancing resilience to climate-related risks and hazards in last-mile delivery activities. Given Bologna's recent devastating flood, the city plans to utilize Digital Twin technology for weekly LMD intervention planning in the city centre, incorporating factors such as weekly weather forecasts.

Sustainability triangulation

As reported in chapter 3.1.2, NORCE carried out 2 workshops with each LL that both started and ended with sustainability: one on Design Thinking and one on the Sustainable Business Model Canvas. The workshops were aimed at helping the LLs take the position of the users and their collaborators involved in their innovations, helping them to consider different aspects and implications of their implementation.

Bologna identified mainly two different personas: the transport operators delivering goods to the lockers, and the logistics operators who distribute and operate the 'last mile.' With this categorization, two central parts of the innovation case are represented: the actors that *deliver to* and *pick up from* the consolidation centres. Additionally, the city government was discussed as a persona. In the prioritization phase (2) the three personas were summarized as being the transport operator, city authority and last miler. In the point of statement-phase, the collaboration between these personas was central, both in terms of how they could directly work together in making the logistics possible, but also in terms of enabling and facilitating for each other's success in a broader perspective. This also highlighted that the privately owned businesses would lead the way in finding sustainable business models, whilst the public actors and authorities need to provide clear regulation and rules for the operators to work within, as well as giving some incentives for making the innovations economically sustainable. The last section of the workshop (4) provided insights into how vertical collaboration between operators could be achieved with the help of public authorities, as well as what is and should be done to facilitate a regulatory framework that encourages the technological development that the Bologna LL is aiming to achieve. The Design Thinking map for Bologna LL can be found below in Figure 5.

During the Sustainable Business Canvas Workshop, Bologna highlighted the goal to develop a business model for urban deliveries that promotes collaboration between operators. Technological costs and increased delivery costs were named as barriers, but there were several benefits such as effective use of public space and improved working conditions for delivery workers. LL participants saw the potential for access to restricted areas in Bologna as a benefit to actors, yet also recognized the risk of losing smaller actors and competition in last-mile deliveries. For the necessary processes, Bologna named the need for space, internet and electricity for the parcel lockers, as well as loading zones and charging stations for the delivery vehicles. Locker owners and transport operators must sign the necessary contracts, and the city must provide the space and permits for the lockers and loading zones. For this LL, the key stakeholders are the transport operators, the municipality, the regional foundation (ITL) and the technological provider (GEL Proximity). The latter company enables communication and collaboration between the last mile and transport operators. The Sustainable Business Canvas for Bologna LL can be found below in Figure 6.

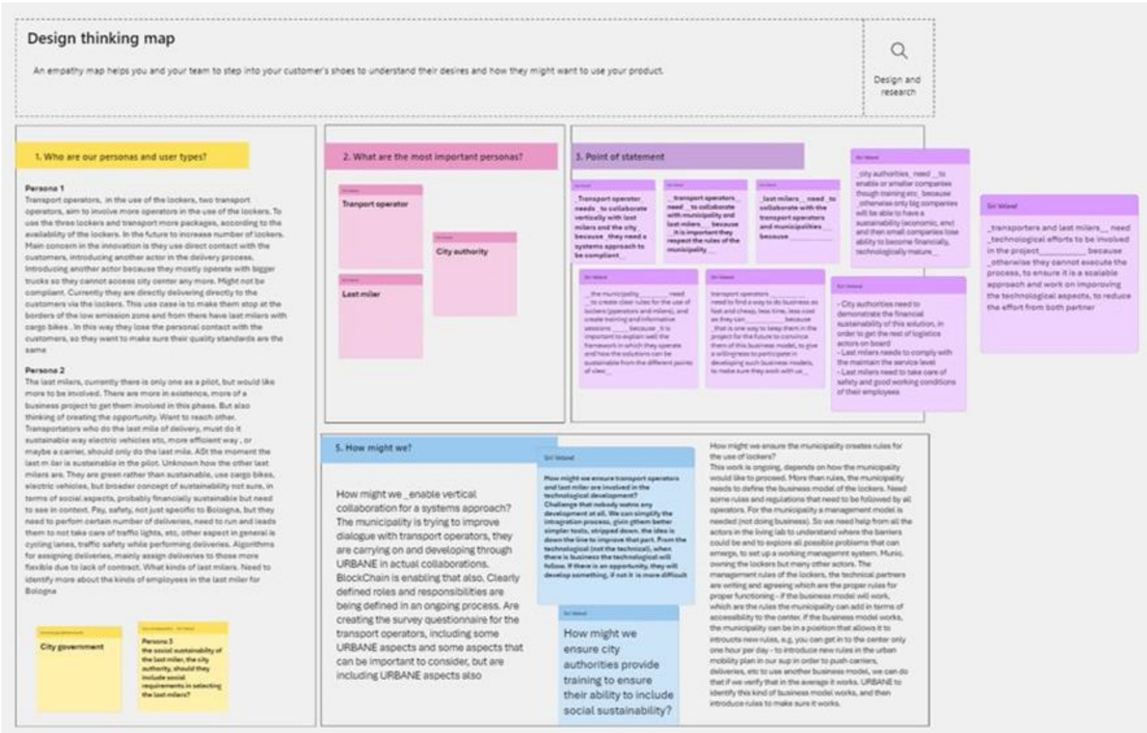


FIGURE 5 BOLOGNA DESIGN THINKING WORKSHOP

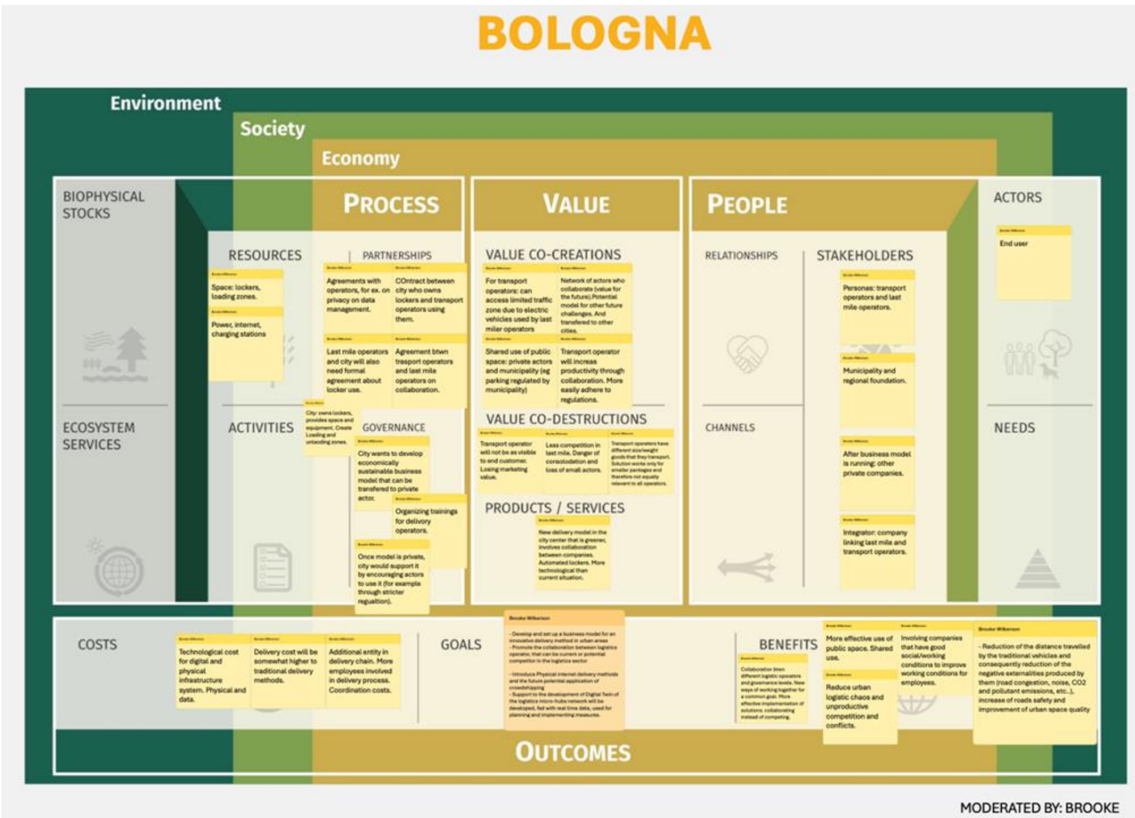


FIGURE 6 BOLOGNA SUSTAINABLE BUSINESS CANVAS WORKSHOP

4.1.2 Process evaluation

In this paragraph, the results of the Bologna process evaluation questionnaires are reported. The first round took place in October 2023, before the Bologna WP-3 alignment meeting. The answers were collected from researchers, technology providers, and couriers (3 in total). The results are reported in WP3 *Impact Assessment Methodology and KPIs* internal deliverable. Between June and July 2024, the same stakeholders confirmed the results and reported them in the following table (Table 9):

TABLE 9 BOLOGNA USE CASE 1 PROCESS EVALUATION RESULTS

UC1	Barriers	Drivers	Potential impact on KPI final values
POLITICAL INSTITUTIONAL	Cost-effective management of micro-hubs (lockers) -Difficulty in defining an attractive administrative, commercial and contractual agreement to make the micro-hubs model attractive for commercial operators in the future (1/3) Bureaucratic/administrative procedures slowing down permits (2/3)	**Strong guidance from public authority** and commitment to sustainability (3/3) and capacity in stakeholder engagement (1/3)	Infrastructure & policy KPIs
ECONOMIC & FINANCIAL	**Financial sustainability of the innovation** (3/3): Fragmenting the logistics chain and introducing an additional operator necessarily brings extra costs	**Economy of scale, changes to the BM** (allowing consumers to pick-up goods directly at micro-hub) could help financial sustainability (1/3); public funding (1/3)	Delivery costs KPIs
SOCIAL	LSPs collaboration (2/3) and employees work conditions (3/3)	**Attractiveness of the solution for the consumer** once the pickup points are proposed also to the final customer (1/3), **Stakeholder collaboration** (1/3), deployment of shared assets (agnostic PuDos, micropubs, etc.)	SDG Decent work KPIs
TECHNOLOGICAL	**Standardisation and Integration**: (3/3) Difficulty to standardise process across carriers and last milers	Capability and willingness of the involved actors (1/3), open access data and blockchain (1/3), service scalability (1/3)	Service quality KPIs

DATA/INFORMATIONAL	**Data standardisation** (3/3), **data sharing** (willingness to share strategic data) (2/3), difficulties to share data in real time (1/3)	Usage of data to demonstrate improvement of the process through **simulation** (1/3), Available **Open Access data**, anonymisation techniques, survey tools (1/3)	Service quality and data accessibility KPIs
ENVIRONMENTAL	**Bad weather conditions** (2/3) could be an issue in case of cargo-bike operators	Environmental sustainability of the solutions (2/3)	Operations KPIs
LEGAL/REGULATION	**Lack of clarity on roles and responsibilities** (3/3) (responsibility on the goods transported and allocation of costs), **lack of specific regulations** on technologies (1/3)	Clarify roles and responsibilities, (1/3) local/regional policy implementation (1/3)	Innovation uptake of the solution

4.1.3 Conclusions

Overall, the Bologna LL has focused its efforts on contributing to SDGs 7-11 (7 Affordable and clean energy; 8 Decent work and economic growth; 9 Industry, innovation and infrastructure; 10 Reduced inequalities; 11 Sustainable cities and communities). SDG 8 on Decent work and economic growth has been at the centre of these efforts, which is reflected in the project's KPIs, the sustainability triangulation and the process evaluation. Efforts to implement the Nearby Delivery Area in Bologna included considerations of how this implementation would affect workers, and in the process evaluation this was seen as a barrier.

Despite a focus particularly on SDG 8 in the project's KPIs, the brief span of the Bologna LL means that there are no reported changes in the social KPIs, except for the inclusion in the TO BE situation of GEL Proximity (technological integrator) and Salerno Trasporti (last miler) values. Specifically, the continued implementation of the solution is expected to positively impact key performance indicators (KPIs) such as average salary and educational level. Increased and optimized delivery volumes will likely reduce the number of drivers, leading to higher average salaries. Moreover, the solution's advanced technology will require a workforce with increased knowledge of information and communications (ICT) skills. Finally, expanding the use of agnostic microhubs could decrease the driver's need to make multiple stops and handle parcels individually, potentially resulting in less physical work and improved safety.

KPI data from Month 24 shows that Bologna LL has contributed directly to SDG 9.4 by reducing average CO2 emissions made by the use case deliveries compared to the baseline, and indirectly to 11.6.2 by reducing km travelled by the delivery vehicles and likely reducing particulate matter.

Connected to this, Bologna LL has also contributed to reach project key targets, such as successful demonstration of the innovation leading to improved environmental performance (>20% CO2 reduction) in intervention areas. TYP saved about 3.298 CO2 Kgs a day (-52%) comparing their conventional door-to-door deliveries with the new deliveries with micro-hubs and Electric Delivery Vehicles Last Miler in the demo area. However, with increased delivery volumes and operators, this percentage reduction in CO2 emissions is expected to extend to other transport operators in the Bologna city center.

The above-mentioned objective is also connected with the second project key target as Bologna LL solution halved deliveries made with conventional vehicles. Prior to implementing the solution, TYP and Due Torri relied on their conventional diesel vehicles instead of zero-emission vehicles to access to the city center. TYP experienced a more significant reduction in conventional vehicle deliveries in Bologna city center compared to Due Torri, as Due Torri primarily handles B2B shipments with multiple items, resulting in fewer deliveries passing through the microhub. This is explained in detail in D2.3 Bologna Demonstrator – Chapter 10 Lessons Learned and Results.

4.2 Helsinki

4.2.1 Impact evaluation

4.2.1.1 City/Local impact evaluation

For each partner in Helsinki LL, the one goal is to increase the customer satisfaction rate by providing services that create value for its users. Therefore, the most important KPI on high level, reported in Table 10 below, is the NPS score which measures the quality of the services in general.

TABLE 10 HELSINKI HIGH LEVEL KPIS

KPI name	Measurement unit	Data source	Baseline Value	Value at M23/24	% change	Connection with URBANE platform/models/other tools	Comments
L33. Residents' acceptance level (Helsinki: (NPS score) (>70%)) - Quality of services	Percentage	Baseline: DB Schenker's parcel delivery service in 2023, Final value: Forum Virium Helsinki survey	75%	86,66%	15.5% increase in customer satisfaction	HUMAT-MASS-GT	Note: the response rate was quite low due to low volumes.

4.2.1.2 Use cases impact evaluation

The KPIs related to each of the 3 sprints/use cases to be demonstrated in Helsinki are reported below in Tables 11 – 19.

Sprint 1 - Delivering tools from the Würth Center Sörnäinen to nearby construction sites in Kalasatama region

TABLE 11 HELSINKI SPRINT 1 KPIS

KPI name	Measurement unit	Data source	Baseline Value	Value at M23/24	% change	Connection with URBANE platform/models/tools	Comments

L.9 Average number of km per trip - Efficiency	Kilometres	Baseline: DB Schenker, Final value: LMAD	Van: 65km Construction van: 2km	Van: 45km Cargobike: 15km ADV: 0.7km	33% reduction in kms driven by the van	2-echelon	Average Per trip excludes the travelling outside the city area. Van vs. ADV
L10. Average number of km per vehicle - Efficiency	Kilometres	Baseline: DB Schenker, Final value: LMAD	Van: 65km Construction van: 2km	Van: 45km Cargobike: 15km ADV: 0.7km	33% reduction in kms driven by the van		Van vs ADV
L11. Total distance travelled in urban area - Efficiency	Kilometres	Baseline: DB Schenker, Final value: LMAD	Van: 20km Construction van: 2km	Van: 10km Cargo bike: 15km ADV: 17km	54.5% reduction in kms driven by the van		Excludes the travelling outside the city area.
L22. Average deliveries per trip - Efficiency	Average number of parcels delivered per trip	Baseline: DB Schenker, Final value: LMAD	Van: 15 Construction van: 1	Cargo bike: 7 ADV: 1	53.3% reduction in efficiency when compared to the cargo bike, no change when comparing the construction van and the ADV		Demand volume was low

TABLE 12 HELSINKI SPRINT 1 KPIS (CONTINUED)

KPI name	Measurement unit	Data source	Baseline Value	Value at M23/24	% change	Connection with URBANE platform/models/tools	Comments
L1. CO2 emissions - Sustainability	g/km	Baseline: DB Schenker, Final value: LMAD	EUR-5 CLASS 670 g/km	Van: 670 g/km Cargo bike: 0 g/km ADV: 0 g/km	33% reduction in emissions		Van vs ADV

L14. Time to complete a delivery route - Efficiency	Hours and minutes	Baseline: DB Schenker, Final value: LMAD	Van: 6h 0 minutes Construction van: 1h	Van: 50 minutes Cargo bike: 1h 30min ADV: 0 hours 24 minutes	76% increase in efficiency when using the ADV compared to construction van	2-echelon	Van vs van + cargo bike Construction van vs ADV Notice the average number of parcels delivered per trip.
L8. Fuel consumption per Km - Sustainability	Liters / 100 kilometres	Baseline: DB Schenker, Final value: LMAD	Diesel 25L/100km	Van: 25L/100km Cargo bike: 0l/100km ADV: 0L/100km	33% reduction in fuel consumption		Van vs van + cargo bike Construction Van vs ADV
NEW. Number of parcels delivered through ADVs - Efficiency	Total number of successful deliveries	Baseline: DB Schenker, Final value: LMAD	0	40	Not comparable		
L37. Security of deliveries (no losses or thefts) - Quality of services	Safely delivered parcels / Total parcels	Baseline: DB Schenker, Final value: LMAD	99.999%	100%	0.001% increase	Blockchain	ADV under constant supervision
L36. Safety of deliveries (no damages) - Quality of services	Undamaged parcels / Total parcels	Baseline: DB Schenker, Final values: LMAD	99.998%	100%	0.002% increase		ADV under constant supervision
NEW. Missed deliveries due to vehicle issue – Quality of services	Missed deliveries / Total deliveries	Baseline: DB Schenker, Final value: LMAD	0.001%	0	0.001% decrease		The number of failed deliveries due to an issue in the vehicle.

TABLE 13 HELSINKI SPRINT 1 KPIS (CONTINUED)

KPI name	Measurement unit	Data source	Baseline Value	Value at M23/24	% change	Connection with URBANE platform/models/tools	Comments

L67. Rate of successful delivery from 1st attempt - Efficiency	Successful delivery / total deliveries	Baseline: DB Schenker, Final value: LMAD	98%	96.15%	1.85% decrease		Communication issues
L57. Number of failed deliveries per trip - Efficiency	Failed deliveries / total deliveries	Baseline: DB Schenker, Final value: LMAD	2%	4%	2% increase		Due to low demand volume the number becomes higher
L52. Presence of IT and AI driven optimisation system – Efficiency	yes/no	Baseline: DB Schenker, Final value: LMAD	No	Yes	100% Upgrade	2-echelon	LMAD’s VRP solution
L50. Failures in the IT system - Quality of services	Failed deliveries / Total deliveries	Baseline: DB Schenker, Final value: LMAD	1%	0%	1% decrease		The number of failed deliveries due to a problem in the IT system.

Sprint 2 Delivering B2B and B2C e-commerce parcels in the Ruoholahti and Jätkäsaari region using the ADV

TABLE 14 HELSINKI SPRINT 2 KPIS

KPI name	Measurement unit	Data source	Baseline Value	Value at M23/24	% change	Connection with URBANE platform/models/tools	Comments
L.9 Average number of km per trip - Efficiency	Kilometres	Baseline: DB Schenker, Final value: LMAD	45km	Van: 45km ADV: 0.6km	No change	2-echelon	Van vs van + ADV Baseline value considers delivery to only one collection point, while van + ADV is closer to home delivery
L10. Average number of km per vehicle - Efficiency	Kilometres	Baseline: DB Schenker, Final value: LMAD	45km	Van: 45km ADV: 0.6km	No change		Van vs Van + ADV
L11. Total distance travelled in urban area - Efficiency	Kilometres	Baseline: DB Schenker, Final value: LMAD	20km	Van: 10km ADV: 11.1km	50% reduction in kms driven by the van		Excludes the travelling outside the city area.
L22. Average deliveries per trip - Efficiency	Average number of parcels delivered per trip	Baseline: DB Schenker, Final value: LMAD	15	1.1	93% decrease	2-echelon	Demand volume was still quite low
L1. CO2 emissions - Sustainability	g/km	Baseline: DB Schenker, Final value: LMAD	EUR-5 CLASS 670 g/km	0 g/km	Comparing to L11: 50% reduction in CO2		Van vs ADV
L14. Time to complete a delivery route - Efficiency	Hours and minutes	Baseline: DB Schenker, Final value: LMAD	1 hour	Van: 1 hour ADV: 0 hours 22 minutes	26.8% decrease in efficiency	2-echelon	Van vs van + ADV Baseline value considers delivery to only one collection point, while van + ADV is closer to home delivery

L8. Fuel consumption per Km - Sustainability	Liters / 100 kilometres	Baseline: DB Schenker, Final value: LMAD	Diesel - 25l/100km	0l/100km	Comparing to L11: 50% reduction in fuel consumption		Van vs ADV

TABLE 15 HELSINKI SPRINT 2 KPIS (CONTINUED)

KPI name	Measurement unit	Data source	Baseline Value	Value at M23/24	% change	Connection with URBANE platform/models/tools	Comments
NEW. Number of parcels delivered through ADVs - Efficiency	Total number of successful deliveries	Baseline: DB Schenker, Final value: LMAD	0	50	Not comparable. 25% increase compared to sprint 1.		
L36. Safety of deliveries (no damages) - Quality of services	Damaged parcels / Total parcels	Baseline: DB Schenker, Final values: LMAD	99.998%	100%	0.002% increase	Blockchain	ADV under constant supervision
L37. Security of deliveries (no losses or thefts) - Quality of services	Safely delivered parcels / Total parcels	Baseline: DB Schenker, Final value: LMAD	99.999%	100%	0.001% increase	Blockchain	ADV under constant supervision
NEW. Missed deliveries due to vehicle issue – Quality of services	Missed deliveries / Total deliveries	Baseline: DB Schenker, Final value: LMAD	0.001%	0	0.001% decrease		The number of failed deliveries due to an issue in the vehicle.
L57. Number of failed	Failed deliveries / total deliveries	Baseline: DB Schenker, Final value: LMAD	2%	2%	No change		

deliveries per trip - Efficiency							
L67. Rate of successful delivery from 1st attempt - Efficiency	Successful delivery / total deliveries	Baseline: DB Schenker, Final value: LMAD	98%	98%	No change	2-echelon	

TABLE 16 HELSINKI SPRINT 2 KPIS (CONTINUED)

KPI name	Measurement unit	Data source	Baseline Value	Value at M23/24	% change	Connection with URBANE platform/models/tools	Comments
L52. Presence of IT and AI driven optimisation system – Efficiency	yes/no	Baseline: DB Schenker, Final value: LMAD	No	Yes	100% upgrade	2-echelon	LMAD's VRP solution
L50. Failures in the IT system - Quality of services	Total number of failures/Total deliveries	Baseline:	1%	0%	1% decrease		The number of failed deliveries due to a problem in the IT system.
L65. Fuel cost (euros per litre) and electricity cost (euros per kWh) - Financial sustainability	€/l or €/kWh	Baseline: DB Schenker, Final value: LMAD	Diesel M5/2023: 1,86 € / l – M6: 1.85 € /l - M7: 1,85 € /l - M8 1,94 € /l	0.13 €/kWh meaning 0.14€ during the sprint 2	Using 11.1km as a refence and M7 price, the fuel cost decrease is 97.24%		Van vs ADV
NEW. Electricity consumption per Km - Sustainability	kWh/100km	Baseline: DB Schenker, Final value: LMAD	0 kWh/100km	10 kWh/100 km	Not comparable		Van vs ADV

Sprint 3 will be an iteration based on the previous sprints. It aims at collecting values for the same KPIs as the sprint 1 and 2, but in addition it has at least three more KPIs as reported in Table 17, 18 and 19:

TABLE 17 HELSINKI SPRINT 3 KPIS

KPI name	Measurement unit	Data source	Baseline Value	Value at M23/24	% change	Connection with URBANE platform/models/tools	Comments
L2. NO2 emissions - Sustainability	g/km	Baseline: DB Schenker, Final value: DB Schenker	0.18g/km	0 g/km	100% decrease		
L3. PM10 emissions - Sustainability	g/km	Baseline: DB Schenker, Final value: DB Schenker	0.005g/km	0 g/km	100% decrease		
L.9 Average number of km per trip - Efficiency	Kilometres	Baseline: DB Schenker, Final value: LMAD	45km	Van: 45km ADV: 1.252km	No change	2-echelon	Van vs van + ADV Baseline value considers delivery to only one collection point, while van + ADV is closer to home delivery
L10. Average number of km per vehicle - Efficiency	Kilometres	Baseline: DB Schenker, Final value: LMAD	45km	Van: 45km ADV: 1,252km	No change		Van vs Van + ADV
L11. Total distance travelled in urban area - Efficiency	Kilometres	Baseline: DB Schenker, Final value: LMAD	20km	Van: 10km ADV: 20km	50% decrease in kms driven by van		Average Per trip Excludes the travelling outside the city area

L22. Average deliveries per trip - Efficiency	Average number of parcels delivered per trip	Baseline: DB Schenker, Final value: LMAD	15	1	93.33% decrease	2-echelon	Demand volume was still quite low

TABLE 18 HELSINKI SPRINT 3 KPIS (CONTINUED)

KPI name	Measurement unit	Data source	Baseline Value	Value at M23/24	% change	Connection with URBANE platform/ models/tools	Comments
L1. CO2 emissions - Sustainability	g/km	Baseline: DB Schenker, Final value: LMAD	EUR-5 CLASS 670 g/km	0 g/km	50% decrease when compared to L11		Van vs ADV
L14. Time to complete a delivery route - Efficiency	Hours and minutes	Baseline: DB Schenker, Final value: LMAD	1 hour	Van: 1 hour ADV: 0 hours 25 minutes	41.67% increase	2-echelon	Van vs van + ADV Baseline value considers delivery to only one collection point, while van + ADV is closer to home delivery thus taking more time to deliver
L8. Fuel consumption per Km - Sustainability	Liters / 100 kilometres	Baseline: DB Schenker, Final value: LMAD	Diesel - 25l/100km	0l/100km	50% decrease when compared to L11		Van vs ADV
NEW. Number of parcels delivered through cargo bike - Efficiency	Total number of successful deliveries	Baseline: DB Schenker, Final value: DB Schenker	0	464	100% increase		Between 3 June and 31 July 2024.
NEW. Average number of parcels delivered per day using a cargo bike	Average of deliveries per day	Baseline: DB Schenker, Final value: DB Schenker	0	12.23	100% increase		Between 3 June and 31 July 2024.
L36. Safety of deliveries (no damages) - Quality of services	Damaged parcels / Total parcels	Baseline: DB Schenker, Final values: LMAD	99.998%	100%	0.002% increase	Blockchain	ADV under constant supervision
L37. Security of deliveries (no losses or thefts) - Quality of services	Safely delivered parcels / Total parcels	Baseline: DB Schenker, Final value: LMAD	99.999%	100%	0.001% increase	Blockchain	ADV under constant supervision

TABLE 19 HELSINKI SPRINT 3 KPIS (CONTINUED)

KPI name	Measurement unit	Data source	Baseline Value	Value at M23/24	% change	Connection with URBANE platform/models/tools	Comments
NEW. Missed deliveries due to vehicle issue – Quality of services	Missed deliveries / Total deliveries	Baseline: DB Schenker, Final value: LMAD	0.001%	0	0.001% decrease		The number of failed deliveries due to an issue in the vehicle.
L57. Number of failed deliveries per trip - Efficiency	Failed deliveries / total deliveries	Baseline: DB Schenker, Final value: LMAD	2%	0%	2% decrease		
L67. Rate of successful delivery from 1st attempt - Efficiency	Successful delivery / total deliveries	Baseline: DB Schenker, Final value: LMAD	98%	100%	2% increase	2-echelon	
L52. Presence of IT and AI driven optimisation system – Efficiency	yes/no	Baseline: DB Schenker, Final value: LMAD	No	Yes	100% upgrade	2-echelon	LMAD's VRP solution
L50. Failures in the IT system - Quality of services	Total number of failures/total deliveries	Baseline:	1%	0%	1% decrease		The number of failed deliveries due to a problem in the IT system.
L65. Fuel cost (euros per litre) and electricity cost (euros per kWh) -	€/l or €/kWh	Baseline: DB Schenker, Final value: LMAD	Diesel M5/2023: 1,86 € / l – M6: 1.85 € /l - M7:	0.13 €/kWh meaning 0.26€ during the sprint 3	97.24% decrease		Van vs ADV

Financial sustainability			1,85 € /l - M8 1,94 € /l				
NEW. Electricity consumption per Km - Sustainability	kWh/100km	Baseline: DB Schenker, Final value: LMAD	0 kWh/100km	10 kWh/100 km	Not comparable		Van vs ADV

4.2.1.3 Social impact evaluation

Social KPIs – Decent work

While KPIs commonly identified in European urban logistics projects and literature align well with SDGs 9 - Industry, innovation, and infrastructure, 11 - Sustainable cities and communities, 12 - Responsible consumptions, 13 - Climate action, 17 - Partnerships for the goals, the SDG 8 - Decent work and economic growth, was not sufficiently covered. To address this, specific indicators, reported in Table 20, related to personnel turnover, salary, education level, gender diversity, and flexible work were collected in a dedicated data sheet and reported in the following table (Table 20).

TABLE 20 HELSINKI SOCIAL KPIS

KPI name	Measurement unit	Data source	Baseline Value	Value at M23/M24	Comments
Personnel turnover	%	Privacy issues to provide the data			No impact nor data available.
Average salary	€	Privacy issues to provide the data			URBANE operations could have a potential increase in average salary in the future
Education level	%	The project team	Masters: 50, Bachelor: 30, High School: 20	Masters: 50, Bachelor: 30, High School: 20	No change
Gender diversity	%	The project team	10% female	20% female	Service point operations and cargo bike had an impact.

Percentage of self-employed workers	%	The project team	0	0	Depends on the companies in the future.
Percentage of part-time workers	%	The project team	0	0	Depends on the companies in the future.
Precariousness rate	%	Privacy issues to provide the data			No data available.
Flexibility of working hours	Yes/No	The project team	No	No	Even remote operator must work during the delivery hours, but optimizing the working hours based on the delivery schedule could be possible.
Percentage of remote work	%	The project team	0	0	ADV can't run currently independently, so there was no change in the value of remote work. Potentially in the future.

DNSH principle compliance

The KPIs of Helsinki LL use cases align with the DNSH principle as they are linked to some of the six objectives outlined in the EU Sustainable Taxonomy for defining a sustainable activity. Helsinki use cases are compliant with objective 1 and 5 by rethinking urban distribution models through testing sustainable modes (cargo-bikes), but also possibly for customer service (pick-up and drop-off points and/or locker systems for parcel pick-up). Moreover, Helsinki use cases are also connected with objective 4 as one of the aims of Helsinki LL (use case/sprint 3) is to utilize a pre-existing micro hub as a homebase for the ADVs, cargo bikes and a service point for the residents in Helsinki. This contributes to the transition to the circular economy as it implies the utilization of an already existing infrastructure.

Sustainability triangulation:

As reported in chapter 3.1.2, in the first reporting period NORCE carried out 2 workshops with each LL that both started and ended with sustainability: one on Design Thinking and one on Sustainable Business Model Canvas. The workshops were aimed at helping the LLs take the position of the users and their collaborators involved in their innovations, helping them to consider different aspects and implications of their implementation.

Helsinki focused on the different service-providers in the process of defining personas (1), resulting in the identification of both major and smaller logistics operators, as well as policy makers. During the prioritization phase (2) the decision was made to focus on one large and one smaller logistics operator, ensuring that the Living Lab (LL) innovation could effectively address the needs of both operator types. In the ideation process (3) it became evident that the LLs could significantly enhance the sustainability, foster collaboration, and promote extensive learning and knowledge-sharing among diverse stakeholders. In the final phase (4), the discussion centred on how LL participants could ensure sustainability, underscoring URBANE's role as a facilitator to showcase the viability of innovative sustainability practices.

During the Sustainable Business Canvas Workshop, Helsinki focused on lessons that could be learnt from a scaled-up version of its LL activities with more autonomous delivery vehicles, with potential infrastructure costs as a barrier and time savings as a benefit. LL participants saw acceptance of the new solutions and collaboration between competitors as necessary values to create, and the worry of theft and accidents as values to destruct. To achieve the LL outcomes, participants pointed to the need for negotiations and agreements regarding micro-hub operations and the idea that provision of public space is best regulated when it is an offer to all operators. For People, LL participants named data sharing and information on customer segments as important for relationships and stakeholders. They named the information sharing between the project team and the freight operator and marketing of the robot delivery option as two concrete communication examples. Lastly, the LL participants named the visual presentation of the ADV as a challenge, with issues such as children approaching the vehicles to admire them and the potential challenge of social acceptance of many these vehicles in public spaces. The Design Thinking map and the Sustainable Business Canvas for Helsinki LL are reported below in Figure 7 and 8.

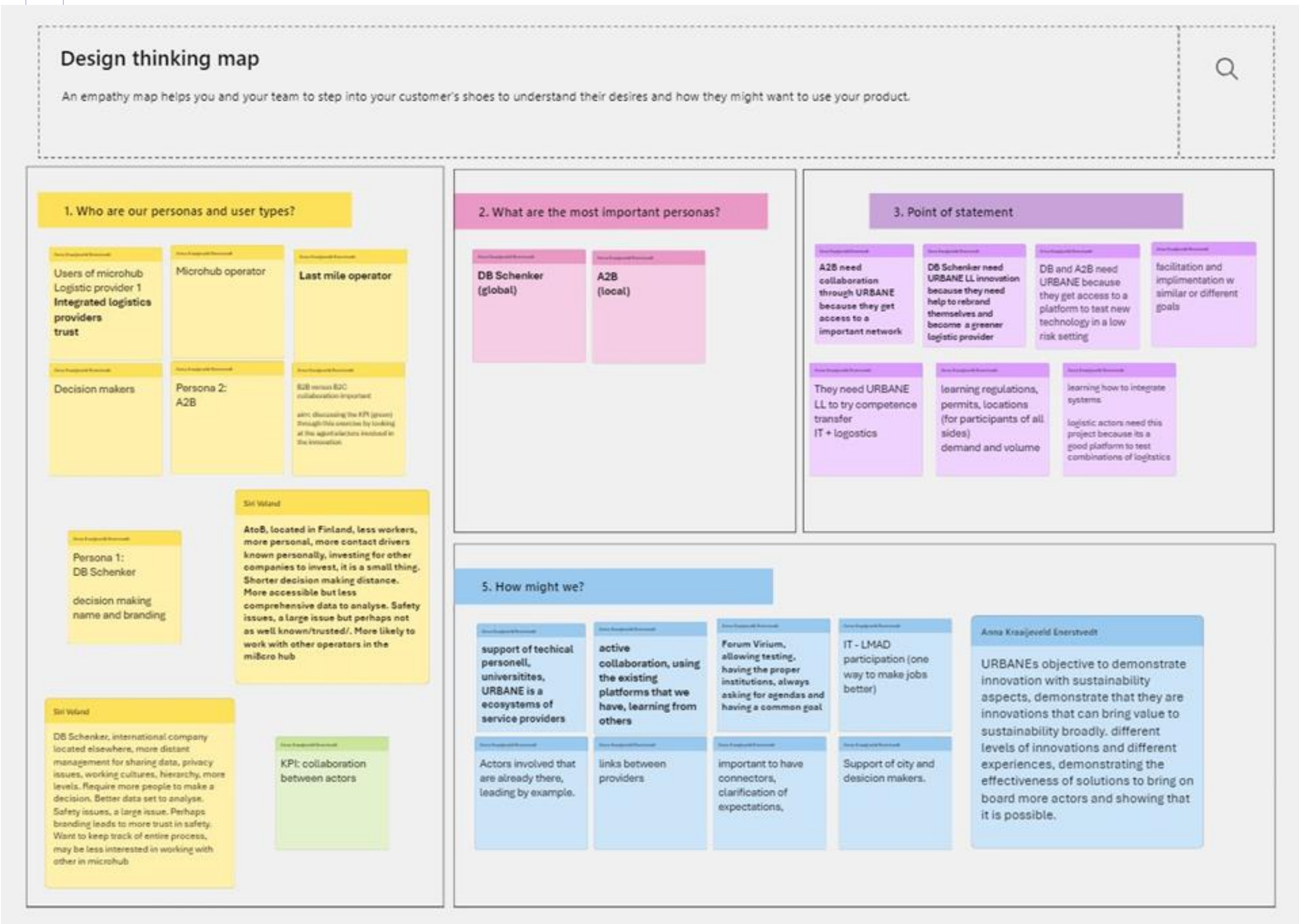


FIGURE 7 HELSINKI DESIGN THINKING WORKSHOP

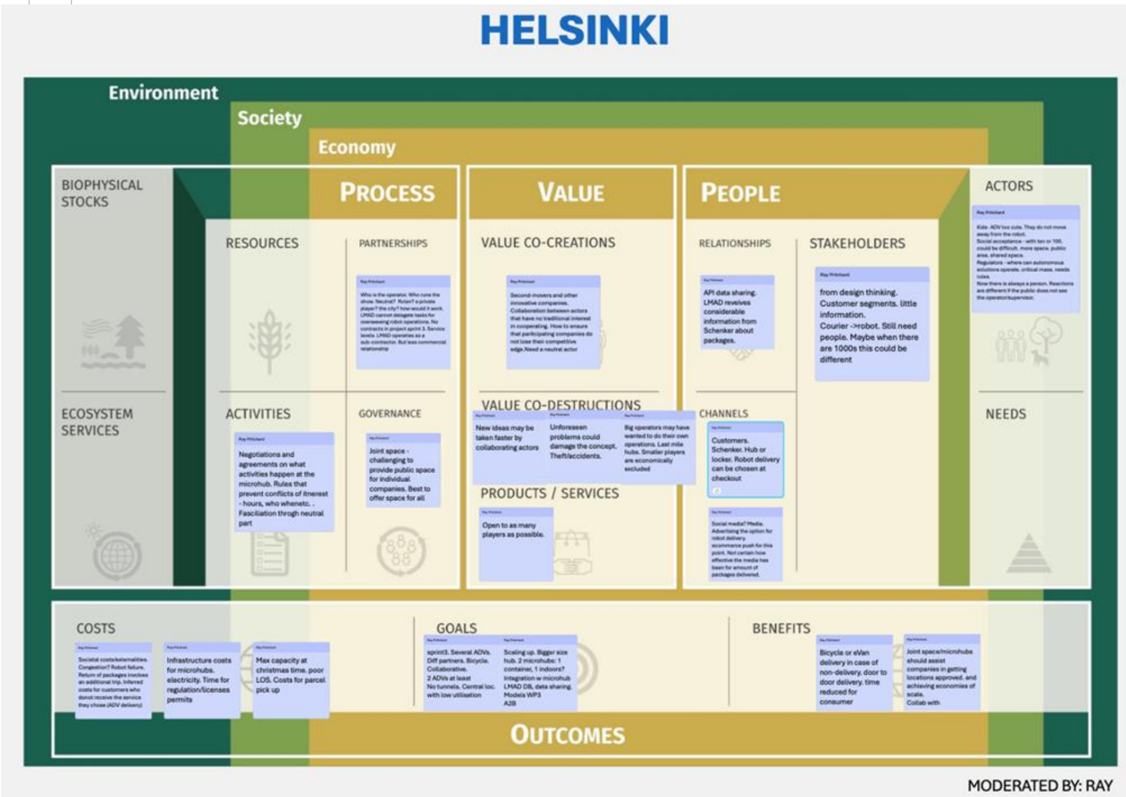


FIGURE 8 HELSINKI SUSTAINABLE BUSINESS CANVAS WORKSHOP

4.2.2 Process evaluation

In this paragraph, the results of the process evaluation questionnaires deployed among Helsinki LL actors for sprints 1, 2 and 3 are reported (Table 21); results have been merged as similar barriers and drivers have been identified. The first round took place in October 2023 and the answers have been collected from City, LSP, project management (e.g. city. LSP etc) (6 in total) and reported in WP3 *Impact Assessment Methodology and KPIs* internal deliverable. The second round was executed during the spring 2024 while Helsinki partners were updating the insights based on the lessons learned during the previous and ongoing piloting phases.

Sprint 1, 2 and 3

TABLE 21 HELSINKI SPRINT 1, 2 AND 3 PROCESS EVALUATION

Sprint 1	Barriers	Drivers	Potential impact on KPI final values
POLITICAL INSTITUTIONAL	The land usage is very restricted. NEZ/LEZ could be a barrier if the hub's location is not suitable. (UC3) Light-weight autonomous sidewalk vehicles descriptions/definitions are very restrictive regarding the size/weight etc. (It's benefitting Starship robots creating a competitive advantage and skewing the market of new innovations.)	Local Authority commitment: The city has a drive to enable less emissions through greener delivery modes and more consolidation. Authorities have a positive attitude and are open to testing novel innovations.	Not all operations can be executed, or they need to be executed further from the city centre on private properties due to regulations which might cost more.
ECONOMIC & FINANCIAL	Financial sustainability (The solution is not financially efficient enough to make a real-life business case.) Distribution of the cost and benefits especially when the revenue is uncertain.	Rising cost of labour, high level of competition in booking rooms from parcel lockers, overflowing collection points from high volume requires more space, renting can be high on your own. Quite many funding opportunities for urban logistics innovations.	ADVs might not be financially sustainable if the regulations won't allow them to be fully remotely operated. The cost sharing between the users of the micro hub might make the solution financially sustainable in the long term.
SOCIAL	Finding the right use case for the ADVs, Resident safety concerns because they don't know how the robot functions in different situations.	Sustainability commitment/awareness of consumers (willingness to shift to more sustainable delivery options if it's a convenient option). Curiosity among the residents to use/try out the new service. Willingness to collaborate among LSPs.	NPS might get higher over time. Volume is an unstable factor - we need data in the long run. Consumer behaviour is a factor that we cannot predict just yet.
TECHNOLOGICAL	Technological Maturity of the ADV: agility of the vehicle, uptime, hardware issues, unpredictable aspects. Charging infrastructure for e-vehicles. Electric vans performance could also be a bit better (range, battery capacity, especially during the wintertime).	The pace of development is fast; maturity is continuously evolving.	Dependent on whether the vehicles operate without issues or not.

DATA/ INFORMATIONAL	Data sharing (GDPR), knowing what data is valuable and should be collected. Structuring the data to analyse it efficiently is a resource constraint.	Facilitating the operations using a neutral party ensures the data sharing as transparently as possible.	Data availability and relevant volume to demonstrate the efficiency of the solution.
ENVIRONMENTAL	Weather conditions might affect the ADV (especially winter), difficulty in manoeuvring in the old parts of the city (high street thresholds etc.).	The difficulty level of operating in the city centre using conventional delivery vehicles -> using smaller ADV's/cargo bikes might bring benefits in operating in small spaces. Carbon neutral targets are driving the implementation of the novel solutions.	Potentially facing unexpected issues to execute operations because of the weather conditions. Reduction of CO2 emissions.
LEGAL/ REGULATION	Unpredictable processing times for the permits (scheduling the operations is almost impossible) and the lack of standardization for the vehicle in the permit process. Also, heavy/expensive processes for implementing light structures in the urban environment. Contractor's obligations and liability act is making the collaboration more difficult.	Local Authority commitment and strategic goals of the city of Helsinki.	Lower volume in general due to past delays during our sprint 2.

4.2.3 Conclusions

In Helsinki, one focus has been on reducing use of vans for delivery in central areas of the city, mainly contributing to SDGs 9 and 11 (9 Industry, innovation and infrastructure; 11 Sustainable cities and communities). During the use cases, most KPIs have contributed to SDG 9 by addressing distances driven with conventional internal combustion vehicles and to SDG 11 by addressing local air pollution (NOx). This is done by testing out zero-emission and smaller alternatives (autonomous delivery vehicles and cargo bikes). Initial results point to a higher distance driven by the smaller vehicles than the vans, due to their smaller capacity, but this could nonetheless have required less energy and contributes to reduction of CO2 emissions and local air pollution.

KPI data from Sprint 2 and Sprint 3 shows that Helsinki LL has contributed directly to SDG 9.4 by reducing average CO2 emissions made by the use case deliveries compared to the baseline and Spring 1, and indirectly to 11.6.2 by reducing km travelled by the delivery vehicles and likely reducing particulate matter.

The most important result in Helsinki LL operations was to successfully demonstrate that these zero emission vehicles could provide value for the LSPs and consumers without increasing safety issues for the residents. It is important, because these factors will have a direct impact whether the operations could be financially sustainable in the future or not. The reduction in CO2 emissions and the number of vans is dependent on the attitudes and satisfaction rate of the residents and consumers who are the users of these low-emission services. The more willing they are to adopt these new technologies, the safer it is for LSPs to invest in ADVs and cargo bikes meaning reducing the number of vans in urban environment. These results contribute to the project key targets to improve efficiency through the use of low-emission vehicles and the introduction of innovative technologies and to reduce CO_2 emissions.

4.3 Valladolid

4.3.1 Impact evaluation

4.3.1.1 City/Local Level impact evaluation

Valladolid has a SUMP but not a SULP; nonetheless, the city faces several problems related to last mile logistics like traffic congestion. The city faces major traffic congestion problems due to (1) the growth of urban freight distribution and (2) the fact that citizens are increasingly using private cars to move around the city centre.
The need for more a sustainable trade model is apparent: the transport and logistics sector is responsible for a large proportion of emissions. In this regard, Valladolid aims to promote the use of electric fleets among couriers. Moreover, a lack of adequate loading and unloading spaces has become a pressing issue with the surge in e-commerce, leading to an increase in delivery vehicles on the streets. As a result, many couriers resort to double parking.
Therefore, among the objectives to be achieved with the development of URBANE, Valladolid has prioritized the following:

- Making loading and unloading zones more efficient, with view to achieving a more sustainable, orderly and efficient urban goods distribution.
- Promoting the delivery of small goods through a fleet of fully electric vehicles.
- Building a safer city for pedestrians by integrating intelligent systems into delivery vehicles.

For these city main objectives, Valladolid selected the following KPIs reported in Table 22:

TABLE 22 VALLADOLID HIGH LEVEL KPIS

KPI name	Measurement unit	Data source	Baseline Value	Connection with URBANE platform/models/tools	Comments
CO_2 emissions reduced	g/trip	Actual measurements	1.905,12g/trip (data from Use Case 3)	INLECOM's UDR Supply Resources Estimator model (+EVCO2, +COPERT)	Interventions in UC2 & 3 promote the reduction of pollutant emissions in the city. On the other hand, one major objective of the LL is to explore how different EV typologies can enhance logistics operations in the city.

VRU identification accuracy	%	On field measurements	0 (no technologies installed)	CIDAUT's Vehicle detection & tracking algorithm	Plug-and-play solution able to detect VRUs successfully can be easily adopted by LSP whose vehicles do not include them as standard equipment
Identification of L/U misuse	% non-authorised vehicles detected % double parking detected % of vehicles that exceed the allowed parking time	On field measurements, target L/U zones	0 (random control)	CIDAUT's Vehicle detection & tracking algorithm	Actual data about real usage of L/U zones during the day/week will provide insights to support policy decisions

It should be highlighted that Valladolid LL doesn't include logistics service providers in their local partnership; therefore, it has not always been possible to determine the baseline values, which are also necessary for quantifying the problems listed at the beginning of the paragraph. In fact, Use Case 1, which involves installing cameras to monitor the use of loading and unloading zones, is specifically aimed at reconstructing this baseline, highlighting, among other things, the misuse of these areas. On the other hand, Use Case 3 conducted a specific activity with the Spanish postal service to obtain baseline values and reconstruct the AS-IS situation. Use Case 2 addresses the operational (kilometres travelled) and environmental (CO_2 emissions) of two different delivery strategies (conventional at-home delivery vs in-trunk delivery, see D2.4 for details); in this sense, the high-level KPIs are shared with Use Case 3.

4.3.1.2 Use cases impact evaluation

The KPIs related to each of the 3 use cases to be demonstrated in Valladolid are reported below in Table 23, 24 and 25.

Use Case 1 Monitoring of loading and unloading areas using artificial intelligence (AI)

TABLE 23 VALLADOLID USE CASE 1 KPIS

KPI name	Measurement unit	Data source	Baseline Value	Value at M23	Connection with URBANE platform/models/tools	Comments
Average time for L/U operations	min	CV-based system	Unknown	25	CIDAUT's Vehicle detection & tracking algorithm	Average time between start (vehicle completely parks in the L/U area) and end (vehicle leaves the L/U area). There is no record of data on it prior to URBANE.
No. of L/U areas	-	City's datasets	301	301	N/A	Total areas of the city. The development of the project does not affect this metric.

No. of unauthorised parking in the urban area	n	CV-based system	Unknown	13	CIDAUT's Vehicle detection & tracking algorithm	No. of vehicles parked outside the L/U area. There is no record of data on it prior to URBANE.
Failures in the IT system	n/day	CV-based system	No IT system installed	0	N/A	
Presence of IT and AI driven optimisation system	Y/N	CV-based system	N	Y	N/A	
L/U bays availability	Average time (mins) in which the bays is free per hour	CV-based system	Unknown	44,7%	CIDAUT	Average daily occupancy rate.

Use case 2 Implementation of an innovative and sustainable solution of contactless parcel delivery

TABLE 24 VALLADOLID USE CASE 2 KPIS

KPI name	Measurement unit	Data source	Baseline Value	Value at M23	% Change	Connection with URBANE platform/models/tools	Comments
Average km/parcel	km	GPS travel recorder	Bicycle: 1,82 Hybrid vehicle: 2,25	Bicycle: 1,25 Hybrid vehicle: 1,18	Bicycle: -31.31% Hybrid vehicle: -47.55%	N/A	The implementation of the in-trunk delivery option allows reducing the length of the delivery routes
CO2 emissions per parcel	g	COPERT data	Bicycle: 1 Hybrid vehicle: 275,6	Bicycle: 0,85 Hybrid vehicle: 144,54	Bicycle: -15% Hybrid vehicle: -47.55%	COPERT	As less distance needs to be covered after the implementation of the in-trunk delivery solution, there are less CO_2 emissions
km travelled in LEZ	km	GPS travel recorder	Bicycle: 6,07 Hybrid vehicle: 10,71	0	-100%	N/A	All the deliveries are made in the deterrent parking, which is outside the LEZ

Use case 3 Techno-economic comparison of the use of combustion vehicles, commercial EVs and IFEVS prototype vehicles in delivery services

TABLE 25 VALLADOLID USE CASE 3 KPIS

KPI name	Measurement unit	Data source	Baseline Value	Value at M23	Connection with URBANE platform/models/tools	Comments
CO2 emissions	g/km	Vehicle specs	196	1 (Bike – no PV) 0,69 (Bike – yes PV) 6,88 (Van)	COPERT	Data on the vehicle used by the postman
NO2 emissions	g/km	Vehicle specs	0.017	0	COPERT	Data on the vehicle used by the postman
Noise level	dBA	Experimental study	69.35	0		Test track data; ICE-based vehicle, 50kmph
Fuel consumption per km	l/100km (baseline value) Wh/km (values at M23)	Vehicle specs	7.6	14,488 (Bike – no PV) 9,872 (Bike – yes PV) 98,303 (Van)		Data on the vehicle used by the postman
Average km/trip	km	GPS travel recorder	9.72	11,741 (Bike – no PV) 11,148 (Bike – yes PV)		CIDAUT campus case. Considering that the van was used in a different setting than the other scenarios, it is not possible to compare this metric.
Average km/vehicle	km	GPS travel recorder	4.24 (by bike) 5.48 (by car)	11,741 (Bike – no PV) 11,148 (Bike – yes PV)		CIDAUT campus case. Considering that the van was used in a different setting than the other scenarios, it is not possible to compare this metric.
No. of freight vehicles per category	-	National statistics	...	...		The development of the project does not affect this metric.
Average speed/trip	km/h	GPS travel recorder	16.40	17,222 (Bike – no PV) 17,530 (Bike – yes PV)		CIDAUT campus case. Considering that the van was used in a different setting than the other scenarios, it is not possible to compare this metric.
Average deliveries/trip	-	GPS travel recorder	20	26 (Bike – no PV) 21 (Bike – yes PV)		Average number of stops made per trip. Considering that the van was used in a different setting than the other scenarios, it is not possible to compare this metric.

Commercial vans:
452.531 (<500 kg)
1.254.247 (500-749 kg)
409.714 (750-999 kg)
500.653 (>1000 kg)
Light-duty trucks:
1.582.730 (<1 T)
454.184 (1-1.5 T)
113.830 (1.5-3 T)

Commercial vans:
452.531 (<500 kg)
1.254.247 (500-749 kg)
409.714 (750-999 kg)
500.653 (>1000 kg)
Light-duty trucks:
1.582.730 (<1 T)
454.184 (1-1.5 T)
113.830 (1.5-3 T)

Total delivery costs	€	4,824	3,167 (Bike – no PV) 3,805 (Bike – yes PV)	CIDAUT campus case. Note that this scenario is located in an area with low population density. Considering that the van was used in a different setting than the other scenarios, it is not possible to compare this metric.

4.3.1.3 Social impact evaluation

Social KPIs – Decent work

While KPIs commonly identified in European urban logistics projects and literature align well with SDGs 9 - Industry, innovation, and infrastructure, 11 - Sustainable cities and communities, 12 - Responsible consumptions, 13 - Climate action, 17 - Partnerships for the goals, the SDG 8 - Decent work and economic growth, was not sufficiently covered. To address this, specific indicators related to personnel turnover, salary, education level, gender diversity, and flexible work were collected in a dedicated data sheet and reported in Table 26 below. Data from Valladolid Living Lab indicates varied working conditions among delivery personnel and the importance of effective communication when implementing new delivery methods. Use case 3 highlighted the need for extended testing and adaptation periods for workers and the potential of electric assisted bikes to enhance the overall work experience. Comprehensive results are presented in Section 4.3.3 Conclusions.

TABLE 26 VALLADOLID SOCIAL KPIS

KPI name	Measurement unit	Data source	Baseline Value	Value at M23/M24	Comments
Personnel turnover	%	Correos Group database	22,4%	22,4%	TO BE benefits: the implementation of the I-FEVS electric bikes for last mile delivery operations increases the amount of the daily work that can be done by bike, which has a positive impact on the health of the postal service workers as more active lifestyles are fostered. It also diminishes the physical effort to do the job, compared with conventional bikes
Average salary	€	Correos Group database	1.312€	1.312€	TO BE benefits: counting with more convenient vehicles to work should lead to a higher commitment of the workers, which would mean higher productivity and, in the mid-term, higher valuation of the work
Education level	%		NA	NA	TO BE benefits: the introduction of electric vehicles for the last-mile deliveries should increase the interest and the knowledge of the workers in this technology, thus acquiring new skills.

Gender diversity	%	Correos Group database	53,2%	53,2%	TO BE benefits: thanks to the reduction of the physical effort linked to the used of electric-assisted bikes, the number of women working in last-mile delivery companies will increase
Percentage of self-employed workers	%	Correos Group database	0%	0%	Being Correos a national service, there are no self-employed workers in the company
Percentage of part-time workers	%	Correos Group database	7,0%	7,0%	TO BE benefits: if the in-trunk delivery option becomes widespread, the need for adjustments/reshuffling would reduce, and consequently the need of extra part-time staff.
Precariousness rate	%	Correos Group database	0%	0%	TO BE benefits: better working conditions should lead to lower precariousness rate
Flexibility of working hours	Yes/No	Correos Group database	Yes	Yes	TO BE benefits: The possibility of delivering parcels by bike or by car allows a more flexible distribution of the working efforts throughout the day (e.g. depending on the weather forecast)
Percentage of remote work	%	Use Case 1	NA	NA	The implementation of UC1 L/U zones monitoring solutions would allow a remote control of the status of the infrastructure, instead of the actual method that requires a person being present in the L/U zones

DSNH principle compliance

The KPIs of Valladolid LL use cases are aligned with the DNSH principle, as they contribute to several of the six objectives outlined in the EU Sustainable Taxonomy for defining a sustainable activity. They align with objectives 1 and 5 by enhancing greenhouse gas emissions reductions and pollution abatement with a fully electric vehicle fleet for small goods delivery. Additionally, they improve loading and unloading zone efficiency by implementing a CV-based system to monitor urban freight distribution patterns. Moreover, use case 3 is compliant with objective 4 as they aim at making use of PV panels, thus reducing usage of non-renewable resources.

Sustainability triangulation:

As reported in chapter 3.1.2, in the first reporting period NORCE carried out 2 workshops with each LL that both started and ended with sustainability: one on Design Thinking and one on Sustainable Business Model Canvas. The workshops were aimed at helping the LLs take the position of the users and their collaborators involved in their innovations, helping them to consider different aspects and implications of their implementation.

Valladolid identified several personas (1). One was the postal service, which is the only logistics operator right now. This operator mostly employs middle-aged people organized in a labour union, ensuring decent working conditions. A second persona was described as food-delivery companies where the employees often are younger people who may not have contracted work, and where the hours and salaries are quite variable. In this case the prioritization phase was not noted (2), but the two aforementioned personas were the ones selected. In the idea development phase (3,4) the statements revolved around the fact that both personas needed electric bikes and electric cargo bikes, because this is part of the local LL solution.

During the Sustainable Business Canvas Workshop, Valladolid focused on its third Use Case, which involves the use of specially produced e-bikes and electric vans within a determined area. The group identified several goals for the LL: demonstrating that the vehicles can provide as high-quality service as existing delivery vehicles, reducing greenhouse gas emissions, and meeting the national requirement to establish a zero-emission zone. The group considered the need to invest in charging infrastructure as a cost and the opportunity to test customised zero-emission vehicles as a benefit. The postal service and its workers, as the chosen persona in the first workshop, were of interest in the rest of the conversation. Participants mentioned the need to test the proof of concept to compare the new delivery vehicles to conventional ones. During the process phase this became more important, as the postal service determines routes and delivery days which the LL must adapt to, and the LL depends on resources from both the postal service and the company providing the vehicles to pilot. Regarding People, the LL is also dependent on the city of Valladolid and the Spanish road authority (the Directorate-General for Traffic) for relevant regulatory approval of LL operations. The city itself depends on the trust of its citizens for the LL activities to be continued if successful, and the postal service workers must be allowed to build trust in the technology provided for the LL. The Design Thinking map and the Sustainable Business Canvas for Valladolid LL are reported below in Figure 9 and 10.

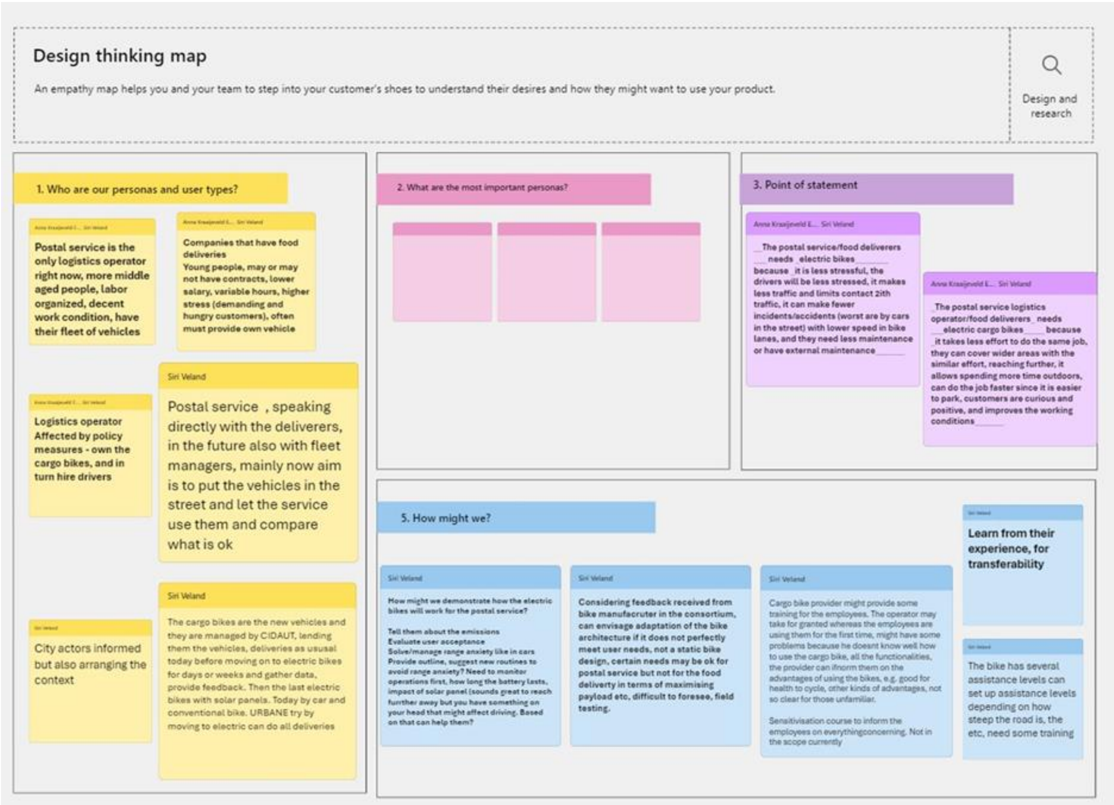


FIGURE 9 VALLADOLID DESIGN THINKING WORKSHOP

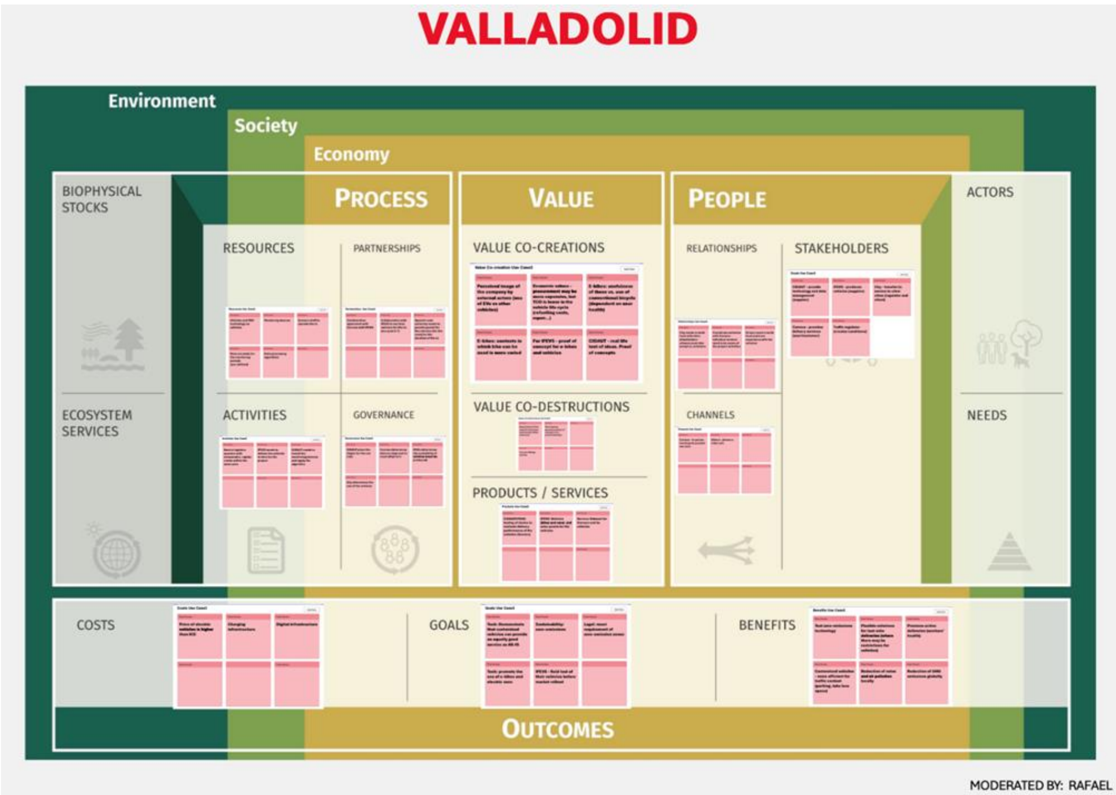


FIGURE 10 VALLADOLID SUSTAINABLE BUSINESS CANVAS WORKSHOP

The Valladolid LL carried out a survey sent out to the general public during July 2024 through the Municipality of Valladolid. A total of 169 valid answers were collected through Microsoft Forms, out of which one was below the age of 16 and therefore excluded. All others were between ages 16 and 64. Valladolid citizens were recruited through the web site and social media of the Agency for Innovation of Valladolid and Valladolid City Council, as well as through information screens at "youth centres" and "community centers" and the intranet of the City Council. The survey included questions ranging from urban delivery habits to questions on citizen preferences. In this report, we focus on the results of the following three questions, with corresponding answers, scales and results. The first question was a follows, with results summarised in Table 27:

Q: When deciding whether you want the goods delivered to your home or to a collection point, how important are the following aspects for you?

0. Not important at all, 1. Of little importance, 2. Moderately important, 3. Quite important, 4. Very important

- Convenient location
- I can receive/pick up the package at a time that suits me
- Shipping cost
- Speed of delivery
- Data privacy guarantee
- Working conditions of the delivery person
- Environmental impact of delivery

TABLE 27 VALLADOLID SURVEY QUESTION 1

When deciding whether you want the goods delivered to your home or to a collection point, how important are the following aspects for you?	Mean	SD
Convenient location	3.37	0.79
I can receive/pick up the package at a time that suits me	3.36	0.92
Shipping cost	3.22	0.91
Speed of delivery	3.05	0.94
Data Privacy Guarantee	2.92	1.22
Working conditions of the delivery person	2.56	1.11
Environmental impact of delivery	2.24	1.13

This first question sought to determine to what extent residents of Valladolid consider each of seven provided delivery factors consumers important. These values represent the mean of the Valladolid responses above on a scale from 0 to 4, where a mean of 2 implies that the average response value was "moderately important." The values tell us that out of all the given aspects, respondents value delivery location and delivery pick-up time the most, whilst the environmental impact of delivery is the least important, on average. However, it is worth noting that the mean response of *environmental impact of delivery* is above 2, implying that even the "least important" aspect of a delivery is still important to respondents. These results are visualised in Figure 11 below to show that very few respondents gave little or no importance to any of the aspects. It is also worth noting that location was the most important aspect for respondents under 45, whilst pick-up time was the most important for those over 45. Additionally, location is on average more important for women whilst price is most important to men.

FIGURE 11 VALLADOLID SURVEY QUESTION 1

The second question was as follows, with results reported in Table 28.

Q: The parcel logistics sector is moving towards more sustainable and efficient delivery modes. Do you know the following trends?

Not important, Of little importance, Moderately important, Slightly important, Very important

- Lockers (mailbox inside an automated locker that allows you to safely pick up packages 24/7) I can receive/pick up the package at a time that suits me
- Zero emissions delivery (through the use of electric vehicles and bicycles)
- Access restrictions for large cargo vehicles to the city centre
- Trunk delivery in your private vehicle in a public car park
- Robot delivery system (autonomous delivery vehicle)

TABLE 28 VALLADOLID SURVEY QUESTION 2

The parcel logistics sector is moving towards more sustainable and efficient delivery modes. Do you know the following trends?					
	No answer	I have never heard about this	I have heard a little bit about this	I have heard a lot about it but never used it myself	I have used it myself
Lockers (mailbox inside an automated locker that allows you to safely pick up packages 24/7)	0%	3%	9%	35%	53%
Zero emission delivery (through the use of electric vehicles and bicycles)	6%	12%	17%	36%	30%
Access restrictions for large cargo vehicles to the city centre	10%	18%	28%	39%	5%
Trunk delivery in your private vehicle in a public car park	7%	68%	12%	11%	2%
Robot delivery system (autonomous delivery vehicle)	1%	45%	38%	15%	1%

In this second question, respondents were asked of their knowledge of different technologies being put to use in the URBANE LLs. Unlike the first question, we represent the results of this question in terms of response rate for each alternative provided. This allows us to see that a significant majority of respondents in Valladolid (over 60%) know of or have used parcel lockers or zero-emission delivery. At least half of respondents had heard of or had knowledge of access restrictions, whilst respondents had least knowledge of trunk deliveries and autonomous delivery vehicles. This could be evidence of the novelty of these technologies in this context, which is particularly important in the case of trunk deliveries in Valladolid. These findings are visualised in Figure 12 below.

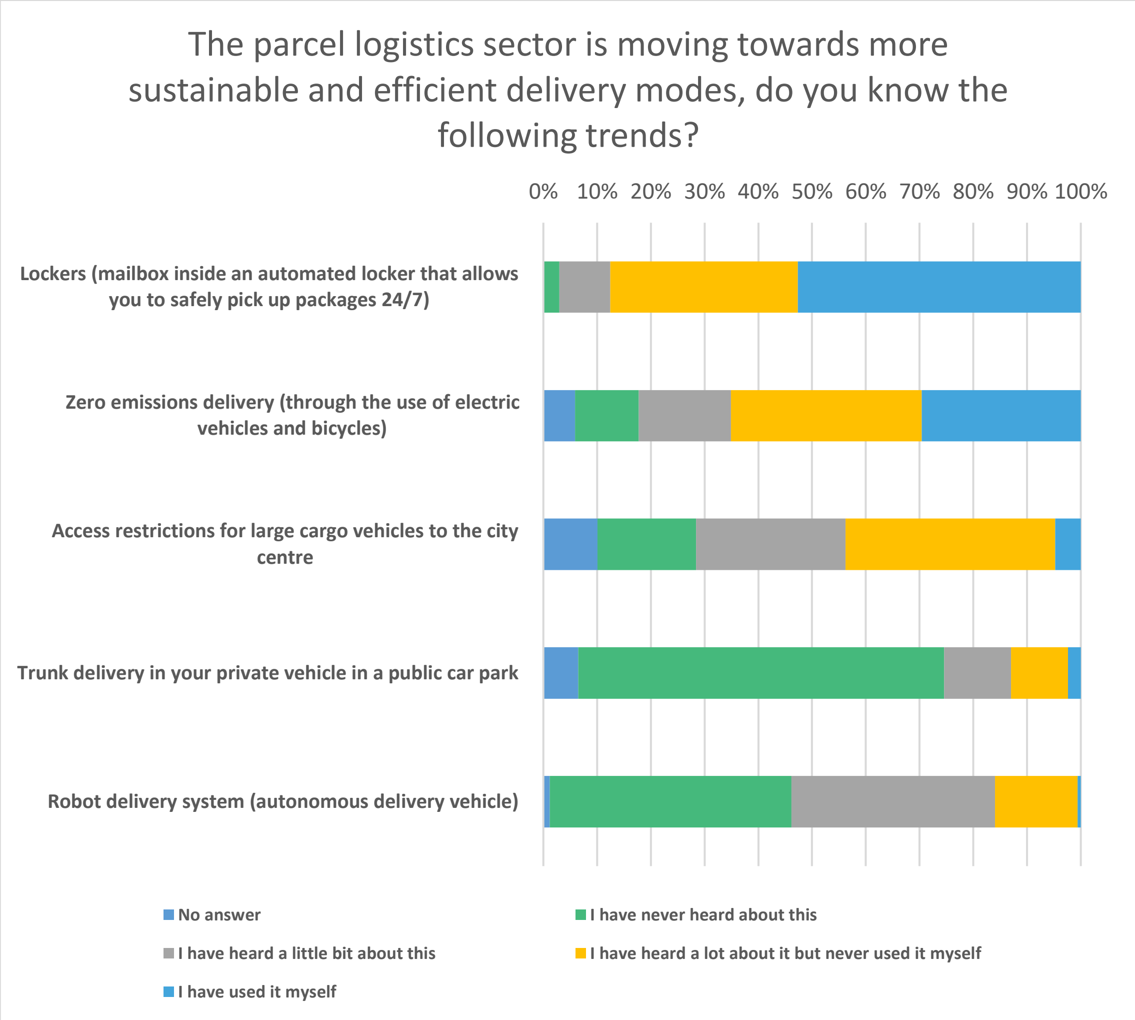


FIGURE 12VALLADOLID SURVEY QUESTION 2

The third question was as follows, with results reported in Table 29.

Q: What is your opinion on the trends outlined in the previous question?

(-3. Very negative, -2 Negative, -1. Somewhat negative, 0. Neither negative nor positive, 1. Somewhat positive, 2. Positive, 3. Very positive)

- Lockers (mailbox inside an automated locker that allows you to safely pick up packages 24/7) I can receive/pick up the package at a time that suits me
- Zero emissions delivery (through the use of electric vehicles and bicycles)
- Access restrictions for large cargo vehicles to the city centre
- Trunk delivery in your private vehicle in a public car park
- Robot delivery system (autonomous delivery vehicle)

TABLE 29 VALLADOLID SURVEY QUESTION 3

What is your opinion on the trends outlined in the previous question?	Mean	SD
Lockers (mailbox inside an automated locker that allows you to safely pick up packages 24/7)	1.78	0.81
Zero emissions delivery (through the use of electric vehicles and bicycles)	1.85	0.61
Access restrictions for large cargo vehicles to the city centre	1.49	1.16
Trunk delivery in your private vehicle in a public car park	0.46	1.90
Robot delivery system (autonomous delivery vehicle)	0.81	1.74

This final question asked what opinion (positive or negative) respondents in Valladolid had of the technologies named in the previous question. Here, the scale is from -3 (very negative) to 3 (very positive), where a mean of 0 would indicate an average neutral or lack of opinion on the technology. This table shows that perceptions of the technologies mostly follow knowledge of them, with parcel lockers and zero-emission deliveries receiving the most positive average opinion, whilst trunk deliveries and robot delivery systems have the most neutral average opinions. Similar to in the first question, the average does not fall below the neutral option for any of the delivery alternatives. This may imply that respondents are most positive to the alternatives they know and are used to, but that they are generally not negative to new delivery alternatives.

4.3.2 Process evaluation

In this section, the results of the first and second round of the evaluation questionnaire of the deployed processes (use cases 1, 2 and 3) that took place in October 2023 and in July 2024 are presented. Specifically, Table 30 collects the responses for Use Case 1, Table 31 for Use Case 2 and Table 32 for Use Case 3 for the actors involved in Valladolid LL: technology providers, electric vehicle developers, policy makers, national postal service and some citizens.

Use Case 1 Monitoring of loading and unloading areas using artificial intelligence (AI)

TABLE 30 VALLADOLID USE CASE 1 PROCESS EVALUATION

Monitoring of L/U areas using AI	Barriers	Drivers	Potential impact on KPI final values
POLITICAL INSTITUTIONAL	(1) Changes in the management of different issues of interest to citizens (e.g. the loading and unloading areas themselves) due to changes in government. (2) The new Local Government strategy	(1) The strategic line for city's small businesses (2) The policies that facilitate the mobility by improving traffic flow (3) The possible exploitation of the system by private services (the developed system is applicable to hotel loading and unloading areas, parking spaces reserved, etc.).	Permission or limitations to install cameras on public streets

	(3) The excessive bureaucracy associated with the installation of video surveillance systems in public spaces (4) Crisis of confidence in local government by some citizens due to the installation of image recording systems	(4) The possibility of transferring the system to the public taxi service to optimise its operation.	
ECONOMIC & FINANCIAL	(1) The high cost of the system and its maintenance (2) The cost associated with storing large amounts of data (3) The higher personnel costs implied by the operation of the system (the hiring of a data manager is required) (4) The initial investment associated with the implementation of the system in all the city's loading and unloading zones	(1) Generation of new jobs (data manager, maintenance operators...). (2) The direct economic benefits (sale of data) and indirect benefits (optimisation of the use of current resources) derived from the information collected (3) The optimisation of the logistics flows	
SOCIAL	(1) The concern for the privacy when there are cameras. In particular, the reluctance of citizens to be recorded by a camera (2) The risk of vandalism (3) The unequal public opinion on the effectiveness of the system depending on their political ideology.	(1) The benefits of living in a smart city (2) The improvement of the citizens' quality of life due to the existence of more space, less noise and fewer emissions derived from the information collected	
TECHNOLOGICAL	(1) The delay on the deployment of digital tools to manage LSPs operations in the city (2) The information collected by the system alone is not enough to improve mobility; it is necessary to add a human element to build	(1) The smart city designation and what it entails (2) The data may be processed for other purposes.	Missing data for the AS-IS scenario

	strategies that optimise resources.		
DATA/INFORMATIONAL	(1) The fundamental right to the protection of personal data (2) The complexity and slow development of data protection regulation at national level	(1) The availability of real information (2) The possibility to make decisions based on real data	
ENVIRONMENTAL	The electricity consumption associated with the system.	(1) Flow traffic improvement (2) The application of the technology allows for a reduction in emissions associated with smoother management of loading and unloading areas. (3) The promotion of less environmentally harmful vehicles because of the implementation of the system. (4) The possibility of installing a self-consumption photovoltaic system.	
LEGAL/REGULATION	(1) The Data Protection Act (2) For the system to have a direct effect on mobility, it is necessary to modify municipal regulations.	(1) LEZ (2) The preliminary draft of the sustainable mobility law (3) The existing laws aim to improve air quality and public health.	

Use Case 2 Solution of contactless parcel delivery (trunk delivery)

TABLE 31 VALLADOLID USE CASE 2 PROCESS EVALUATION

Monitoring of L/U areas using AI	Barriers	Drivers	Potential impact on KPI final values
POLITICAL INSTITUTIONAL	The success of the solution is contingent on the reservation of a certain number of parking spaces specifically for this delivery model. This action may lead to a crisis of confidence in local government by some citizens.	Promotion of new construction and/or extension projects of deterrent parking.	
ECONOMIC & FINANCIAL	(1) The economic profitability of the model depends largely on customers' willingness to	(1) Possibility to operate as a free service, thanks to cost reductions compared to the	↓ Average km/parcel

	concentrate at specific points at specific times. (2) The economic cost associated with the development and maintenance of the application needed to implement the delivery model.	current model and government subsidies. (2) The possibility to monetise your vehicle by converting it into a parcel collection point. The possibility to monetise your vehicle by converting it into a parcel collection point. (3) The fuel savings that occur thanks to shorter travel distances. (4) The implementation of the model exempts the operators from renewing the vehicle fleet by avoiding driving in the low emission zone.	↓ km travelled in LEZ
SOCIAL	(1) Among the factors that determine the success of the model, a strict commitment to delivery times by the deliverer is required. (2) Risk of vandalism inside the vehicle. (3) Possibility of a new method of vehicle theft without leaving a trace.	Greater flexibility for the customer to pick up its package.	
TECHNOLOGICAL	Need for a remote boot opening control system.	The possible exploitation of the model as a system for measuring the level of occupancy of deterrent parking.	
DATA/INFORMATIONAL	Risk of information theft by third parties.	The data collected allow, among other things, to quantify the level of occupancy of the car parks in question.	
ENVIRONMENTAL	Increase in journeys in private car to the workplace to benefit from the service in question.	Reduction of number of vehicles and therefore emissions in the city centre, which also contributes to reducing traffic congestion.	↓ CO_2 emissions per parcel
LEGAL/REGULATION	(1) Need for a new regulation to prevent theft. (2) The right of privacy of personal belongings	Possibility to trace stolen vehicles.	

Use case 3 Techno-economic comparison of the use of combustion vehicles, commercial EVs and IFEVS prototype vehicles in delivery services

TABLE 32 VALLADOLID USE CASE 3 PROCESS EVALUATION

UC3	Barriers	Drivers	Potential impact on KPI final values
POLITICAL INSTITUTIONAL	(1) Unequal political opinion with respect to mobility (2) The need for incentives for the success of the solution to succeed due to the price disparity between internal combustion engine (ICE) and electric vehicles (3) Lack of adequate infrastructure to ride safely in the urban environment (4) The new Local Government strategy	(1) Improvement of the public image of the city for its environmental commitment thanks to the use of innovative solutions (2) Promotion of new construction and/or extension projects of cycle lanes (3) The LEZ that the City is obliged to implement (4) The city's commitment to become neutral by 2030	
ECONOMIC & FINANCIAL	(1) Expensive repairs due to the limited-edition nature of the vehicles (2) Limited transport capacity in the case of bicycles (3) High initial investment (4) The higher price of EV compared to combustion vehicles	(1) Reduction of the fixed costs associated with the transport (lower fuel costs, maintenance...) (2) Increased productivity thanks to the time saving in parking search that takes place with this solution (3) The possibility of obtaining an economic benefit with these vehicles in other sectors (airports, factories, etc.) (4) The price of electricity	↓ Total delivery costs
SOCIAL	(1) Drivers fear that the vehicle runs out of battery during the delivery service (2) In the case of bicycles, the danger of the accidents (3) The limitation in adverse weather conditions (4) Electric vehicle range anxiety	(1) Improvement of the physical health and well-being of drivers (2) Less monotonous journeys in the case of bicycles, which contribute to lower levels of stress and fatigue (3) Strengthening of the urban cycling (4) The strategies that encourage people to cycle (5) The willingness of companies to move towards a more sustainable service	
TECHNOLOGICAL	(1) The added danger to the vehicle batteries. (2) The penalty to consumption on non-sunny days due to the weight of the PV panels (3) Lack of EV charging stations	(1) The reduction of energy consumption added to using solar panels (2) The generation of new knowledge associated with the creation of a new product (3) Travelling longer distance with less effort and in less time	↓ Fuel consumption per km

		(4) More comfortable driving (less noise)	
DATA/ INFORMATIONAL	Lack of interest in electric mobility	(1) The ability to easily monitor the vehicle status in real time (2) The possibility to collect data more easily	↑ Average speed/trip ↑Average deliveries/trip
ENVIRONMENTAL	The recyclability of solar panels.	(1) The reduction of harmful gases added to the use of electric vehicles (2) The reduction of traffic congestion (3) Zero CO2 emissions	↓ CO2 emissions ↓ NO2 emissions ↓ Noise level
LEGAL/ REGULATION	(1) Need for new labour regulation that recognises the profession of professional bicycle driver (2) Need for new insurance due to the existence of 'new' risks (3) Lack of concrete indications for achieving the decarbonisation objectives	(1) Greater labour control (2) Vehicles exempt from registration, in the case of bicycles (3) No need for driving licences (bicycles) (4) LEZ (5) The preliminary draft of the sustainable mobility law	

4.3.3 Conclusions

The Valladolid LL has sought to address congestion, pollution and emissions, as well as free up space taken up by double-parked vehicles. The focus in this LL has therefore been contributions to SDGs 9 and 11 (9 Industry, innovation and infrastructure; 11 Sustainable cities and communities), with additional attention given to SDGs 8 and 10 (8 Decent work and economic growth; 10 Reduced inequalities) within the use cases, the sustainability triangulation and the process evaluation. SDGs 9 and 11 are addressed through the choice of novel delivery technology that reduces CO2 emissions and both air and sound pollution, whilst SDGs 8 and 10 are addressed through the focus on worker conditions in the different use cases. It is noted that delivery workers face differing working conditions and that introducing a new delivery method requires good communication before and during implementation. Two lessons from use cases 3 are that: 1) delivery workers require a longer period of testing and adaptation than originally expected, and 2) once adapted to the new delivery vehicles, the use of electric assisted bikes may contribute to a better working experience.

Further implementation of the Valladolid LL use cases is expected to positively impact key performance indicators (KPIs) such as CO2 emissions, noise levels, and levels of self-employment. For example, carbon dioxide, NO2 and sound pollution have significantly dropped in Use Case 3. The use of innovative last-mile delivery technologies and pick-up solutions will reduce distances driven by polluting vehicles, and will take deliveries out of LEZs of cities, and the possibility for companies like *Correos* to use these innovations will make their model competitive with businesses that outsource their employment contracts. Besides, it will allow using more sustainable and active vehicles, hence reducing the need of conventional combustion vehicles.

Summarising, the following quantitative impacts arose from the Valladolid LL, per Use Case:

- Use Case 1: the average parking time per vehicle is around 25 minutes. Also, on average, a 45% of the L/U zones analysed are free for parking, although it must be mentioned that the usage pattern of these zones is not homogeneous during the day.
- Use Case 2: the in-trunk delivery option moves deliveries out of the LEZ (so -100% km in LEZ for the deliveries made using this method). In general, between 30-50% reduction of distance travelled can be expected, leading to a 15-50% CO_2 emissions reduction depending on the characteristics of the route and the vehicle employed. Besides, thanks to route simplification, up to 40% distance can be saved if cars are substituted by bikes to make the deliveries in city centres.
- Use Case 3: photovoltaic assistance in bikes led to 30% less energy consumption. In terms of CO_2 emissions, the electrification of the fleet leads to massive gains: -96% emissions for vans, and -99% emissions for bikes (plus, nitrogen oxide emissions are fully avoided).

The impacts related to Use Case 2 and 3 are connected to the two key project targets aimed at the improvement of environmental performance (>20% GHG reduction) in intervention areas and the decrease in deliveries made via traditional vehicles: 50%.

4.4 Thessaloniki

4.4.1 Impact evaluation

4.4.1.1 City/Local Level impact evaluation

Thessaloniki has a SUMP, and a SULP is under development; in this sense, activities developed within URBANE aim at supporting the transition towards climate neutral last mile logistics by finalizing the Regional SULP and provide quantified arguments. Within this macro-objective, Thessaloniki identified the following implementation objectives:

1. **Organization of Micro-Hubs** (Hub & Spoke) in the historical centre by ACS (tactical & operational planning)
2. Assessment of shared lockers scheme in public spaces (Operational planning) including users' behaviour
3. **Optimum Last mile Facility location network design for climate neutral cities (strategic planning)** using the models & tools of the As a Service last mile delivery platform provided by THESSM@LL for:
    - **Predictive analytics** for demand forecasting
    - **Facility location model for micro hubs** integrating public & private actors' criteria *(to be adapted for PI requirements)*
    - **Simulation** of new services, hubs and vehicles in last mile operations and collaborative solutions

4.4.1.2 Use cases impact evaluation

KPIs selected by Thessaloniki are reported below, together with baseline values, identified with support from URBANE models and expected evolution on KPI values. It should be considered that ACS, acting as LSP in Thessaloniki who provided baseline values, is the primary logistics operator of Greece (about 35% of the urban deliveries). This peculiarity of the Thessaloniki LL means that the baseline values already provide valuable and significant information about the current state of urban logistics in Thessaloniki. The Impact evaluation in Thessaloniki is performed in a stepwise manner. The first stage of implementation exploits the impact of a locker network that each company installs separately. The second stage involves the exploitation of a locker alliance network and the related impact. The 3rd stage (Use Case 2 Ideal composition of new fleet (EVs) and services under a shared shared urban consolidation center) further extends the implementation and considers that the alliance network served by a UCC and a fleet of eLCVs is accessible to all last-mile providers. The Thessaloniki KPIs include the following abbreviations: *ILN (Individual Locker Network), ALN (Alliance Locker Network), UCCLN (Urban Consolidation Centre Locker Network) – see* Table 35 below.

TABLE 33 THESSALONIKI LL KPIS

KPI name	Measurement unit	Data source	Baseline Value	Value at M24	% change	Connection with URBANE platform/models/other tools	Comments
CO_2 emissions	g/parcel	ACS databases	0.648	ILN: 0.3279, ALN: 0.248, UCCLN: 0.067	ILN: -49.6%, ALN: -61.7%, UCCLN: -89.6%	Agent-based Model, Facility location Model, Impact assessment Radar (Level 3)	The aim is to minimize route km for home delivery and replace it with walking distance to reach the locker. Also putting multiple parcels at one place.
Average number of km per Delivery	Km/parcel	ACS databases	3.63	ILN: 1.75, ALN: 1.33, UCCLN: 0.65	ILN: -52.3%, ALN: -63.5%, UCCLN: -82.0%	Impact assessment Radar (Level 3) Agent-based Model, Facility location Model,	In a route that can deliver e.g. 10 parcels at once the total km driven expected to be reduced
Average deliveries per trip	Parcels/route	ACS databases	37	ILN: 42 ALN: 45 UCCLN: 53	ILN: +13.5%, ALN: +21.6%, UCCLN: +43.2%	Impact assessment Radar (Level 3) Agent-based Model, Facility location Model	This KPI also expected to be improved as the per visit delivery (on locker) will be increased
Parcel Lockers pickup rate (B2C)	Mins/parcel	ACS databases	1141	ILN: 1025 ALN: - UCCLN: -	ILN: -10.2% ALN: - UCCLN: -	Impact assessment Radar (Level 3) Agent-based Model, Facility location Model	The time that a single parcel stays on a locker is critical to the overall utilization of the lockers . This KPI can be extracted only from operational data.
Parcel Lockers fill rate (B2C)	%	ACS databases	4.15%	ILN: 29.3%, ALN: -, UCCLN:-	ILN: 606%, ALN: ,- UCCLN:-	Agent-based Model, Facility location Model, Impact assessment Radar (Level 3)	The aim of this KPI is to utilize the locker space as much as possible. The data collected from ACS operations until July 2024.
Rate of successful delivery from 1st attempt	%	ACS databases	82%	ILN: 85% , ALN: 90.9% , UCCLN: 95.5%	ILN: 3.7% , ALN: 10.5%, UCCLN: 16.1%	Impact assessment Radar (Level 3) Agent-based Model, Facility location Model, Thessaloniki Logistics Digital Twin	The goal of this KPI is to reduce failed deliveries even from the first attempt

Number of freight vehicles of All last mile providers on the network	n. Vans	ACS databases	720	ILN: 410, ALN: 286, UCCLN: 189	ILN: 42.4%, ALN: 60.3%, UCCLN: 73.8%	Impact assessment Radar (Level 3) Agent-based Model, Facility location Model, Thessaloniki Logistics Digital Twin	The goal is to reduce the number of vehicles operate in the city

The evaluation of Thessaloniki's urban logistics KPIs provides a detailed understanding of the impact of different delivery network strategies, particularly focusing on reducing environmental impact and improving operational efficiency. The KPIs reveal significant improvements as the city transitioned from an Individual Locker Network (ILN) to an Alliance Locker Network (ALN), and eventually to an Urban Consolidation Centre Locker Network (UCCLN). Each step represents a progressively more collaborative and integrated approach to urban logistics, leveraging the use of parcel lockers and, ultimately, a unified consolidation center supported by electric Light Commercial Vehicles (eLCVs).

One of the most noticeable results is the reduction in CO_2 emissions per parcel, which decreases from 0.648 grams in the baseline scenario to just 0.067 grams under the UCCLN model. This reduction, which represents an 89.6% decrease, is attributed not only to the consolidation of deliveries but also to the deployment of eLCVs, which produce zero direct emissions during operation. The UCCLN model combines these two factors—consolidation and the use of eLCVs—leading to an unprecedented reduction in CO_2 emissions. While this significant decrease might seem unrealistic at first glance, it is grounded in the combined effects of reducing the number of delivery trips through consolidation and using cleaner vehicle technology.

The average number of kilometers driven per delivery also shows substantial improvement, particularly in the UCCLN scenario, where it decreases by 82%, from 3.63 km per parcel to 0.65 km per parcel. This reduction is primarily due to the strategic placement of lockers and the efficient routing enabled by the consolidation center. The use of eLCVs further amplifies this benefit by allowing multiple parcels to be delivered in a single, optimized route with minimal environmental impact.

Operational efficiency is also reflected in the increase in average deliveries per trip, which rises from 37 parcels in the baseline to 53 parcels in the UCCLN scenario. This 43.2% increase underscores the effectiveness of consolidation and routing strategies in maximizing the utilization of each delivery trip. Additionally, the rate of successful deliveries on the first attempt improves to 95.5% in the UCCLN scenario, indicating that the consolidated approach not only reduces the number of delivery attempts needed but also enhances customer satisfaction.

The parcel lockers themselves see improved utilization, with the fill rate increasing from 4.15% to 29.3% in the ILN scenario. The reduced time parcels spend in lockers, as seen in the pickup rate KPI, further indicates that customers are adapting well to the locker-based delivery system, allowing for more efficient use of locker space.

Finally, the number of freight vehicles required for last-mile delivery shows a significant reduction, from 720 vehicles in the baseline scenario to just 189 in the UCCLN scenario. This 73.8% reduction is a direct result of the consolidation of deliveries and the deployment of eLCVs, which not only reduces the number of vehicles on the road but also decreases congestion and associated emissions.

In summary, the stepwise evaluation of Thessaloniki's urban logistics strategies demonstrates that combining consolidation with the use of eLCVs in the UCCLN scenario leads to significant environmental and operational benefits. These results, though they may seem ambitious, are supported by the real-world implementation of these strategies and provide a convincing case for their broader adoption in urban logistics. The drastic improvements in CO_2 emissions, delivery efficiency, and vehicle reduction clearly show the potential of a well-planned, integrated approach to urban logistics.

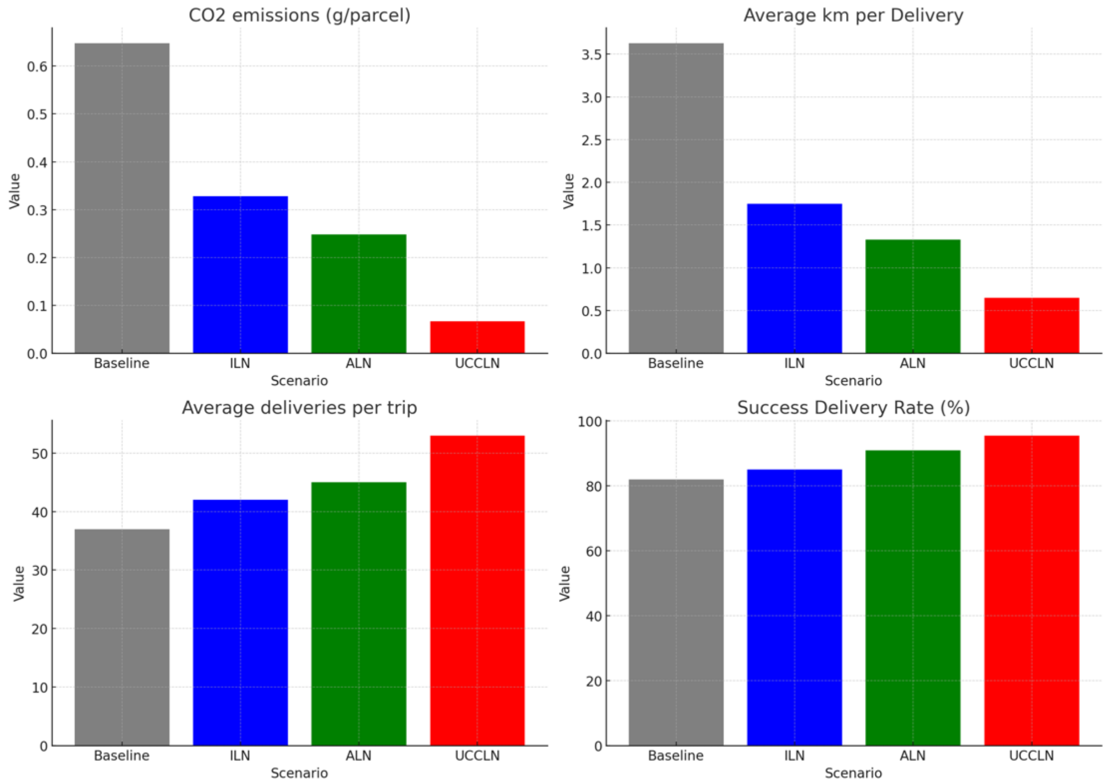


FIGURE 13 IMPACT OF URBAN LOGISTICS STRATEGIES ON KEY PERFORMANCE INDICATORS IN THESSALONIKI: COMPARING CO_2 EMISSIONS, DELIVERY EFFICIENCY, AND OPERATIONAL METRICS ACROSS LOCKER AND CONSOLIDATION NETWORKS

4.4.1.3 Social impact evaluation

Social KPIs –Decent work:

While KPIs commonly identified in European urban logistics projects and literature align well with SDGs 9 - Industry, innovation, and infrastructure, 11 - Sustainable cities and communities, 12 - Responsible consumptions, 13 - Climate action, 17 - Partnerships for the goals, the SDG 8 - Decent work and economic growth, was not sufficiently covered. To address this, specific indicators related to personnel turnover, salary, education level, gender diversity, and flexible work were collected in a dedicated data sheet and reported in Table 36.

TABLE 34 THESSALONIKI SOCIAL KPIS

KPI name	Measurement unit	Data source	Baseline Value	Comments
Personnel turnover	%	ACS	40%	D Parcel lockers are likely to reduce personnel turnover as they make last-mile delivery tasks more manageable. Safer and more comfortable working conditions, thanks to the automation and convenience of parcel lockers, can lead to increased job satisfaction and retention.
Average salary	€	Gov.gr	1187€	While parcel lockers might not directly influence average salaries, they could lead to more efficient operations, allowing companies to optimize labour costs. With fewer manual deliveries needed, savings could potentially be redirected to improve wages or other employee benefits.
Education level	%	ACS	Primary and Secondary education: 76.51%, Higher education: 10.51%, Post-secondary Education or Master 12.83% Doctorate: 0.15%	The shift towards a parcel locker alliance network not only reduces the demand for traditional courier roles but also positively impacts the Education KPI. As the network increasingly relies on digital infrastructure, there is a growing need for IT professionals, logistics coordinators, and data analysts, all of which typically require higher levels of education and specialized skills.
Gender diversity	%	ACS	79% males / 21% fem	Parcel lockers could improve gender diversity by making delivery roles less physically demanding, which might attract more female workers. The automation and reduced need for heavy lifting or extended physical exertion could create a more gender-neutral job environment.
Percentage of self-employed workers	%	ACS	0%	The use of PI- led parcel lockers alliance network may reduce the need for self-employed workers (such as gig economy couriers) by

				consolidating deliveries in central locations. This could lead to a more stable, employed workforce rather than relying on self-employed contractors.
Percentage of part-time workers	%	ACS	39%	Parcel lockers could lead to a more stable workforce with regular hours, potentially decreasing the percentage of part-time workers. The efficiency gains from automated lockers could support the transition to more full-time roles.
Precariousness rate	%	ACS	0	Parcel lockers can help maintain or further reduce precarious work by providing more stable employment opportunities. The reduction in manual delivery tasks can support a more secure job (less km driven) environment with predictable hours and duties.
Flexibility of working hours	Yes/No	ACS	No	The alliance network inherently promotes flexibility. Freelancers can choose when and where to pick up deliveries from lockers, working as much or as little as they prefer. This model addresses the inflexibility of traditional roles by leveraging the decentralized nature of parcel lockers, thus providing significant work-hour flexibility.
Percentage of remote work	%	ACS	1-2%	The introduction of a parcel locker alliance network reduces the demand for traditional courier roles as the need for door-to-door deliveries decreases. Instead, this shift creates new opportunities for IT professionals and educated staff who manage and maintain the digital infrastructure that supports the network. Jobs in logistics coordination, software development, data analysis, and customer support become more prominent, reflecting a move towards a more skilled workforce. This change aligns with the broader trend of automation and digitalization, where physical tasks are increasingly supplemented by roles that require higher education and technical expertise.

DSNH principle compliance

The KPIs of the Thessaloniki LL use cases support several of the six objectives outlined in the EU Sustainable Taxonomy, thereby aligning with the DNSH principle. The Thessaloniki LL use cases align with Objectives 1 and 5 by rethinking the ACS urban distribution model. This involves optimizing micro hub locations in the historic centre and designing a last-mile facility network to improve efficiency, reducing vehicles and kilometres travelled, thereby alleviating traffic congestion. Use case 1 enhances operational planning and customer experience through parcel locker installation. Use case 2 supports stakeholders in evaluating energy efficiency and carbon emissions reduction by simulating new zero-emission and modular service and vehicle options.

Sustainability triangulation:

As reported above, in the first reporting period NORCE carried out 2 workshops with each LL that both started and ended with sustainability: one on Design Thinking and one on Sustainable Business Model Canvas. The workshops were aimed at helping the LLs take the position of the users and their collaborators involved in their innovations, helping them to consider different aspects and implications of their implementation. Thessaloniki LL also distributed a social perception survey that gathered 188 responses. The results from this survey are outlined in D3.2 Modelling Framework and Agent-Based Models.

In the Design Thinking workshop, **Thessaloniki** identified in total seven potential personas in their discussions (1), with primary emphasis on consumers and users of the logistics services, particularly those engaged in online shopping. Discussions also touched upon retailers and policymakers. Subsequently, consumers, public authorities and the last mile providers emerged as the most pivotal personas (2). During the "point of statement" phase (3) these personas served as a starting reference, each highlighting separate needs. Regarding the parcel lockers, which are a focal point of the Thessaloniki innovations, the needs of both costumers and policymakers were identified, and thereby also identification of the sustainability needs that the project can meet. In part (4), Thessaloniki LL outlined their approach to meeting these needs. This involved acquiring and sharing skills, such as utilizing design thinking tools, to illustrate how their innovations align with various aspects of SDGs. Furthermore, the strategy included a focus on delivering a service that facilitates individuals in making intelligent and eco-friendly choices during parcel delivery and pickup processes.

During the Sustainable Business Canvas Workshop, Thessaloniki LL participants named the creation of a SULP, reducing distance travelled per parcel, and familiarising locals with physical internet solution as three goals. To achieve these, purchases of public space and the redesign of operational models were mentioned as costs, while cooperation between companies and familiarity with parcel locker technology were mentioned as benefits. The local logistics operator and the Region of Macedonia are key stakeholders, with the region providing the permits for the operation of the lockers and the operator providing insights into representative demand patterns. To achieve the LL goals, Thessaloniki needs to provide curbside areas and space for the parcel lockers, and the transport operator needs to provide the vehicles and data for the project. This data and the KPIs will be used to develop a local SULP. The Design Thinking map and the Sustainable Business Canvas for Thessaloniki LL are reported below in Figure 14 and 15.

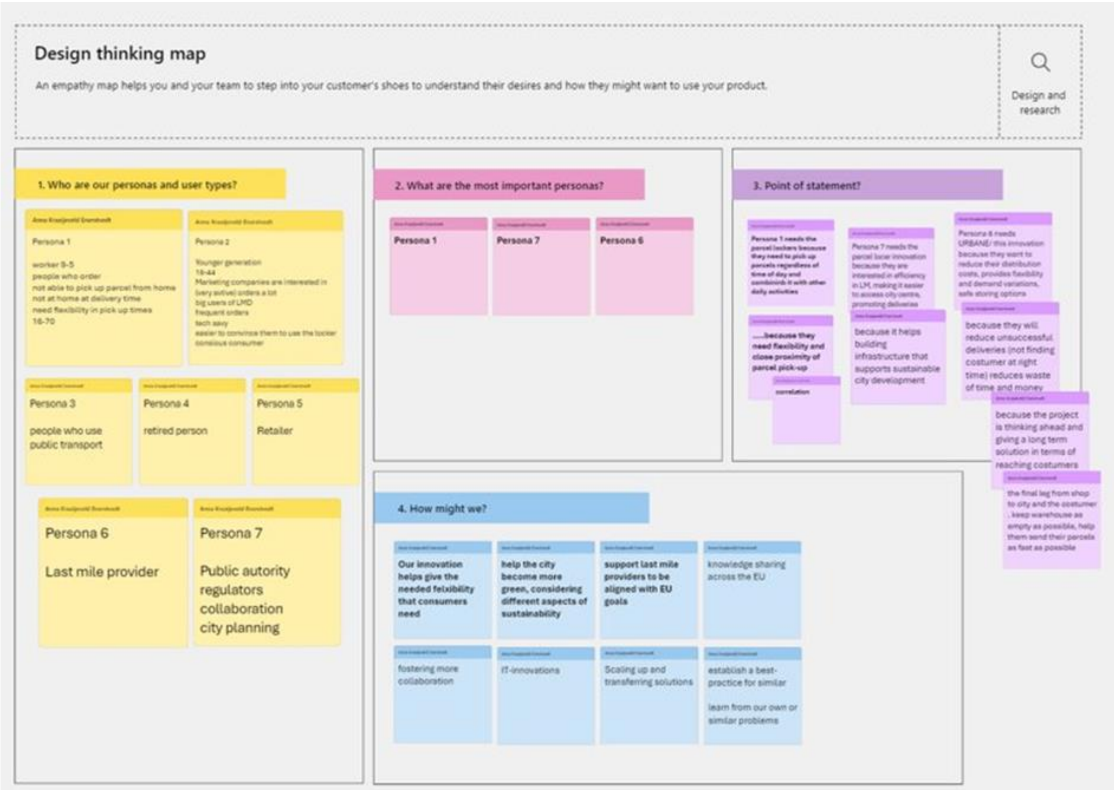


FIGURE 14 THESSALONIKI DESIGN THINKING WORKSHOP

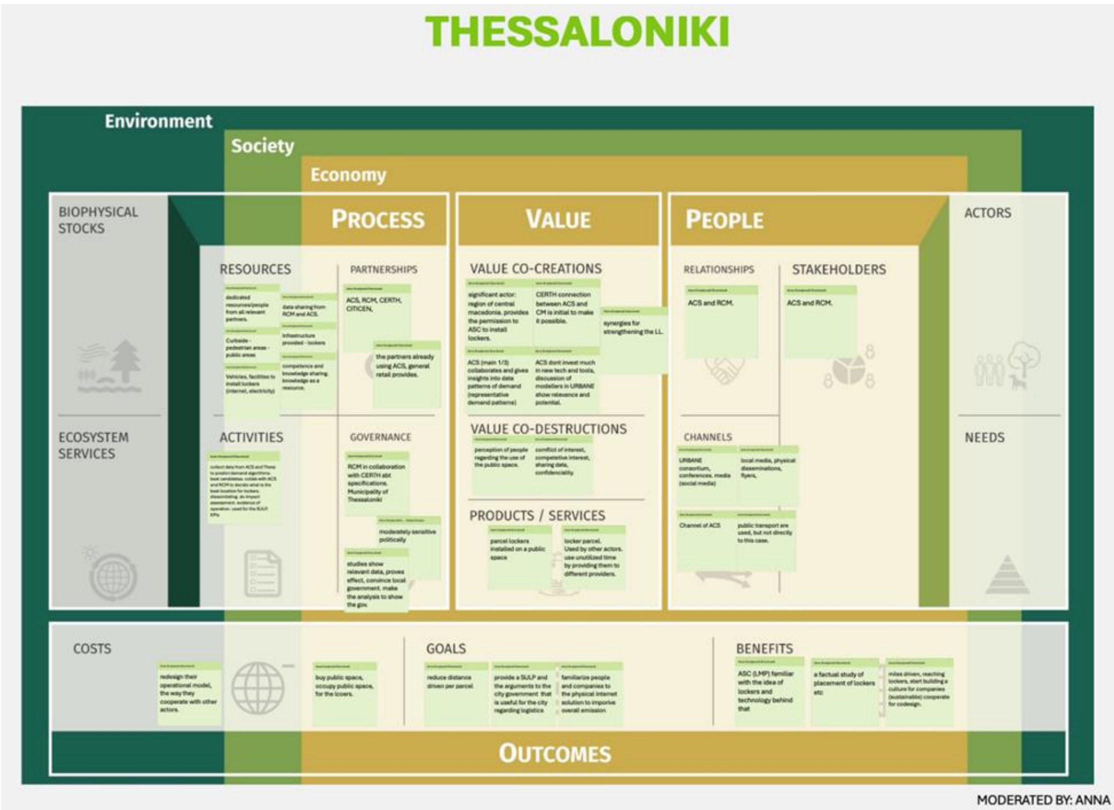


FIGURE 15 THESSALONIKI SUSTAINABLE BUSINESS CANVAS WORKSHOP

Lastly, the survey comprised of 188 responses, which were divided into socio-demographic segments defined by a combination of sex (M, F), age group (18-39, 40-64, 65+), education level (not higher education, higher education) and employment status (not employed, employed). Results, which are outlined in detail in D3.2, showed that when asked the following question "*When deciding to have goods delivered home or to a parcel locker, how important are the following aspects for you*?" Thessaloniki residents gave most importance to the statements "*the delivery cost is low*" and *"I can get the parcel at a convenient time"* and least importance to *"the working conditions of the courier delivering the package"* and *"the delivery has low environmental impact."* The fifth option, "*the parcel details are kept private (item types or the sender is not revealed)"* was given an importance somewhere in between. It is worth noting that respondents, on average, gave a high importance (5 or more on a scale from 0 (*not important at all*) to 10 (*absolutely essential*) to all five statements. This implies that consumers in Thessaloniki value all five characteristics of goods deliveries that are stated (time, environmental impact, working conditions, cost, and privacy), but that delivery time and cost are particularly important to them.

4.4.2 Process evaluation

In this paragraph, results from the process evaluation questionnaires deployed among Thessaloniki LL actors are reported. Thessaloniki included two rounds of data collection in October 2023 regarding data in the period September 2022 – August 2023 and a second round from September 2023 to August 2024.

TABLE 35 THESSALONIKI PROCESS EVALUATION

Use case 1	Barriers	Drivers	Potential impact on KPI final values
POLITICAL INSTITUTIONAL	Political support due to change in leadership and new goals/agendas	Reduction of emission. Thessaloniki is in Mission 100 EU cities to be climate neutral by 2030. Congestion events	The locations of the locker network was produced according to the demand data patterns and reflect the most popular for home deliveries and movements. The analysis results convinced public authorities to proceed with licence for public space usage.
ECONOMIC & FINANCIAL	Investments and maintenance costs on the locker network expansion	Reduce costs caused from externalities from urban logistics such as congestion, noise, km driven.	Reduce vehicles, km driven, fleet size, for LSPs and improve efficiency of deliveries.
SOCIAL	Occupation of public space. A lot of locker pickups performed by car trips as the network is not optimal globally.	Perform greener and more sustainable urban logistics and consequently improve air quality and traffic.	Improvements on active mobility for parcel pickup. Minimum utilization and occupation of public space (optimized alliance network)

TECHNOLOGICAL	Difficult to communicate systems across various LSPs as they work on different technologies.	Share infrastructure and reduce costs by creating simple communication protocols via blockchain networks.	Improved operational and service level efficiency at all levels.
DATA/INFORMATIONAL	Conflict of interests (competition) among various LSPs.	To get a more general view of the demand and better organized the networks	Optimized planning of the parcel forwarding to the city
ENVIRONMENTAL	-	Reducing the km driven and co2 produced.	Perform a greener delivery as the km per parcel reduced
LEGAL/REGULATION	No existence of any legislative framework for hub installation in public space	SULP is under development. (Low emission zones, restriction on km driven etc.)	Upscaling of the innovative solution of locker alliance on larger instances.

4.4.3 Conclusions

Thessaloniki has focused on reducing distances driven by delivery vehicles in central areas of the city and shifting these to zero emission vehicles, mainly contributing to SDGs 7, 9 and 11 (7 Affordable and clean energy; 9 Industry, innovation and infrastructure; 11 Sustainable cities and communities). Use case 1 contributed to SDG 9 by addressing distances driven with conventional internal combustion vehicles and to SDG 11 by addressing local air pollution (NOx). This is done by testing a hub and spoke system of deliveries in central Thessaloniki. Use case 2 simulates the potential for reduced carbon emissions with zero-emission delivery vehicles supporting the operations of an Urban Consolidation Centre that serves as a unique access point to last mile for every provider in the region.

The analysis of Thessaloniki's urban logistics interventions demonstrates substantial improvements across multiple KPIs, reflecting the effectiveness of progressive strategies like the Individual Locker Network (ILN), Alliance Locker Network (ALN), and Urban Consolidation Centre Locker Network (UCCLN). CO_2 emissions per parcel saw a reduction of 89.6%, dropping from 0.648 g/parcel in the baseline to 0.067 g/parcel in the UCCLN scenario, largely due to the combined impact of consolidation and the deployment of electric Light Commercial Vehicles (eLCVs). The average kilometres driven per delivery decreased by 82%, while the average number of deliveries per trip increased by 43.2%, from 37 to 53 parcels per route. Additionally, the success rate of first-attempt deliveries improved by 16.5%, reaching 95.5% under the UCCLN model. Finally, the fleet size required for last-mile deliveries was reduced by 73.8%, demonstrating a significant decrease in the number of freight vehicles on the road, from 720 to just 189. These outcomes underscore the transformative potential of integrated and collaborative logistics solutions in achieving more sustainable and efficient urban delivery systems.

The transition from the Individual Locker Network (ILN) to the Alliance Locker Network (ALN) represents a critical evolution in Thessaloniki's urban logistics strategy, showcasing the impact of collaborative efforts among last-mile providers. While the ILN already demonstrated significant benefits, such as a 49.4% reduction in CO_2 emissions and a 51.8% decrease in kilometres driven per parcel, the shift to the ALN brought even more pronounced improvements. CO_2 emissions were further reduced by 24.4% from ILN to ALN, achieving a total reduction of 61.7% compared to the baseline. Similarly, the average kilometres per delivery saw an additional 24% decrease, indicating that shared locker networks substantially enhance route efficiency. Moreover, the success rate of first-attempt deliveries increased by 7%, from 85% in the ILN to 90.9% in the ALN. These differences highlight the added value of cooperation between logistics providers, emphasizing that moving from isolated locker networks to an integrated alliance significantly amplifies the benefits in terms of environmental impact, operational efficiency, and customer satisfaction.

5. Findings and Results

Together, the different data collection methods that compose the SEAMLESS framework provide an overview of the barriers to and possibilities for implementation of innovations for last mile logistics. To do so, the SEAMLESS framework required analysis of the different contexts of each Living Lab, including the governance context, the relevant stakeholders and perception data relevant to implementation of each LL innovation. All this data was standardized for comparability and the results of the SEAMLESS framework are outlined in this chapter. Table 29 below outlines the steps in the SEAMLESS framework in the order they were carried out, the methods related to each step and the results produced.

TABLE 36 SEAMLESS FRAMEWORK STEPS

Step in SEAMLESS Framework	Method and Results
Stakeholder Mapping	Scoping Document (basis of Deliverables 2.2, 2.3, 2.4, 2.5 on each demonstrator) and LL self-collection Overview of relevant stakeholders in each LL Overview of roles of stakeholders in implementation of each LL innovation
Qualitative Governance Analysis	Scoping Document and Design Thinking workshops Overview of regulations relevant to LL Overview of relevant barriers to LL implementation
Public Perception Data	Survey data from citizens regarding acceptance of different logistics solutions in Valladolid (169 responses) and Thessaloniki (188 responses)

5.1 SEAMLESS Framework

5.1.1 Stakeholder Mapping and Qualitative Governance Analysis

As part of the stakeholder mapping, Living Lab partners were initially asked to reflect on who the relevant stakeholders in their context are, how they may aid or inhibit the implementation of the LL innovations and how they may work with these key stakeholders to ensure LL success. This included self-collection of data through small questionnaires distributed to LL partners and meetings with each LL for guidance. LL partners included their responses in the Scoping Documents (D2.2 - D2.5 LL demonstrators). These responses were later analysed alongside findings from the Prioritisation step of the Design Thinking workshops, where LL partners were asked to identify the key stakeholders who may aid or prevent implementation. Table 39 below outlines the relevant stakeholders in each Living Lab categorised as business, public, or other stakeholders. It shows that there are commonalities between the cities despite the differences in the innovations. Naturally, most similarities are to be found in the type of business stakeholders that are key to each LL, as all depend on a combination of large logistics operators, last-mile operators and technology developers. The differences arise in the governance context of each city, with varying importance given to regional and national stakeholders for local implementation. Each LL also named other stakeholder groups, with researchers appearing as the only commonality across cities.

TABLE 37 STAKEHOLDER MAPPING

	Business	Public	Other
Bologna	Logistics operators, last-mile operators, technology developers, hub providers	Local authority, metropolitan authority, regional authority	Researchers, residents, civil society groups, logistics interest organisations
Helsinki	Logistics operators, last-mile operators, technology developers	Local authority, public logistics actors, National Road agency, Ministry of transport, National Police Board, Mobility Lab Helsinki	Researchers, residents, other cities
Thessaloniki	Logistics operator, last-mile operator, technology developer, retailers	Local authority, regional authority	Researchers, academia, users
Valladolid	Logistics operators, last-mile operators, technology developers, specific businesses	Local authority, agency for innovation, agency for mobility	Researchers, residents, cyclist association

Following the completion of the LL Scoping Documents (D2.2 - D2.5 LL demonstrators) and the workshops described above, NORCE carried out a qualitative governance analysis of the four LL contexts. Governance analysis includes consideration of the legislative and social context that each LL faces, pointing to the barriers that LLs must consider before implementation of their innovation. Early findings were considered in the Design Thinking and Sustainable Business Canvas workshops as LL were asked to reflect on the purpose of their innovation in each context and possible barriers to implementation. These findings complemented those from the Scoping Documents and the results are outlined in standardized manner in Table 40 below. All four cities have a variety of traffic regulations, climate and urban development plans, and all have a plan that abides by the framework of Sustainable Urban Mobility Plans (SUMPs). In three of them, regional plans were also identified as relevant for LL implementation, whereas in Thessaloniki the LL innovation is meant to serve as inspiration for a regional SULP. Helsinki and Valladolid identified concrete national legislation that influences development of their LL innovations, whilst Thessaloniki only mentioned national vehicle registration without providing further details. At the European level, all four LL cities are part of the Climate Neutral Cities Initiative, and the local innovations are seen as contributing to this initiative. For Bologna this is particularly acute due to a European ruling that its local air pollution breaches legal limits and for Valladolid the EU goal of preventing sales of ICE vehicles from 2035 is similarly influential. Lastly, Bologna and Thessaloniki are aware of their positions as nodes in the Trans-European Transport Network (TEN-T).

TABLE 38 GOVERNANCE ANALYSIS RESULTS

	Local	Regional	National	EU
Bologna	Limited traffic zone, SUMP, SULP, Electric mobility plan, Parking regulations	Regional land use Plan, Regional transport plan,	New General Transport and Logistics Plan	Climate Neutral Cities Initiative, Trans-European Transport Network, ECJ Emissions Ruling
Helsinki	Traffic norms, leasing land, Economic Priorities, Municipal Climate Strategy, Action Plan for City Logistics	Regional land use, housing and transport plan	Road Traffic Act, Climate Act	Climate Neutral Cities Initiative
Thessaloniki	Traffic norms, leasing land, SUMP	Regional SULP (under development), Regional Plan for Adaptation to Climate Change, Integrated Sustainable Urban Development Strategy	Vehicle registration	Climate Neutral Cities Initiative, Trans-European Transport Network, National Climate Law
Valladolid	Municipal Road regulation, SUMP, Municipal Urban Agenda, Municipal Climate Strategy, Municipal Innovation Plan, Smart parking platform	Sustainable Development Strategy, Regional Climate Strategy Castile and Leon	Ordinance on Low Emission Zones, Mobility Strategy 2030, Climate Change Law, Sustainable Mobility Law (pending)	Euro 7 standards Ban on new ICE vehicles from 2035, Climate Neutral Cities Initiative

5.1.2 Design Thinking and Sustainable Business Model Canvas

The Design Thinking and Sustainable Business Canvas workshops, described in chapter 3.1.2, together comprised of the five steps in the Design Thinking process, are visualized in Figure 16 below. The results from each step are summarized in Table 41 below for all four cities. Each step in the Design Thinking process builds on the previous one, such that the sustainability considerations (1) of each LL were related to the local context (2), and these in tandem were reflected in how each LL identified the key goals and stakeholders in the prioritization step (3). In the last two steps, the target stakeholders and sustainability priorities helped formulate what each LL innovation seeks to provide (4), and finally all these considerations are gathered in the outline of a Sustainable Business Canvas. This final step ensured that Living Labs returned to the starting point of their innovation – the aspired sustainability impacts and what may contribute or prevent their achievement in a local context. The results in Table 41 must therefore be considered row by row for each city.

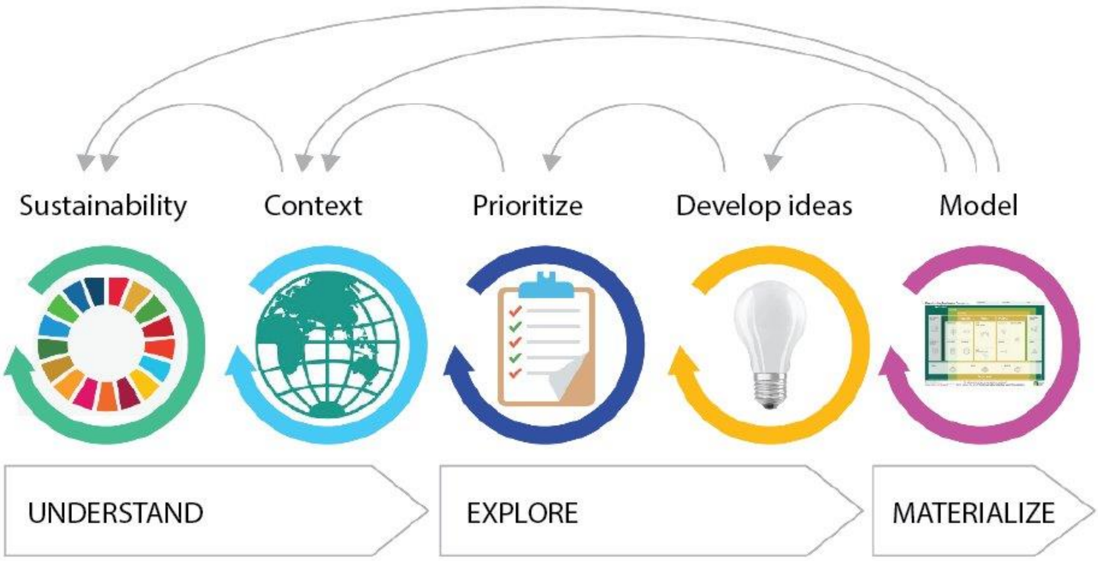


FIGURE 16 DESIGN THINKING MAP

TABLE 39 DESIGN THINKING RESULTS AND SUSTAINABLE BUSINESS MODELS CANVAS IN EACH LL

	Bologna	Valladolid	Thessaloniki	Helsinki
(1) Sustainability	Business models, balance of costs and externalities, emissions	Business activities, working conditions, pollution, traffic	Balancing aspects of sustainability, emissions, investments, public space	Jobs, citizen collaboration, balancing aspects of sustainability
(2) Context	Logistics operators, last-milers, city government, B2B customers	Postal service, Food delivery companies, logistics operators	Last-milers, public authorities, retailers, customers of different ages	Logistics operators, users of micro-hub, decision-makers
(3) Prioritise	Logistics operators, last-milers, city government	Third use case – electric bikes for the postal service	Young people, last-milers, public authorities	Logistics operators (local and global)
(4) Develop Ideas	Collaboration with municipality, blockchain and technical development	Communicate solutions, evaluate user acceptance and range anxiety	Collaboration, knowledge-sharing, IT innovations	Collaboration with research and developers, links between providers, proper institutions
(5) Model	Business model that promotes operator collaboration, reducing driving distances and space use	Demonstrate vehicles for zero-emission last mile delivery, reducing local pollution and	Familiarise people and companies with parcel lockers, contributing to SULP and less emissions	Combining autonomous delivery vehicles and micro-hubs to increase business collaboration and reduce traffic

		improving working conditions		

5.1.3 Impact and process evaluation results

All Lighthouse LLs successfully addressed urban challenges such as congestion, pollution, and emissions through innovative last-mile delivery solutions contribution to several SDGs related to affordable clean energy, decent work, economic growth, industry, innovation, reduced inequalities, and sustainable cities. In particular key outcomes of the impact evaluation in conjunction with the project KERs include:

Key Impact Pathway 4: Addressing EU policy priorities & global challenges through R&I

- **Significant CO2 emissions reduction** (aligned with the project KPI**:** *Successful demonstration of innovations in 6 real operational environments leading to improved environmental performance (>20% GHG reduction) in intervention areas*):
  - Bologna LL: the adoption of electric delivery vehicles for city center deliveries resulted in a daily saving of approximately 3,298 kg of CO2 (-52%) when comparing conventional door-to-door deliveries with the new system utilizing micro-hubs and Electric Delivery Vehicles
  - Helsinki LL: by testing zero-emission alternatives, such as autonomous delivery vehicles and cargo bikes, the distance driven by conventional internal combustion vehicles was reduced, leading to a 3% decrease in CO2 emissions and local air pollution.
  - Valladolid: In Use Case 2, the in-trunk delivery option, which shifted deliveries outside the Low Emission Zone (LEZ), achieved a 15-50% reduction in CO2 emissions depending on the route and vehicle used. Use Case 3 demonstrated that photovoltaic-assisted bikes consumed 30% less energy, and the electrification of the fleet resulted in a massive reduction in emissions: -96% for vans and -99% for bikes.
  - Thessaloniki: CO_2 emissions per parcel saw a remarkable reduction of 89.6%, dropping from 0.648 g/parcel in the baseline to 0.067 g/parcel in the UCCLN scenario, largely due to the combined impact of consolidation and the deployment of electric Light Commercial Vehicles (eLCVs).
- **Enhanced efficiency through the use of low-emission vehicles and the introduction of innovative technologies** (aligned with the project KPI: *Deliveries made with conventional vehicles in Lighthouse LLs halved thanks to the introduction of innovative technologies such as CCAM. KPI: decrease in deliveries made via traditional vehicles: 50%*):
  - Bologna LL: TYP conventional vehicle deliveries entering the LTZ were halved, reducing traffic congestion and emissions.
  - Helsinki LL: zero-emission vehicles provided value to logistics service providers and consumers without increasing safety risks for residents. The reduction in the number of traditional vans depends on the attitudes and satisfaction levels of residents and consumers who use these low-emission services.

  - Valladolid LL: the adoption of innovative last-mile delivery technologies and pick-up solutions contributed to reducing the distance traveled by polluting vehicles and moving deliveries out of city LEZs.
  - Thessaloniki: the number of freight vehicles required for last-mile delivery dropped from 720 in the baseline scenario to just 189 in the UCCLN scenario—a 73.8% reduction driven by delivery consolidation and the deployment of eLCVs, which also reduced road congestion and emissions.
- **Physical Internet Solutions tested** (aligned with the project KPI: *Testing of PI-oriented solutions (e.g. Digital Twins blockchain technology) in Lighthouse LLs KPI: #innovative business models taking advantage of PI-oriented solutions: #2*):
  - Bologna LL: Tested both blockchain and Digital Twin Applications, as well as the Impact Assessment Radar.
  - Helsinki LL: Tested both blockchain and Digital Twin Applications, as well as the Impact Assessment Radar.
  - Valladolid LL: Tested the Digital Twin Application, as well as the Impact Assessment Radar.
  - Thessaloniki LL: Tested both blockchain and Digital Twin Applications, as well as the Impact Assessment Radar.

<u>**Key Impact Pathway 7: Generating innovation-based growth.**</u>

- **Innovative modalities (ADVs, EDVS with PV panels) in LLs**
  - Several innovations were tested in the scope of URBANE, including: ADVs in Helsinki, EDVs in Bologna LL, fully electric vehicles with solar panels and new operation models of loading/unloading areas in in Valladolid LL.
- **Physical Layer innovations.** Aligned with the project KPI: *Upgraded infrastructure (physical layer) in LLs by introducing micro consolidation centres demonstrating improved efficiency of parcel handling,* as follows:
  - Physical layer approaches (micro consolidation centers & hubs are being tested Micro-Fulfilment Centers are tested in the scope of Bologna and Thessaloniki LLs aiming to facilitate faster and more sustainable last-mile deliveries, reducing the distance travelled by delivery vehicles.

<u>**Key Impact Pathway 8: Creating more and better jobs.**</u>

- **Improved working conditions and creation of new jobs** (aligned with the project KPI "*Hub operations will become less labour intensive, with new jobs created upstream in the logistics chain*"): the introduction of automation and more sustainable, lighter vehicles, such as parcel lockers in Thessaloniki and Bologna, is likely to improve employee working conditions, making last-mile delivery tasks more manageable and fostering a more stable workforce. This shift also has the potential to enhance gender diversity by making delivery roles less physically demanding and create new roles requiring advanced ICT skills. In Valladolid LL's Use Case 3, once workers adapted to electric-assisted bikes, it not only improved their working experience but also sparked interest in the technology, leading to new skills acquisition and job creation linked to these innovations.

The process evaluation highlighted that the main drivers for success across all LLs include a strong commitment from local authorities towards implementing these solutions, consumer and business attractiveness, and the challenges of operating in city centers with conventional vehicles versus light, zero-emission and more technological alternatives that can reduce CO2 emissions and collect real data more efficiently and transparently. However, several barriers persist, such as land usage permissions, the costs of investment and maintenance, the financial sustainability of the innovation, and the reluctance to share strategic and real-time data, compounded by data protection concerns.

6. Lessons learned and recommendations

During Wave 1, data collection for the SEAMLESS framework was limited to stakeholder mapping, qualitative governance analysis and limited public perception feedback data from some Living Labs. Stakeholder mapping and qualitative governance analysis was carried out in cooperation between WP2 and the LLs, and this allowed for LL partners to collect data in their own language for WP2 to help analyse. These data, collected in Scoping Documents, are being used to arrive at conclusions as part of the SEAMLESS framework, and this experience can be replicated in Wave 2.

The stakeholder mapping and governance analysis prepared LLs for implementation of their innovations and served as inspiration for the preparation of local surveys by helping to determine the target groups. As part of this, it was particularly helpful that LL partners were sent out a preliminary survey and that this was followed up with meetings with each LL to outline the data needed in the Scoping Documents (D2.2 - D2.5 LL demonstrators). In future applications of the SEAMLESS framework, the guidelines for the Scoping Documents will provide detailed examples of the relevant regulations and policies that must be included in these to carry out the qualitative governance analysis.

Although the Design Thinking workshops were carried out after the initial stakeholder analysis, these provided data to this analysis. This is because a governance context depends on the stakeholders responsible for planning, implementing and enforcing policies and regulations. As such, the workshops were central to the stakeholder mapping as this is where LL partners identified the *key* stakeholders and their role in the local governance contexts. Originally the workshops were intended to be held as one session with all five steps, but it was seen during the first set of workshops (steps 1-4) that not enough time was allocated to reflect on each of the steps and step 5 had to be carried out separately. Therefore, Design Thinking workshops in Wave 2 should provide significant time (ca. 3 hours total) for all five steps, which can either be carried out in one stretch or in two separate occasions of 90 minutes each (steps 1-4 and step 5). These workshops were central to identifying LL objectives, barriers to implementation and potential solutions. If held earlier in the process, the workshops could have been used to identify barriers such as internal zoning processes in Helsinki.

In Wave 1, each LL has collaborated with NORCE to design its own survey questions. However, Wave 1 LLs have been responsible for translation and dissemination of surveys. This has meant LLs have decided on different target groups for their surveys and carried these out at different periods of time, leaving little time to analyse this data before the end of WP2 and include it in the SEAMLESS conclusions. WP2 has sought to include common questions in all the surveys to ensure comparability and transferability, but a common approach to all LL surveys from the start would have strengthened comparability. WP2 recommends that Wave 2 and other surveys are planned in a streamlined manner from the start to prevent data analysis limitations and facilitate mass dissemination. Differences in target groups mean that Bologna gathered much fewer survey responses than the other three living labs. The smaller target groups in Bologna mean that these surveys could be carried out as in person questionnaires aimed at particular stakeholders, with fewer resources. However, businesses were wary of sharing sensitive data and LL only gathered four responses, which was too small a sample to analyse. Meanwhile, Helsinki LL only managed to gather 48 responses from its survey of the general public in the course of almost 4 weeks. This sample was also deemed as too small to use in the validation report. These are important considerations for Wave 2 cities and future replication. It is apparent that timing, duration of survey distribution and considerations of business concerns will strongly affect data collection.

Based on the lessons learned outlined in WP2 deliverables on the demonstrators, each use case has a transferability potential applicable to similar contexts for enhanced urban logistics. In the below sections, the reader can find the recommendations to facilitate the implementation of the use cases in other cities, according to lessons learnt in each Use Case.

6.1 Bologna

6.1.1 Use case 1: Micro-hubs networks and light EDVS – PI last mile deliveries

Key Lesson 1: Challenges in attracting transport operators beyond project partners

Recommendation for transferability: Engaging transport operators beyond initial project partners is a common challenge for many cities. The difficulty in attracting broader participation from various transport operators lies in their diverse characteristics and specific needs. Due Torri, a URBANE partner, for instance, required the return of paper shipping certificates and tags, which posed a logistical obstacle. Additionally, other couriers' concerns about data sharing and freight security prevented them from collaborating with other operators, highlighting the importance of addressing data privacy and security issues to foster wider engagement. Strategies employed in Bologna, such as developing questionnaires to assess interest in micro hub solutions and innovative delivery approaches, can be adapted. However, Bologna encountered difficulties in obtaining comprehensive responses due to security and privacy concerns. To expand the project's reach, meetings were held with major couriers like UPS, GLS, and Poste Italiane to explore potential collaborations. To enhance collaboration and adoption of the solution by various transport operators, it's crucial to include larger courier companies, even those with their own contracted last-mile delivery services.

Key Lesson 2: Microhub management platform and blockchain module application

Recommendation for transferability: Some functionalities of the microhub management platform, including the blockchain module developed by WP3 partners, can be transferred to other cities. While this platform can facilitate a smooth, coordinated and secure delivery process for all stakeholders, it may present challenges for courier companies. These challenges include the additional costs and time required for system integration and staff training. The blockchain solution and other tested technologies become even more powerful at larger scales, as they improve with increasing system size.

Key lesson 3: Adapting to City-Specific Challenges and Regulations

Recommendation for transferability: The success of the solution depends on its adaptability to unique city-level challenges, initiatives, and regulatory frameworks. In Bologna, the pilot aligned seamlessly with the SULP (Nearby Delivery Areas) and the Città 30 initiative, which reduced speed limits to 30 km/h. Specifically, Bologna LL realized a measure included in the SULP: implementation of the Nearby Delivery Area (NDA). The 3 micro-hubs are the first Nearby Delivery Areas, established as part of the SULP and SUMP. To ensure replicability, future implementations must consider and align with local regulations and urban planning strategies.

Key Lesson 4: Expand Microhub Capabilities

Recommendation for transferability: To optimize the microhub's potential, it is recommended to expand its capacity to handle multi-item orders. This would enable a more comprehensive evaluation of collaborative logistics, considering the diverse needs of different carrier profiles.

Key Lesson 5: Application of URBANE Digital Twin Platform

Recommendation for transferability: URBANE Digital Twin platform has demonstrated significant potential for enhancing urban logistics operations and decision-making. By replicating the platform in different urban environments, municipalities and transport operators can benefit from its capabilities in optimizing logistics operations, reducing environmental impact, and improving overall urban sustainability. To ensure effective utilization of the platform it is important to provide comprehensive training and support.

6.2 Helsinki:

6.2.1 Use case 1 and 2

Key Lesson 1: Expand robot use cases

Recommendation for transferability: given the versatility of the ciTHy M and L droids, it is recommended that other cities explore a wider range of applications beyond last-mile delivery. By leveraging these robots for tasks such as elderly assistance, public service support, and goods transport in various sectors, cities can optimize resource utilization, improve public services, and enhance overall urban efficiency. On-demand deliveries work well for B2C deliveries and pre-determined pick-up locations combined with the one-hour timeslots suit well the consumers' needs. However, robots could be also utilized as an overflow capacity for popular parcel lockers, reverse logistics, or even power banks.

Key Lesson 2: Foster multi-stakeholder collaboration

Recommendation for transferability: to accelerate the adoption of robot-based logistics, cities should actively foster collaboration among different stakeholders, including technology providers, logistics operators, regulatory bodies, and the public. By working together, these stakeholders can identify shared goals, address challenges, and develop effective strategies for integrating robots into urban environments. In Helsinki LL's operations, the collaboration between different LSPs resulted in better quality services for residents and negotiations between different companies to build similar collaboration in the future. This will foster the green transition in urban logistics.

Key Lesson 3: Create enabling regulatory frameworks

Recommendation for transferability: clear and supportive regulatory frameworks are essential for the successful deployment of logistics robots. Cities should work with national and regional authorities to develop regulations that promote innovation while ensuring public safety and privacy. The regulatory framework should support the initiative to invest in low-carbon vehicles, invent novel delivery means and provide transparent guidelines to integrate these innovations into urban logistics practices.

6.2.2 Use case 3

Key Lesson 4: Investigate and clearly understand the land use permitting processes at city level

Recommendation for transferability: Given the challenges encountered by Helsinki LL in securing a land use permit for the microhub, it is essential to conduct a well investigation of a city's permitting process prior to microhub installation. The city must engage in the process of finding suitable areas for the usage of urban logistics to enable the carbon neutrality in dense areas with high demand of deliveries. Also, the permit process for the ADV should be streamlined to provide an opportunity for the ADV to run fully autonomously without the supervisor.

To scale up the operations in the future, the location must be found months before the operations can start. Marketing the operations for the customers, consumers and residents takes time. Onboarding the stakeholders, clarifying the roles for each player involved in the operations, setting up the microhub and starting the deliveries is a time-and resource-consuming process. The permit processes must be tackled with a strong collaboration with the city of Helsinki by engaging them to share the vision of the future urban logistics. Simultaneously, defining a neutral role for microhub facilitator should be considered to enable smooth collaboration between competitors and engaging new players whenever wanted.

6.3 Valladolid:

6.3.1 Use case 1: Monitoring of loading and unloading areas using artificial intelligence

The introduction of the monitoring solution for L/U areas is a step towards the optimization of this kind of infrastructure assets by enabling data-driven decision-making processes. The collection and analysis of data regarding the use of L/U areas allows identifying aspects such as usage patterns, amount and nature of parking violations, or the status of the L/U zone at any given time. The impact is positive for various stakeholders: for municipalities, it allows devising more effective policy measures to tackle the existing problems (if any) and make a better use of the L/U zones; for LSPs, it allows them to better plan delivery routes considering the current or expected occupancy of the zones. In relation with it, the following lessons learned and recommendations for transferability have been identified:

Key Lesson 1: Collect information on the application of cameras and on the current legislation.
Recommendation for transferability: Before proceeding with the installation of video cameras on public roads, it is important to have all the information regarding the application and to be aware of the current legislation and recommended procedures. In addition, it is necessary to ensure that the data management that is carried out does not violate the right to privacy. Aligned with this, it is recommended to include in the implementation plans not only the technical aspects of the solutions, but also define clearly all aspects related with data collection, handling and anonymisation in order to obtain the permits as soon as possible. Also, it is recommendable to identify as early as possible all the different stakeholders that may influence the deployment of the solution (e.g staff in charge of mobility, in charge of the infrastructure were the cameras will be located, in charge of the management of electric networks, etc.) to collect and address their requirements in a timely manner.

Key Lesson 2: The need for extensive image training to accurately classify vehicle categories.
Recommendation for transferability: This lesson is highly transferable to other cities as vehicle types and loading/unloading behaviours are generally consistent across urban environments. The AI model, once trained on a diverse dataset, can be adapted to different cities with minimal adjustments. These

adjustments are related to the definition of the Regions of Interest (ROIs) in the selected location, as they are used by the algorithm to decide which cars are parked in the L/U zone, which ones are in a double-parking violation.

Key Lesson 3: Accurate tracking algorithm
Recommendation for transferability: The tracking algorithm included in the model on which use case 1 is based needs to be more accurate to avoid errors in the measurement of parking time. Another algorithm different from the one used should be able to raise the level of accuracy, penalising the processing time.

6.3.2 Use case 2: Implementation of an Innovative and Sustainable Solution of Contactless Parcel Delivery

The implementation of innovative, contactless parcel delivery solutions enables taking out from city centres part of the deliveries, moving them to pre-selected public spaces (e.g deterrent parkings), hence traffic density (and the related emissions) can be alleviated in the most crowded areas. Also, from an LSP perspective, the route planning can be simplified at least to some extent, and as long as the service is chosen by the customer, ensures a successful delivery of the parcel, avoiding returns. In relation with it, the following lessons learned and recommendations for transferability have been identified:

Key Lesson 1: The complexity and variability of delivery scenarios.
Recommendation for transferability: While the specific scenarios may vary between cities, the core challenges of contactless delivery (e.g., package security, delivery infrastructure, consumer acceptance) are common. The lessons learned in developing and testing delivery models can be adapted to different urban contexts. However, the level of transferability will depend on factors such as urban density, infrastructure, and consumer behaviour. It is recommended to carry out a pilot test together with an acceptance survey amongst potential customers and service providers, to ensure that it will succeed once deployed.

Key Lesson 2: Support of vehicle manufacturers and logistics operators.
Recommendation for transferability: In order for the in-trunk delivery model to succeed and its effects to be visible, it is important to first have the support of vehicle manufacturers and logistics operators. In this context, the administration is the only competent body that can encourage both stakeholders to bet on this innovative delivery model, as well as the citizens.

6.3.3 Use case 3: Techno-economic Comparison of Combustion Vehicles, Commercial EVs, and IFEVS Prototype Vehicles in Delivery Services.

The shift from conventional, combustion engine vehicles to electric vehicles (including bikes) entails massive environmental gains (<90% reduction in CO_2 emissions, no NOx emissions) without affecting current operations. Also, the introduction of photovoltaic panels in the vehicles increases their range while lowering even more the CO_2 emissions, as part of the energy is collected while driving. In relation with it, the following lessons learned and recommendations for transferability have been identified:

Key Lesson 1: The significant impact of climatic conditions on the performance and cost-effectiveness of electric vehicles, particularly those with integrated photovoltaic systems (IFEVS).

Recommendation for transferability: The core methodology of techno-economic comparison can be transferred to other cities. However, the specific data and models used to assess vehicle performance and costs will need to be adapted to local conditions. Additionally, the development of a location-based model to assess the potential and cost-effectiveness of IFEVS is essential for widespread application.

Key Lesson 2: Extend the support programs for the purchase of electric vehicles.
Recommendation for transferability: It is advisable to increase the financial incentives for the purchase of electric vehicles so that they are attractive (lower Total Cost of Ownership) to logistics operators. Besides, it is recommended to check whether the charging infrastructure (either public or private) is well-developed to support daily operations without disruptions. These actions would help to increase the adoption of electric vehicles by LSPs. In relation of the charging needs of the vehicles, it is recommended to consider the installation of PV panels, especially in areas with insufficient charging infrastructure, as it increases their range.

6.4 Thessaloniki

6.4.1 Use case 1: Operation of Hub and Spoke delivery model (Parcel Lockers) supported by Digital Twins and Use case 2 - Ideal composition of new fleet (EVs) and services

Key Lesson 1: Tailored logistics strategies based on spatial Density
Recommendation for transferability: Given the significant impact of spatial density on logistics efficiency, it is recommended that cities conduct thorough spatial density assessments to inform the development of tailored logistics strategies. By understanding the specific characteristics of their urban environment, cities can optimize delivery routes, vehicle types, and infrastructure investments.

Key Lesson 2: Prioritize blockchain and dynamic routing technologies
Recommendation for transferability: Given the successful implementation and positive outcomes of blockchain and dynamic routing technologies in the pilot, it is strongly recommended that other cities prioritize the integration of these technologies into their urban logistics systems. These systems can significantly improve the efficiency, transparency, and sustainability of their logistics operations as they considering and address more uncertainty factors such as traffic (traffic aware dynamic routing case) and system failures on data tracking (blockchain case)

Key Lesson 3: Prioritize locker systems and UCC models for labor cost reduction
Recommendation for transferability: the data from Thessaloniki indicates a substantial potential for labor cost reduction through the implementation of locker alliance systems (50-60%) and Urban Consolidation Centers (UCCs) (70-80%). These solutions have demonstrated scalability across different geographic areas, with significant cost savings observed in both the municipality and the region.

Key Lesson 4: Prioritize CO2 reduction through locker systems and UCCs
Recommendation for transferability: The data from Thessaloniki clearly demonstrates the significant potential for reducing CO2 emissions through the implementation of locker systems and Urban Consolidation Centers (UCCs) (61.7% and 89.6%) . To maximize the transferability cities should conduct comprehensive emissions assessments by identifying the primary sources of CO2 emissions within the urban logistics system and continuously tracking and reporting them.

7. Conclusions

The work conducted in Deliverable 2.1 of the URBANE project has been instrumental in advancing the project's second key objective: the setup, prototyping, testing, and demonstration of innovative last-mile delivery solutions across four Lighthouse Living Labs (LLs). This deliverable offers a thorough analysis and validation of the implemented solutions, focusing on their operational effectiveness and sustainability across environmental, economic, and social dimensions, with the aim of replicating these solutions in other contexts and transferring them to Wave 2 LLs and Follower cities.

The evaluated measures were analysed for their effectiveness in achieving both local and project-level objectives, as well as in addressing the needs of stakeholders and consumers. This involved consolidating stakeholder clustering in each Lighthouse LL city, with several key objectives: mapping stakeholders in the different LLs, assessing the effectiveness and sustainability impact of URBANE LL innovations, identifying barriers and enablers to uptake, and evaluating the transferability potential of last-mile solutions.

The Lighthouse Living Labs have made substantial progress in addressing urban challenges like congestion, pollution, and emissions, directly contributing to several Sustainable Development Goals (SDGs). Key achievements include significant reductions in CO2 emissions, enhanced delivery efficiency through the use of electric and autonomous vehicles, improved working conditions, and the creation of new jobs in last-mile logistics. These outcomes affirm the potential of these innovations to sustainably transform urban logistics.

The process evaluation highlighted key success factors, such as strong commitment from local authorities and consumer interest, while also identifying persistent barriers, including challenges related to land use permissions, high investment costs, and reluctance in data-sharing. The evaluation emphasized the critical need to overcome these barriers to maximize the transferability and scalability of the solutions.

The lessons learned from the first wave of LLs provide valuable insights for future implementations. These include the importance of early stakeholder engagement, the necessity for a standardized approach to data collection, and the need for comprehensive regulatory frameworks to support innovation. The detailed recommendations provided for each use case serve as a guide for replication in Wave 2 LLs and other cities, ensuring that the lessons learned are effectively applied to further enhance urban logistics.

In conclusion, Deliverable 2.1 has laid a strong foundation for the ongoing development and scaling of innovative last-mile delivery solutions. The insights gained and the validated methodologies will be critical in guiding the URBANE project’s future efforts, ensuring that the project continues to make meaningful contributions to the EU's objectives for sustainable urban logistics

References

Aifandopoulou, Georgia, and Elpida Xenou. *Sustainable Urban Logistics Planning*. European Commission Directorate-General for Mobility and Transport, 2019.

Bjørgen, Astrid, and Marianne Ryghaug. 'Integration of Urban Freight Transport in City Planning: Lesson Learned'. *Transportation Research Part D: Transport and Environment*, vol. 107, June 2022, pp. 103310–103310, https://doi.org/10.1016/j.trd.2022.103310.

Buhl, Anke, et al. 'Design Thinking for Sustainability: Why and How Design Thinking Can Foster Sustainability-Oriented Innovation Development'. *Journal of Cleaner Production*, vol. 231, Sept. 2019, pp. 1248–57. *DOI.org (Crossref)*,https://doi.org/10.1016/j.jclepro.2019.05.259.*)*, https://doi.org/10.1016/j.jclepro.2019.05.259.

Campbell, Scott. 'Green Cities, Growing Cities, Just Cities?: Urban Planning and the Contradictions of Sustainable Development'. *Journal of the American Planning Association*, vol. 62, no. 3, Sept. 1996, pp. 296–312, https://doi.org/10.1080/01944369608975696.

Carlgren, Lisa, et al. 'Framing Design Thinking: The Concept in Idea and Enactment'. *Creativity and Innovation Management*, vol. 25, no. 1, Mar. 2016, pp. 38–57. *DOI.org (Crossref)*, https://doi.org/10.1111/caim.12153.

Commission Notice Technical guidance on the application of 'do no significant harm' under the Recovery and Resilience Facility Regulation 2021/C 58/01: https://op.europa.eu/en/publication-detail/-/publication/5dce0e53-718b-11eb-9ac9-01aa75ed71a1

D2.4 CIVITAS 2020 process and impact evaluation framework, SATELLITE: https://civitas.eu/sites/default/files/CIVITAS%202020%20Process%20and%20Impact%20Evaluation%20Framework.pdf, February 2020

D3.2 Modelling Framework and Agent-Based Models, URBANE, 2024

European Commission. A call to action on urban logistics, 2013.

Field, C.B., et al., Summary for policymakers, in Climate change 2014: impacts, adaptation, and vulnerability. Part A: global and sectoral aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. 2014, Cambridge University Press. p. 1-32.

Final list of proposed Sustainable Development Goal indicators: https://sustainabledevelopment.un.org/content/documents/11803Official-List-of-Proposed-SDG-Indicators.pdf

Foray, D., *Understanding smart specialisation.* The Question of R&D Specialisation, JRC, European Commission, Directorate General for Research, Brussels, 2009: p. 19-28.

Gaziulusoy, A. Idil, and Han Brezet. 'Design for System Innovations and Transitions: A Conceptual Framework Integrating Insights from Sustainablity Science and Theories of System Innovations and Transitions'. *Journal of Cleaner Production*, vol. 108, Dec. 2015, pp. 558–68. *DOI.org (Crossref)*, https://doi.org/10.1016/j.jclepro.2015.06.066.

Gianelle, C., et al., editors. *Implementing Smart Specialisation: A Handbook.* European Commission, 2016. *DOI.org (CSL JSON)*, https://data.europa.eu/doi/10.2791/610394.

Haarstad, Håvard, et al. 'Freight Logistics and the City'. *Urban Studies*, vol. 61, no. 1, Jan. 2024, pp. 3–19. *DOI.org (Crossref)*, https://doi.org/10.1177/00420980231177265.

Hoolohan, C., Browne, A.L. Design thinking for practice-based intervention: Co-producing the change points toolkit to unlock (un)sustainable practices, Design Studies, 67, 2020.

Government of Norway, Smart spesialisering som metode for regional næringsutvikling [Smart specialisation as a method of regional business development]. Ministry of Local Government and Modernisation. 2018.

Joyce, Alexandre, and Raymond L. Paquin. 'The Triple Layered Business Model Canvas: A Tool to Design More Sustainable Business Models'. *Journal of Cleaner Production*, vol. 135, Nov. 2016, pp. 1474–86. *DOI.org (Crossref)*, https://doi.org/10.1016/j.jclepro.2016.06.067.

Kimbell, Lucy. 'Rethinking Design Thinking: Part I'. *Design and Culture*, vol. 3, no. 3, Nov. 2011, pp. 285–306. *DOI.org (Crossref)*, https://doi.org/10.2752/175470811X13071166525216.

Kin, Bram, et al. 'Integrating Logistics into Urban Planning: Best Practices from Paris and Rotterdam'. *European Planning Studies*, Aug. 2023, pp. 1–21. *DOI.org (Crossref)*, https://doi.org/10.1080/09654313.2023.2242400.

NOVELOG website: https://cordis.europa.eu/project/id/636626/results

Rowe, P.G., *Design thinking*. 1987: MIT press.

STRAIGHTSOL website: https://cordis.europa.eu/project/id/285295/reporting

SULPiTER website: https://programme2014-20.interreg-central.eu/Content.Node/SULPiTER.html

Wilkerson, B. and Lars-Kristian Lunde Trellevik. *Sustainability-oriented innovation: Improving problem definition through combined design thinking and systems mapping approaches*, *Thinking Skills and Creativity*: https://doi.org/10.1016/j.tsc.2021.100932, Volume 42, December 2021.

8. Annexes

Annex 1: URBANE and SDGs KPIs

SDG – KPIs overview

SDGs	Project KPIs	Relevant SDG targets	Relevant SDG indicator(s)
Goal 3. Good health and well-being	Accidents involving freight vehicles	3.6	-
	People killed or seriously injured in collisions involving freight vehicles	3.6	-
Goal 4 Quality education	Education level	-	-
Goal 5 Gender equality	Gender diversity		5.5.2
Goal 7 Affordable and clean energy	R&D capability	7.a	
	Fuel cost (euros per litre) and electricity cost (euros per kWh)		7.1.2, 7.2.1, 7.1.3
Goal 8. Decent work and economic growth	Social inclusion	-	8.3.1
	Employment rate	-	
	Personnel turnover	8.8	-
	Average salary	-	8.5.1
	Percentage of self-employed workers	-	8.3.1
	Percentage of part-time workers	8.5	-
	Precariousness rate	8.5, 8.8	-
	Flexibility of working hours		-
	Percentage of remote work	-	8.5.x, 8.8.2?
	Return on investments	8.1	-
	Revenue growth	8.2	-
Goal 9. Industry, innovation, and infrastructure	CO2 emissions	-	9.4.1
	Average number of km per trip	9.4	-
	Average number of km per vehicle		-
	Total distance travelled in urban area		-
	Number of freight vehicles per category	9.1	-
	Time to complete a delivery route		-
	Average time for loading/unloading		-
	Number of loading/unloading areas		-
	Average vehicles speed per trip		-
	Average vehicles load factor		-
	Quality of transport services		-
	Number of unauthorised parking in the urban area or in a part of it		-
	Average deliveries per trip		-
	Total delivery costs		-
	Adoption rate of sustainable delivery options	-	9.1.2
	Presence of IT and AI driven optimisation system	-	9.b.1
	Degree of innovation of logistics companies	9.5, 9.5	-
	R&D capability	9.5	-
	Affordability of shared logistics services (cost of service's provision compared to the revenue growth of the companies)	9.1	-
10. Reduce inequality	Average salary	-	10.2.1
	Precariousness rate	-	10.2.1
Goal 11. Sustainable cities and communities	NO2 emissions	11.6	-
	PM10 emissions	-	11.6.2
	Noise level	11.6	-
	Social inclusion	-	-
	Waste production	-	11.6.1
	Accessibility of lockers (or B2C micro-hubs) to vulnerable users	11.2, 11.3	-
	Affordability of shared logistics services (cost of service's provision compared to the revenue growth of the companies)	11.2	-
	Air pollutant emissions indicator (SUMI 03)	-	11.6.2
Goal 12. Responsible consumption and production	Waste production	12.5	-
Goal 17. Partnership for the goals	Information accessibility	17.18	-

SDG- KPIs detailed links and explanations

Key Performance Indicator	4 - Education	5 - Gender	7 - Reliable and sustainable energy	8 - Decent work and economic growth	9 - Industry, innovation, and infrastructure	10 - Reduce inequality	11 - Sustainable cities and communities	12 - Responsible consumptions	13 - Climate action	17 - Partnerships for the goals	Comments
CO2 emissions					9.4.1						9.4.1 CO2 emission per unit of value added; in URBANE the definition is adapted to each Use Case to make it more representative of specific innovations.
NO2 emissions							11.6.x				Not mentioned, but is related to 11.6 reduce the adverse per capita environmental impact of cities
PM10 emissions							11.6.2				Not mentioned, but is related to 11.6 reduce the adverse per capita environmental impact of cities
Noise level							11.6.x				Not mentioned, but is related to 11.6 reduce the adverse per capita environmental impact of cities
Fuel consumption per Km			7.a								Not mentioned but is related to 7.a enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology
Average number of km per trip					9.4.1						9.4.1 CO2 emission per unit of value added; current technology implies that shorter trips

											reduce CO2 emissions
Average number of km per vehicle					9.4.1						9.4.1 CO2 emission per unit of value added; current technology implies that shorter trips reduce CO2 emissions
Total distance travelled in urban area					9.4.1						9.4.1 CO2 emission per unit of value added; current technology implies that shorter trips reduce CO2 emissions
Number of freight vehicles per category					9.1.2						9.1.2 Passenger and freight volumes, by mode of transport: mode of transport serves as an indicator of other KPIs, e.g. CO2 emissions
Time to complete a delivery route					9.1.2						
Average time for loading/unloading					9.1.2						
Number of loading/unloading areas					9.1.2						
Average vehicles speed per trip					9.4.1						9.4.1 CO2 emission per unit of value added; current technology implies that steady lower speeds reduce CO2 emissions
Average vehicles load factor					9.1.2						
Quality of transport services					9.1.2						
Number of unauthorised parking in the urban area or in a part of it					9.1.2						
Average deliveries per trip					9.1.2						
Total delivery costs					9.1.2						
Investment in clean energy networks and vehicles			7.b.1								Investments in energy efficiency
Value of goods lost for theft or damage											None
Average logistics costs on turnover											Maybe related to 9.1?
Accidents involving freight vehicles											
People killed or seriously injured in collisions involving freight vehicles				8.8.1							8.8.1 Fatal and non-fatal occupational injuries per 100,000 workers, by sex and migrant status

Awareness level											If related to some sustainability issue, but not clear here
Residents’ acceptance level (Helsinki: (NPS score, service level rating, acceptance incentives) (>70%))											None, as residents' acceptance levels may be unrelated to, or in conflict with SDG goals and targets
Social inclusion				8.3							Proportion of informal employment
Waste production											Proportion of urban solid waste, substantially reduce waste generation
Safety of deliveries (no damages)											Not relevant
Security of deliveries (no losses or thefts)											Not relevant
Employment rate				8.3							Proportion of informal employment
Personnel turnover											Perhaps related to Protect labour rights
Average salary				8.5.1	10.2						Average hourly earnings (8.5.1), Proportion of people living below 50 per cent of median income of median income (10.2.1)
Education level	x										there are two ways we contribute, both in terms of measuring education level and in terms of educating the last milers
Gender diversity		x									Proportion of women in the logistics industry
Percentage of self-employed workers											Perhaps related to Protect labour rights
Percentage of part-time workers											Related to full and productive employment
Precariousness rate											Proportion of people living below 50 per cent of median income
Flexibility of working hours											Perhaps related to Protect labour rights

Percentage of remote work											If related to some sustainability issue, but not clear here
Percentage of customers willing to pay a premium for faster delivery											None, as residents' acceptance levels may be unrelated to, or in conflict with SDG goals and targets
Adoption rate of sustainable delivery options											Passenger and freight volumes, by mode of transport
Failures in the IT system											Might be related to SDG 17 on technology
reverse geofencing integration system											Might be related to SDG 17 on technology
Presence of IT and AI driven optimisation system											Support domestic technology development, might be related to SDG 17 on technology?
Degree of innovation of logistics companies											Upgrade infrastructure and retrofit technological capabilities of industrial sectors industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action, Enhance scientific research, upgrade the technological capabilities of industrial sectors
Parcel Lockers fill rate (B2C)											If related to some sustainability issue, but not clear here
Number of PuDo in the demo area											If related to some sustainability issue, but not clear here
Information accessibility										17.18	Proportion of sustainable development indicators produced at the national level

Number of failed deliveries per trip											Unsuccessfully delivered parcels involve considerably greater last mile (vehicle) involvement. The parcel needs to be returned to a logistics warehouse, and a new delivery attempt made, or it can be sent to a parcel locker in some cases. Minimising failed deliveries improves utilisation efficiency of vehicles. Affects Passenger and freight volumes, by mode of transport
Return on investments											Sustain per capita economic growth
Responsiveness to changes											If related to some sustainability issue, but not clear here
Revenue growth											Achieve higher levels of economic productivity
R&D capability											enhance international cooperation to facilitate access to clean energy research and technology, Enhance scientific research, upgrade the technological capabilities of industrial sector
Parking accessibility in existing consolidation/logistics hubs (micro hubs, consolidation centres e.tc.)											If related to some sustainability issue, but not clear here
Accessibility of lockers (or B2C micro-hubs) to vulnerable users											Provide access to safe, affordable, accessible and sustainable transport, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement

											planning and management
Affordability of shared logistics services (cost of service's provision compared to the revenue growth of the companies)											Develop quality, reliable, sustainable and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all
Fuel cost (euros per litre) and electricity cost (euros per kWh)											Proportion of population with primary reliance on clean fuels and technology, Renewable energy share in the total final energy consumption, Energy intensity measured in terms of primary energy and GDP
Air pollutant emissions indicator (SUMI 03)											Annual mean levels of fine particulate matter (e.g. PM2.5 and PM10) in cities (population weighted)

Annex 2: URBANE and DNSH Principles

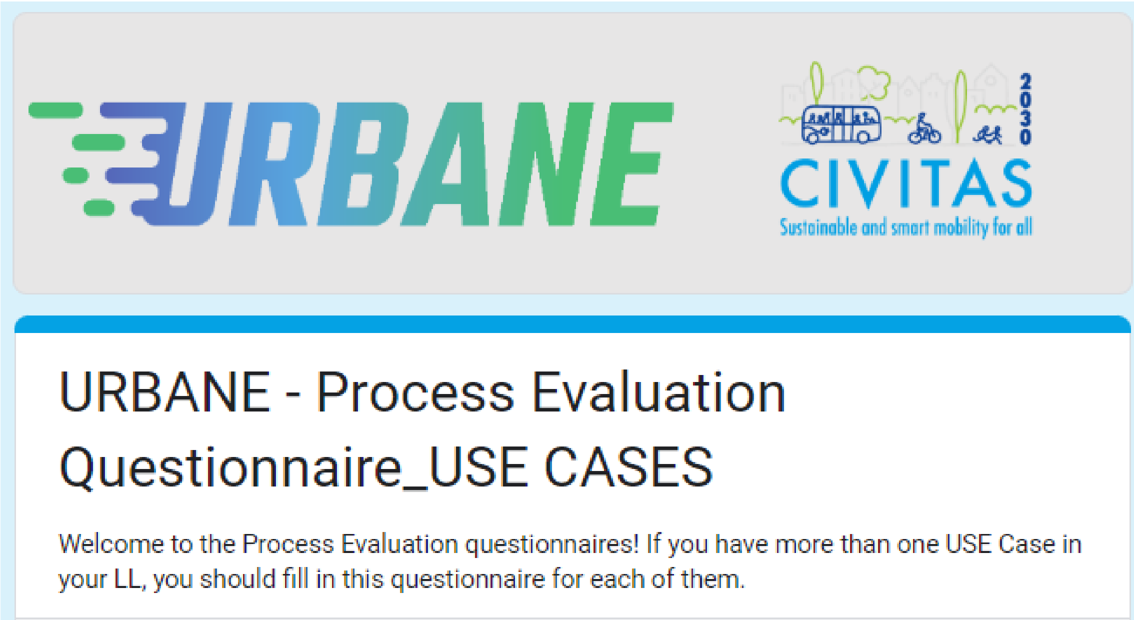
TABLE 40 URBANE AND DNSH PRINCIPLES

ID	Key Performance Indicator	Link to DNSH Principle					
		Climate change mitigation	Climate change adaptation	Sustainable use & protection of water & marine resources	Pollution prevention & control	Transition to a circular economy	Protection and restoration of biodiversity & ecosystems
L1	CO2 emissions	1					
L2	NO2 emissions	1					
L3	PM10 emissions				1		
L5	Noise level				1		
L8	Fuel consumption per Km	1					
L9	Average number of km per trip				1		
L10	Average number of km per vehicle				1		
L11	Total distance travelled in urban area				1		
L13	Number of freight vehicles per category	1			1		
L14	Time to complete a delivery route	1			1		
L15	Average time for loading/unloading	1					
L16	Number of loading/unloading areas	1					
L17	Average vehicles speed per trip	1					
L18	Average vehicles load factor				1		
L19	Quality of transport services						
L20	Number of unauthorised parking in the urban area or in a part of it						
L22	Average deliveries per trip						
L24	Total delivery costs						
L25	Investment in clean energy networks and vehicles	1					
L26	Value of goods lost for theft or damage						
L27	Average logistics costs on turnover						
L28	Accidents involving freight vehicles						
L29	People killed or seriously injured in collisions involving freight vehicles						

L32	Awareness level						
L33	Residents' acceptance level (Helsinki: (NPS score, service level rating, acceptance incentives) (>70%))						
L34	Social inclusion						
L35	Waste production					1	
L36	Safety of deliveries (no damages)						
L38	Security of deliveries (no losses or thefts)						
L39	Employment rate						
L40	Personnel turnover						
L41	Average salary						
L42	Education level						
L43	Gender diversity						
L44	Percentage of self-employed workers						
L45	Percentage of part-time workers						
L46	Precariousness rate						
L47	Flexibility of working hours						
L48	Percentage of remote work						
L49	Percentage of customers willing to pay a premium for faster delivery						
L50	Adoption rate of sustainable delivery options						
L51	Failures in the IT system						
L52	reverse geofencing integration system						
L53	Presence of IT and AI driven optimisation system						
L54	Degree of innovation of logistics companies						
L55	Parcel Lockers fill rate (B2C)						
L56	Number of PuDo in the demo area						
L57	Information accessibility						
L58	Number of failed deliveries per trip						
L59	Return on investments						
L60	Responsiveness to changes						
L61	Revenue growth						
L62	R&D capability						
L63	Parking accessibility in existing consolidation/logistics hubs (micro hubs, consolidation centres e.t.c.)						
L64	Accessibility of lockers (or B2C micro-hubs) to vulnerable users						
L65	Affordability of shared logistics services (cost of service's						

	provision compared to the revenue growth of the companies)						
L66	Fuel cost (euros per litre) and electricity cost (euros per kWh)				1		
L67	Air pollutant emissions indicator (SUMI 03)				1		

Annex 3: Online Process Evaluation Questionnaires


URBANE - Process Evaluation Questionnaire_USE CASES

Welcome to the Process Evaluation questionnaires! If you have more than one USE Case in your LL, you should fill in this questionnaire for each of them.

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Who are you? *

- ◯ Courier & Transport Operators
- ◯ Urban distribution hub/centre Operators
- ◯ Fleet Owners
- ◯ Technology Providers
- ◯ Researchers/Consultants
- ◯ Urban planners and regulators
- ◯ Civil Society
- ◯ Altro: ____________

Which is your main role in the project? *

La tua risposta

In your Region, to what extent do business and universities collaborate on research and development (R&D)? *

	1	2	3	4	5	6	7	
Not at all	○	○	○	○	○	○	○	To a great extent

Which Use Case do you want to evaluate? *

- ○ BOLO 1: Nearby Delivery Areas with unattended lockers
- ○ VAL 1: Monitoring of loading and unloading areas using artificial intelligence (+booking app)
- ○ VAL 2: Access control to the pedestrian zone using AI
- ○ VAL 3: Techno-economic comparison of the use of combustion vehicles, commercial electric vehicles and IFEVS prototype vehicles for the activities of the urban mobility centre of the municipality
- ○ VAL 3: Implementation of an innovative and sustainable solution of contactless parcel delivery
- ○ HEL 1: ADV for the last-mile deliveries of tools, materials and supplies from a construction material and supply shop in the Kalasatama/Söörnäinen district to construction sites near-by
- ○ HEL 2: Microhub in the city center
- ○ HEL 3: Microhub in the city center (To be further defined)
- ○ THES 1: Operation of Hub and Spoke delivery model (Parcel Lockers) supported by Digital Twin
- ○ THES 2: Simulation for the ideal composition of new fleet (EVs) and services

Barriers and drivers

In the following questions, we ask you to indicate the possible barriers that could prevent the correct implementation of the use cases you have selected and the pursuit of your LL objectives. On the other hand, we also ask you to indicate what possible drivers could instead facilitate the correct implementation of the use case and, in the future, a possible upscaling of the demonstrated innovation.
Please, provide arguments for each answer contextualizing the driver or barrier in your city.

What are the POLITICAL/INSTITUTIONAL barriers that you could encounter in implementing this use case? (e.g. lack of commitment to sustainable objectives, lack of interest/competence in urban logistics or innovation, burocratic /administrative procedures slowing down permits etc.)

La tua risposta

What are the possible POLITICAL/INSTITUTIONAL drivers?

La tua risposta

What are the ECONOMICAL/FINANCIAL barriers that you could encounter in implementing this use case? (e.g. the solution is not fincially sustainable, investment/operational costs not easy to be estimated etc.)

La tua risposta

What are the possible ECONOMICAL/FINANCIAL drivers?

La tua risposta

What are the SOCIAL barriers that you could encounter in implementing this use case? (e.g. willingness to collaborate, residents acceptance, consumer willingness to shift to sustainable options, employment, work conditions, safety concerns etc.)

La tua risposta

What are the possible SOCIAL drivers?

La tua risposta

What are the ECONOMICAL/FINANCIAL barriers that you could encounter in implementing this use case? (e.g. the solution is not fincially sustainable, investment/operational costs not easy to be estimated etc.)

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What are the possible ECONOMICAL/FINANCIAL drivers?

La tua risposta

What are the SOCIAL barriers that you could encounter in implementing this use case? (e.g. willingness to collaborate, residents acceptance, consumer willingness to shift to sustainable options, employment, work conditions, safety concerns etc.)

La tua risposta

What are the possible SOCIAL drivers?

La tua risposta

What are the TECHNOLOGICAL barriers that you could encounter in implementing this use case? (e.g. lack of data unit standardisation, technological malfunctions, lack of digital competences etc.)

La tua risposta

What are the possible TECHNOLOGICAL drivers?

La tua risposta

What are the DATA/INFORMATIONAL barriers that you could encounter in implementing this use case? (e.g. willingness to share strategic information, excessive effort required to share data, data standardisation, data analysis etc.)

La tua risposta

What are the possible DATA/INFORMATIONAL drivers?

La tua risposta

What are the ENVIRONMENTAL barriers that you could encounter in implementing this use case? (e.g. Climate change, Weather conditions, Pressure from NGOs etc.)

La tua risposta

What are the possible ENVIRONMENTAL drivers?

La tua risposta

What are the LEGAL/REGULATION barriers that you could encounter in implementing this use case? (e.g. lack of specific regulation for some of the technologies, lack of clarity on the roles and responsibilities etc.)

La tua risposta

What are the possible LEGAL/REGULATION drivers?

La tua risposta

Final Remarks

General notes *

Please shortly provide some general notes regarding the implementation of your Use Case, that you're like to add.

La tua risposta

Queries and comments *

Please shortly provide your queries and comments regarding the evaluation process.

La tua risposta

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