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GREEN-LOG

DELIVERABLE

D1.1 – Knowledge Base of Last-mile Solutions and GREEN-LOG requirements specification

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Executive Summary

This report presents the results of the first six months of work in the GREEN-LOG project with Task 1.1 and Task 1.2 to deliver a 'Knowledge Base of Last-Mile Solutions and GREEN-LOG Requirements Specifications' according to the specification of Deliverable 1.1 in the Grant Agreement (GA). D1.1 is a technical report that frames the background and expected developments of city logistics in Europe and establishes user requirements through living labs formulation. This report targets GREEN-LOG Objective 1 implemented in WP1 with the measurable results R1.1 Knowledge base of best practices, lessons learnt, and impacts and R1.2 The GREEN-LOG Urban Living Lab methodology and the creation of Urban Living Labs. The results documented in the current deliverable are verified through the following KPIs; a) more than thirty (30) last mile interventions and best practices analysed and b) five (5) Urban Living Labs (LL) established in corresponding EU member states and Oxfordshire.

Task's 1.1 objective is to enhance the understanding of best practices and procedures employed by city logistics systems, aiming at facilitating innovation management. To achieve this, the task analyses a range of EU initiatives / projects and studies through thorough desk research, aiming to identify effective solutions and best practices, but also key actors and stakeholders in city logistics business ecosystems. It starts with exploring stakeholder clusters, along with their goals and needs and continues by analysing clusters of solutions with their corresponding barriers and opportunities, while also acknowledging any challenges faced.

Based on the analysis performed, city logistics ecosystems are increasingly interested in adopting electric vehicles (EVs) due to their advantages such as lower operating costs and reduced environmental impact. However, barriers such as a lack of charging infrastructure, limited driving range, and high initial investment hinder their widespread adoption. Other challenges include safety concerns, limited cargo space, and uncertainties regarding resale value and future electricity prices. The sector also explores solutions like autonomous vehicles, customer movement optimization through parcel lockers, consolidation centres, and microhubs, as well as delivery system improvements and crowdsourcing, but each of these approaches has its own set of barriers, opportunities, and challenges that need to be considered.

Task 1.2 has as its main objectives to engage all the stakeholders of the pilot cities to set up local LLs, and work together to identify local requirements in terms of scoping main challenges, barriers, and stakeholders. The task also included creating support structure to share and align knowledge and ideas for how to proceed with establishing the LLs by overcoming these challenges. During this process, the ambition is to create common understandings and synthesise the enrolled actors' different goals, interests, and agendas into common visions. Based on this work, this task also includes creating a cross-country LL activity plan and an action list that organises joint LL activities throughout the lifetime of the project and formulate a common GREEN-LOG LL approach.

This report provides a baseline for the GREEN-LOG LL approach that has been developed through a row of co-creative scoping activities within and across the pilot cities LLs. This baseline provides an overview of the LL contexts, identified local requirements in terms of goals, challenges and success factors, as well as the main barriers and key questions to address to be able to establish the LL. Furthermore, the report also presents an overview of how the LL stakeholders have chosen to organise themselves in terms of which stakeholders are in the core, involved and informed teams respectively, possible locations for implementing the pilots and tentative User journeys.

In sum, the scoping process demonstrates that the main challenges across the LLs can be divided into administrative, organisational, economical, technical, and social challenges. The specificities of each category are provided below:

- Administrative challenges include establishing agreements between stakeholders and gaining permissions for implementing pilots in different locations.
- Organisational challenges mean finding the right locations, reaching the right local stakeholders, organising effective communication among the LL stakeholders, and defining added value to create win-win situations.
- Economic challenges deal with finding business models and getting necessary resources together.
- Technical challenges include overcoming technical issues in the time available whilst adapting in a rapidly developing field, balancing technology research vs implementation and creating technology that supports user needs.
- Social challenges deal with how all stakeholder categories, including citizens, can be reached, and engaged in the LLs.

In the same vein, LLs have identified a set of main questions that are relevant to work with across the different LLs in coming joint activities and that can be clustered into the following categories: Stakeholder Involvement, Citizen Engagement, Translation and Implementation, Scaling, and LL Sustainability. The joint activities will be organised through continuous Meet-Ups where the LL core teams will engage in cross-country discussions and co-creation activities in solving and generating ideas around the key questions. This concludes the GREEN-LOG LL formulation that demonstrates a tailored way to develop and establish sustainable and cost-efficient cooperative last-mile delivery solutions in the LL format prescribed in the GA that relies on the quadruple helix of co-creating and facilitating collaboration between private and public bodies and citizens.

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1.0	30-06-2023	INTRA	Final QA'ed version

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Definitions, Acronyms and Abbreviations

Acronym/Abbreviation	Title
AGV	Automated Ground Vehicles
EFV	Electric and Fuel-efficient Vehicles
EV	Electric Vehicle
FAA	Federal Aviation Administration
IoT	Internet of Things
IR	Internal Reviewers
KPI	Key Performance Indicator
LaaS	Logistics as a Service
LL	Living Lab
LSP	Logistics Service provider
RQ	Research Question
SADR	Sidewalk Automated Delivery Robots
UCC	Urban Consolidation Centre
UFT	Urban Freight Transport
WP	Work Package

1 Introduction

1.1 Document scope

This report presents the result of the first six months work in the GREEN-LOG with task 1.1 and task 1.2 to deliver a 'Knowledge Base of Last-Mile Solutions and GREEN-LOG requirements specification' according to the specification of Deliverable 1.1 in the Grant Agreement.

1.2 Document structure

The document is divided into six main chapters.

Chapter 1 is the introductory section of this deliverable, while section 2 describes the objectives and methodology of this report.

Chapter 3 provides a knowledge base of replicable, safe, and sustainable last-mile solutions which collects a set of best practices and procedures that city logistics systems follow to adopt new solutions (or set of solutions) with emphasis on green vehicles classifications, to manage innovation and to contribute to the priorities of the European Green Deal. This in-depth desk research review based on a selection of EU projects and initiatives also presents clusters of main actors and primary, secondary, and tertiary stakeholders who operate in well-performing city logistics business ecosystems.

Chapter 4 formulates local contexts in each of the Living Labs; key partners, objectives, local sites and key challenges. The overview provided this chapter is based on contractual information (according to the GA), together with outcomes from bilateral interviews and collaborative alignment workshops. The purpose of holding such interviews and workshops was to give each LL opportunities to align their goals and visions with coming activities both between the stakeholders in each LL as well convey and discuss their unique needs and other features to other LLs.

Chapter 5 is a presentation of the results from the scoping activities within and across the LLs where the local agents representing the corresponding LL have had opportunities through digital workshops (so called 'Meet-Ups') across and within the LLs to formulate their common agendas by discussing key barriers and success factors, identifying local sites for implementation, the LL organisational structures and tentative user journeys. The key questions raised by the LLs have been clustered into five themes to create a foundation for upcoming joint activities for co-learning and co-creation of ideas on relevant topics, so called 'trading zones'. The different Meet-Ups were organised and facilitated by HALM as T1.2 leaders to establish the start-up of the GREEN-LOG LLs and to create an overview to be developed into a future collaborative trading zone structure across the LLs that plans and organises upcoming joint LL activities based on the local requirements and demands.

Finally, Chapter 6 presents the conclusions of this deliverable.

2 Objectives and Methodology

2.1 Objectives

The current deliverable (D1.1) targets the following objectives. Section 3 in the current report targets Objective 1.1a and 1.1.b:

- Obj.1.1.a. frames the background and expected developments of last mile solutions in Europe so that we cover the most relevant aspects; and
- Obj.1.1.b. identifies the actors involved in the ecosystems, analyses their roles and responsibilities.

Section 4 and 5 in the current report provide the baseline for Objective 1.2a and b. More specifically:

- Obj.1.2.a. defines the living lab approach for designing sustainable and cost-efficient cooperative last mile delivery solutions; and
- Obj.1.2.b. creates trading zones in which stakeholders co-create and learn from each other without being hampered of conflicting interests and agendas.

The interaction of T1.1 and T1.2 with other WPs and tasks is depicted in Figure 1 (Note: “X” means that the source task feeds all tasks in the respective WP/task).

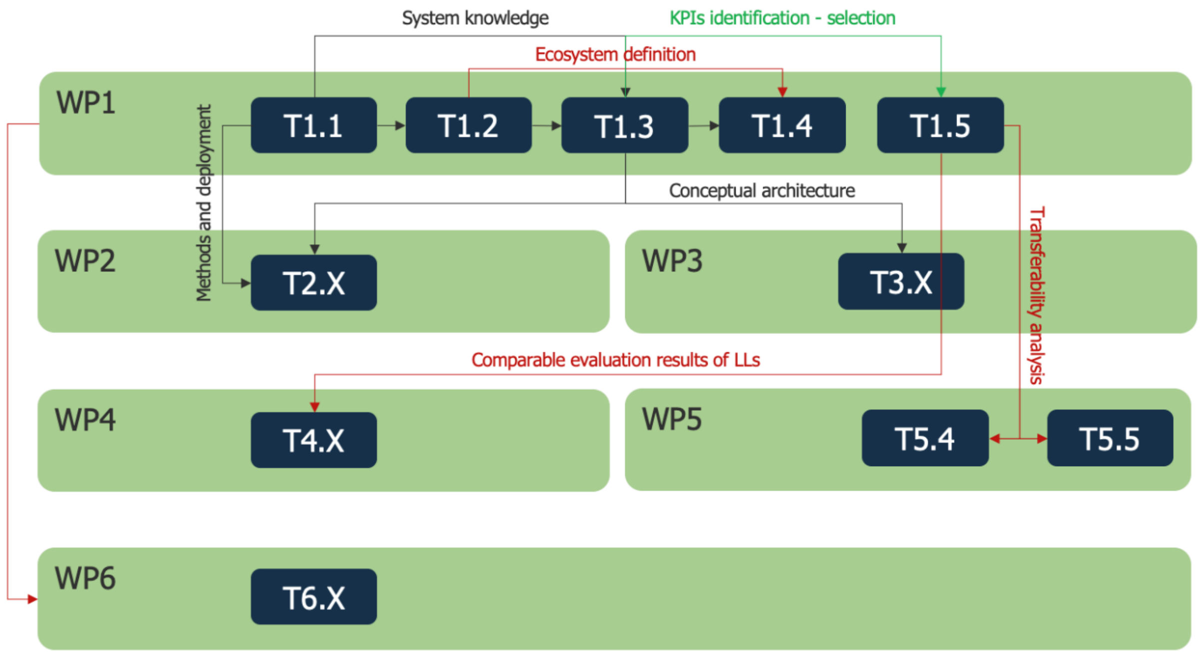

Figure 1: Task 1.1 and Task 1.2 in the sequence of the WP1 implementation plan

2.2 Literature Review Methodology for Knowledge Base

To lay the foundation for the project, the following initial steps were taken to gather relevant information and insights. First, desk research was performed aiming at providing valuable insights on stakeholders' relationships, goals and needs, but also at updating those insights, given the dynamic nature of the urban freight transport systems and the evolution of technological solutions. Second, a systematic literature review was conducted to identify best practices in terms of solutions' implementation as well as opportunities and follow-up actions based on the best practices discovered. During this task, barriers, opportunities and challenges or any other element that was perceived as important along the way were additionally recorded to formulate the GREEN-LOG Knowledge Base.

2.3 Establishing Co-creative LL Methodology

Living Labs (LL) is a pluralistic approach centred around bringing together diverse sets of stakeholders often in new formations to co-create products and services in complex settings ([REF-01]; [REF-02]). LL Co-creation refers to the collaborative and participatory process where stakeholders, including researchers, industry representatives, government officials, and citizens, actively contribute their knowledge, insights, and expertise to jointly design, develop, and refine innovative solutions and services. LL Co-creation has to be tailored to the local social and cultural context and can be organised through inclusive and iterative processes that involve engaging diverse stakeholders, fostering open dialogue, facilitating knowledge exchange, and providing opportunities for collaborative decision-making and experimentation.

While most LLs focus on opening up the interaction between end-users and private actors for technology development through a triple helix perspective, the GREEN-LOG Living Lab model has a specific focus on urban and civic innovation through quadruple helix co-creation to facilitate spatially embodied collaboration between private bodies and the civil society in order to create sustainable products and services ([REF-03]; [REF-04]). Triple Helix Living Labs primarily emphasize collaboration between academia, industry, and government, with a focus on research, technology transfer, and economic growth. In contrast, Quadruple Helix Living Labs incorporate an additional stakeholder group, namely, civil society or citizens, to promote active participation, co-design, and co-governance in the innovation process. While Triple Helix Living Labs predominantly seek to foster technological advancements and commercialization of research outcomes, Quadruple Helix Living Labs strive for societal relevance by addressing pressing societal challenges and incorporating the perspectives and needs of citizens in the innovation process. According to the GA, GREEN-LOG LL emphasizes social innovation through co-design and co-creative activities with local stakeholders (including citizens) through its quadruple helix approach to generating ideas for sustainable future city logistics rooted in the urban context of each Living Lab.

These ambitions are in the GREEN-LOG project being reflected in the chosen approach to establishing the LLs through *Scoping* activities as it is proposed by Smith & Iversen [REF-05] as a stage 0 phase in participatory design projects, followed by dimensions of *Developing*, and *Scaling*. The Scoping dimension involves pre-defined stakeholders in co-design activities and timelines to initiate the development of protagonist communities within the LL. A protagonist community refers to a group of individuals or stakeholders who actively take a leading role in initiating and driving positive change within their community, often through grassroots efforts, collective action, and engagement in decision-making processes. To facilitate protagonist communities with local drivers to develop in the LL is crucial for the staging long-term change beyond the project ends. This stage begins earlier than in traditional participatory design projects, with an extended Stage 0 period for co-exploration and the emergence of relevant participants and research questions. User definition and participation configuration are integral parts of the project and community itself, rather than being determined solely by researchers. The focus is on uncertain and messy activities beyond the core research, fostering dialogues and common understandings among stakeholders and researchers.

This report presents the tailored GREEN-LOG scoping activities that have been set in motion to create a sense of a joint beginning of a GREEN-LOG LL Journey among the LL teams in the project, a baseline from which a common understanding is being built of where we are now, what challenges we are facing and how we can collaborate in response to these challenges to succeed. The project's Task 1.2 has in its core to formulate and establish five Living Labs: engage key stakeholders of the pilot sites, articulate local requirements (barriers and opportunities), and synthesise enrolled actors' different goals, interests, and agendas into a common vision for what the pilot demonstration will achieve and do.

The scoping stage of establishing the five GREEN-LOG LLs during M1-M6 in the project is reported in the following sections and is based on the result of different points of interaction, which the task leaders have facilitated, for the LLs to formulate their approach, in the following way. The methodology of the first introductory phase of the scoping stage is presented in 2.3.1 and the second scoping stage is presented in 2.3.2.

2.3.1 Introducing LLs

The result of the introductory phase of the scoping stage is presented in section 4 of the current report. The points of interaction between the Task 1.2 leaders (HALM) and the LL core teams during this phase are provided below.

20th March 2023: Invitation of Living Labs to get in touch with HALM with two (2) contact persons (ideally one that represents the city and one technology provider) and 1-6 representatives from each Living Lab who will participate in the three planned digital workshops (Meet-Up 1, Meet-Up 2 and Meet-Up 3).

29th March 2023: Participation of GREEN-LOG consortium in the digital "Lunch & Learn Conversation on Living Labs: past, now and future" organized by the HALM.

Week 13-15, 2023: Initial short interview conducted by HALM of each LL's contact people with the goal to map already existing LL activities, to discuss how future activities are imagined and to present/discuss the Meet-Up 1. The interviews were guided by questions regarding the LL stakeholders experiences of the GREEN-LOG project so far; their ideas about what a LL is, their previous LL experiences, the expectations and anticipations of the GREEN-LOG LLs and how they envisioned their collaborations to be organised; in what part of their city they would like to start to implement the solutions and why; and what they imagine they would learn from this particular LL approach both within and between the LLs.

2.3.2 LL Scoping: Aligning Goals and Visions

In the second phase of the scoping stage, a tailored series of Meet-Ups were organised to facilitate the establishment of the GREEN-LOG LLs. The scoping activities included formulating and developing vision and goals based on the GA, defining possible local stakeholders and the LL inner organisation and activities, key questions to explore through the LL framework both within and between the LLs, and possible user journeys in the pilot cities and joint activity plans across the LLs. These activities are presented in more detail in the current section.

During **week 16-19 2023**, HALM organised a series of individual Living Lab Meet-Ups in order to co-create their corresponding LL-journey with a focus on goals, needs, barriers, opportunities and in order to identify key stakeholders. In Figure 2 and Figure 3 there are screenshots from the collaboration platform in MIRO used during the Meet-Ups for feedback acquisition.

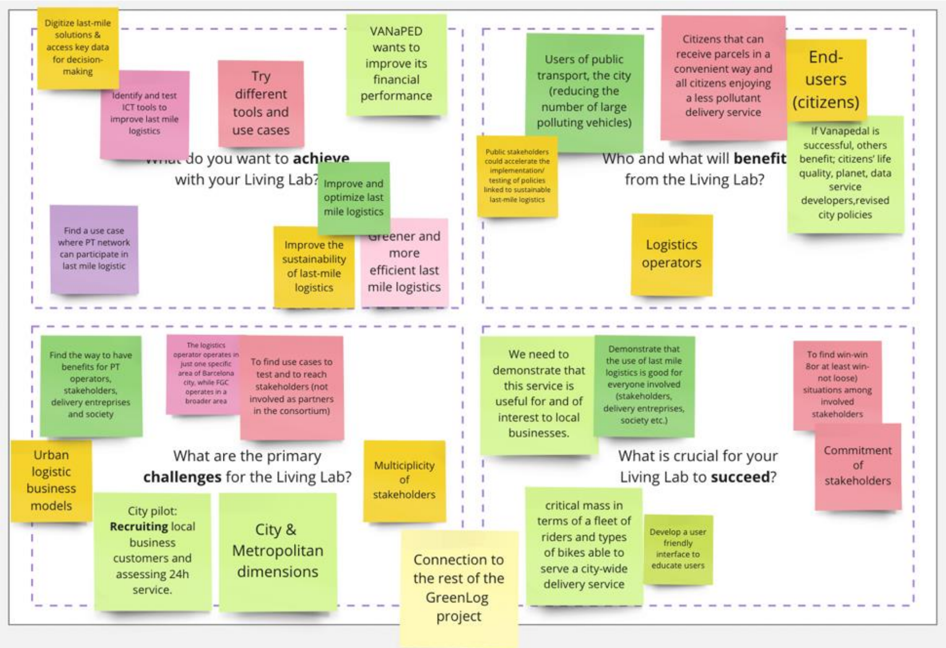

Figure 2: Example from MIRO board used during Meet-Up 1 to define Goals & Visions

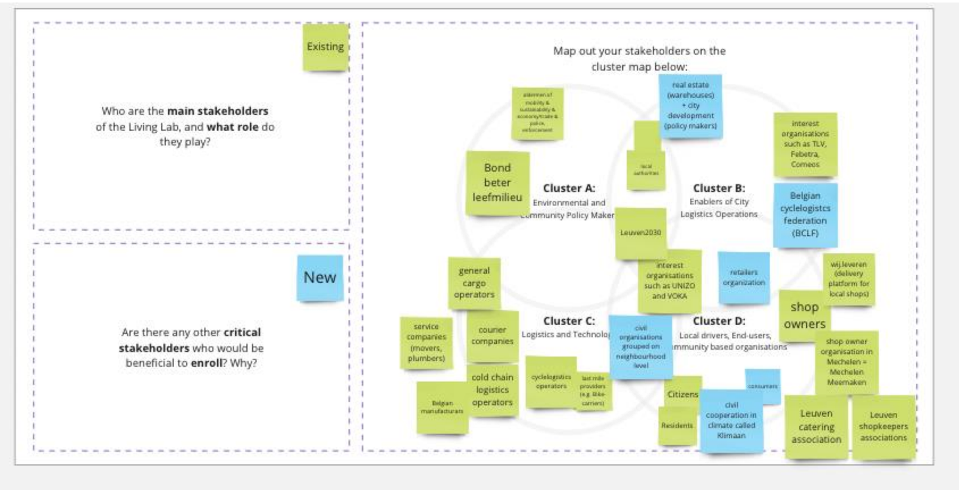

Figure 3: Example from MIRO board during Meet-Up 1 to define stakeholders with input from Task 1.1

On the **10th of May 2023,** GREEN-LOG consortium participated in the second digital Lunch & Learn conversation on Co-Designing Future Mobility – How to stage cross-sectoral and inter-generational design practices.

On the **25th of May 2023,** HALM organised Meet-Up 2. This was a joint LL Meet-Up across the LLs to initiate the work on establishing an activity plan by identifying a core team and a collaborative structure with involved and informed stakeholders, and on identifying different users and their possible user journey while interacting with the suggested service. In Figure 4 and Figure 5 there are screenshots from the interactive MIRO board used during the Meet-Up 2.

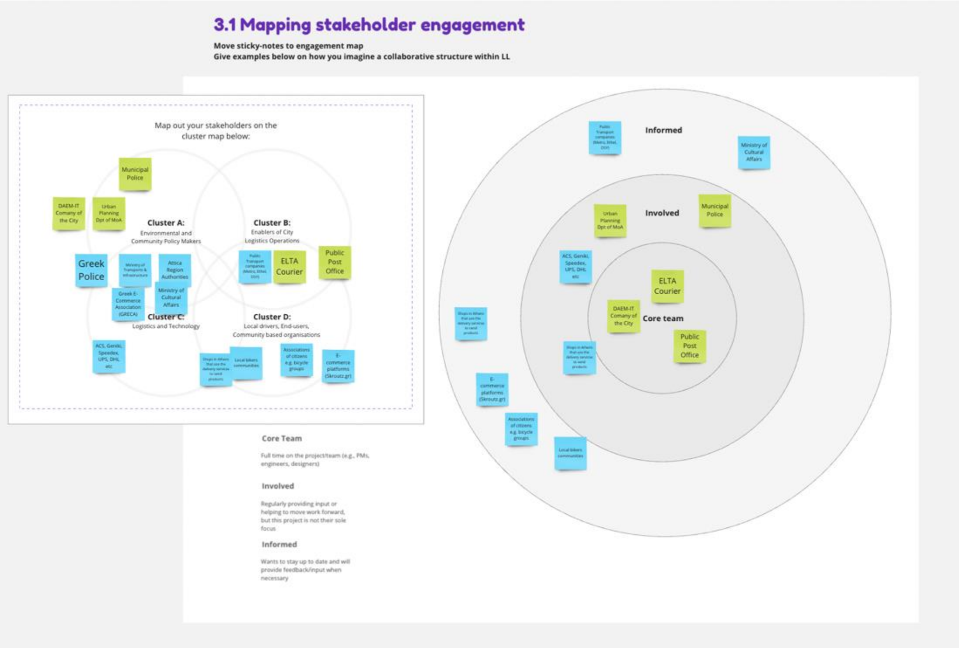

Figure 4: Example from MIRO board in Meet-Up 2 for mapping local LL organization and stakeholders.

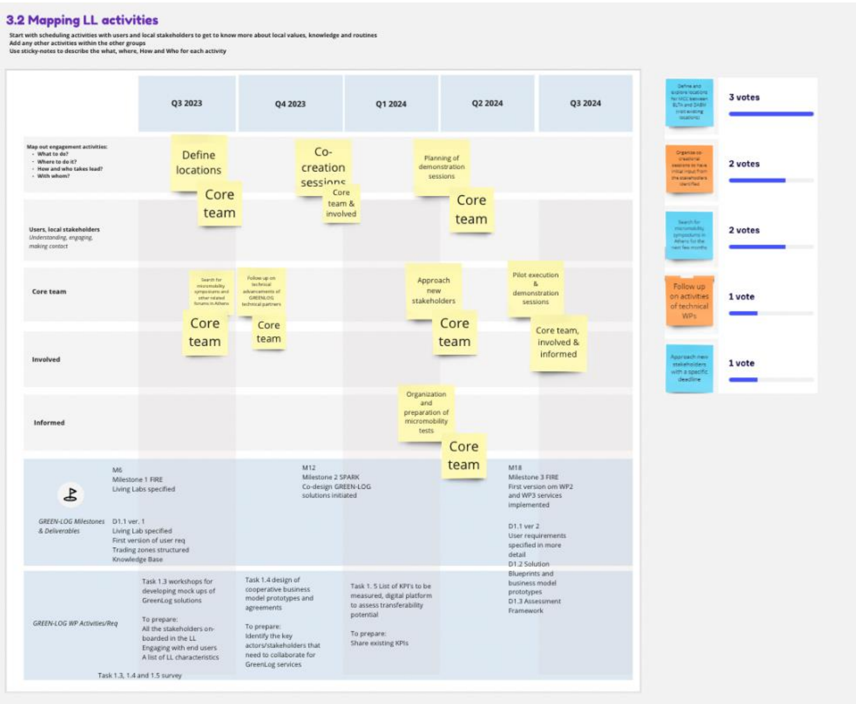

Figure 5: Example from MIRO board in Meet-Up 2 for mapping LL activities.

On the **16th of June 2023**, HALM organised Meet-Up 3. This included presentations from the different Living Labs to conclude the initiated scoping work that had started in Meet-Up 2, and at the same time to try out a structure for trading zones based on LL key questions.

The scoping report for each LL is presented in the current section. Each LL was invited to provide the following information:

- Top four things to achieve
- Geographical orientation
- User journey ideas
- LL organisation
- Top 3 challenges
- Top 3 success factors

Indicatively, Figure 6 provides a snapshot from Meet-Up 3, and questions addressed by Oxfordshire LL participants. The whole MIRO board for this Meet-Up can be viewed HERE.

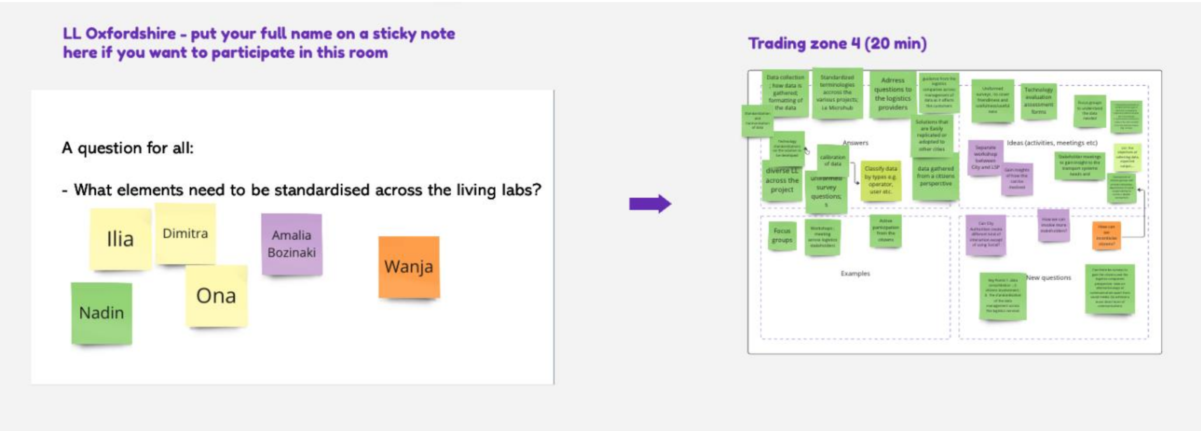

Figure 6: Example from MIRO board in Meet-Up 3 trying out a way to organize cross-country LL digital trading zones based on key questions raised by LLs.

3 Knowledge Base of Replicable, Safe and Sustainable Last-mile Solutions

This section aims to report the work performed in the context of T1.1 "Knowledge Base of Replicable Safe and Sustainable Last-mile Solutions" and specifically, to identify solutions and best practices around replicable, safe and sustainable last-mile solutions by analysing research studies and EU projects & initiatives. There are two Research Questions (RQs) that need to be addressed:

- RQ1: What are the current stakeholder relationships, goals, and needs in the dynamic urban freight transport system, and how are they updated in the context of evolving city logistics solutions and their related business models?
- RQ2: What are the best practices for implementing city logistics solutions, and how can opportunities and follow-up actions be identified based on these best practices? Additionally, what are the barriers, challenges, and other important aspects in the implementation process?

The two aforementioned RQs are answered separately in the following subsections (Section 3.1 & 3.2).

3.1 Stakeholders

Clarkson [REF-06] suggests that the satisfaction of a system's development is dependent on the level of satisfaction perceived by all the categories of stakeholders involved in it. A city logistics system is characterized as being open and continuously evolving, with the existence of different stakeholder groups having conflicting goals, varying degrees of autonomy, and differing perspectives. Thus, the effective implementation of a solution is heavily reliant on properly identifying the stakeholders and ensuring they work together in a harmonious manner.

There are multiple stakeholder categories that can be identified in the literature. Table 1 shows an indicative list of highly cited research papers which categorise stakeholders in the field of city logistics. At the bottom of the same table, recent research papers findings are also presented to ensure that the knowledge is up to date. It should be noted that the sample of the studies included in this review is considered representative, as a point was reached where no new categorizations or insights were being found.

Table 1: Stakeholder categories in Urban Freight Transport - Insights from individual studies

Reference	Stakeholder categories	Comment
[REF-07] * 45 citations	City region Logistics service provider Municipality Retailers Shippers' association Trucking association Wholesalers	These actor groups are all heavily involved in urban freight transport, with focus on Urban Consolidation Centers implementation (although other groups such as real-estate owners have a role).
[REF-08] * 130 citations	Transport providers, representing the supply for urban distribution services; Own-account operators, who are retailers that instead of buying	The selection of these stakeholders types and the exclusion, for example, of citizens and public administration reflects the

Reference	Stakeholder categories	Comment
	transport services from third parties self-organize/produce them; Retailers, who hire third parties to perform transportation services.	specific research objective pursued that is, adopting a private point of view, determining desirable operational levers for improving urban freight transport services.
[REF-09] * 83 citations	Local authority Residents (consumers) Shippers Receivers Transport companies Public transport operators	-
[REF-10] * 65 citations	Internal business External business Government and community stakeholders	The categorisation was performed based on management of resources, use of public space, and legitimacy in the city.
[REF-11] *111 citations	Carriers End-receivers and local authorities City residents Suppliers Shippers	-
[REF-12] *272 citations	Actors (those that have a direct influence on the system) Stakeholders (they have an interest in the system of urban freight transport)	The actors are divided into Shippers; Customers; Freight Transport operators; and Authorities. All of these have a direct impact on urban freight transport through direct operations or regulations. The stakeholders are divided into Vehicle manufacturers; Public transport operators; Trade associations and commercial organisations; Land and property owners.
[REF-13] *207 citations	Private actors (i.e., shippers, carriers, receivers, B2B shippers, 3PLs, retailers and the citizens of a city) Public actors (i.e., national, regional, and local authorities)	-
[REF-14] *163 citations	Shippers Freight carriers Administrators Residents (consumers)	A neutral entity such as a city logistics company or a Non-Profit Organization (NPO) is needed to take leadership
[REF-15] *187 citations	Carriers Receivers Residents, workers, and shoppers Local authorities	-
[REF-16] *97 citations	Public authorities	List of stakeholders surveyed about the problems

Reference	Stakeholder categories	Comment
	Demand stakeholders (i.e., industry and commerce associations) Supply stakeholders (i.e., associations of transporters, forwarders, freight transport companies, industrial freight association)	surrounding goods movements in Rome's LTZ.
[REF-17] *157 citations	Those who make decisions (i.e., public authorities, private companies and public-private partnerships) Those who abide by these decisions (i.e., end-consumers, receivers, shippers and wholesalers or retailers).	-
[REF-18] *62 citations	Local authorities Freight transport associations Chambers of commerce Other local business groups Professional bodies Freight transport companies Retailers and manufacturers Service companies The police Environmental/civil amenity groups Resident groups	A list of stakeholder types participated in Freight Quality Partnerships (FQP) in the UK.
Recent research papers (2020-2023)		
[REF-19]	Local authorities Supply chain (SC) actors Goods receivers Property owners	Based on direct impact on city-planning of urban freight system.
[REF-20]	Authority Shipper Customer Freight operator Stakeholder	Examples of stakeholders who are not actors, according to this definition, are NGOs, property owners, and residents.
[REF-21]	Private organizations (haulage and shipping companies, logistics operators) Public organizations NGOs General public	-
[REF-22]	Shippers Freight carriers or transport providers Administrators Residents Others	The "Others" category includes NGOs and property owners.

* Number of citations by the date of preparing this deliverable (M06).

Other than studies, research projects or other initiatives attempted to categorise stakeholders. The table below (Table 2) shows, respectively, this categorisation.

Table 2: Stakeholder categories in Urban Freight Transport - Insights from research projects/initiatives (the included projects span from 2016 onwards)

Reference	Stakeholder categories	Comment
[REF-23]	Customers Shop owners Shippers Carriers Public authorities	The long-term vision of LEAD is to design an Open Physical Internet (PI)-inspired framework for Smart City Logistics that incorporates the created Digital Twins, laying the foundations for the development of large-scale city Digital Twins.
[REF-24]	Suppliers Carriers Receivers NGOs Local government bodies Other interest groups	ULaaDS aims to transform the urban on-demand logistic towards sustainable solutions, which will be tested in the lighthouse cities Bremen, Mechelen and Groningen. These solutions focus on containerised last-mile delivery, sharing economy platforms for on-demand city logistics, city-wide platform for integrated management of urban logistics, dual mobi-hubs and cargo hitching.
[REF-25]	Transportation agencies and authorities Transport operators and service providers Industry associations and trade organizations Technology providers Research institutions and academia Non-governmental organizations (NGOs) Public representatives and policymakers Users and consumers	To increase and accelerate the take-up of cargo bikes solutions, CCCB project uses expertise and know-how from previous successful implementations and transfer them on a larger scale and in the best way possible to new cities and their local context
[REF-26]	Local government authorities and agencies Transportation and logistics companies Urban retailers and businesses Public transport operators	The SUCCESS project intends to analyse the problems related to the cost of freight transport and the negative impacts of urban freight logistics, which hinder initiatives to meet the development of construction and infrastructure for the enlargement of cities, and aims to find solutions by exploring the impacts of Supply Chain Management

		and Construction Consolidation Centers (CCCs) to develop business plans focused on the implementation of a sustainable urban supply chain.
[REF-27]	Supply chain stakeholders (i.e. freight forwarders, transport operators, shippers, major retail chains, shop owners Public authorities (i.e. local government, national government) Other stakeholders (i.e. industry and commerce associations, consumer associations, research and academia, residents)	Inspired by the triple helix of co-creation to facilitate spatially embodied collaboration between private bodies and the civil society [REF-28]

This deliverable groups stakeholders into four main clusters (Figure 7); (a) environmental and community policy makers (Cluster A); (b) enablers of city logistics operations (Cluster B); (c) logistics and technology actors (Cluster C); (d) end-users (Cluster D). This approach was preferred over the previous literature review derived grouping approaches as it provides a comprehensive and well-rounded view of all the stakeholders involved in city logistics ecosystems. Each stakeholder has a unique perspective and interest, while understanding these perspectives is crucial for developing effective policies and solutions. Another reason for selecting this approach is that these stakeholder categories cover a broad range of areas that are important to city logistics, such as regulations, transportation, technology, sustainability, community impact, emergency response, financing, and risk management. By including these categories, GREEN-LOG can address the complex and multifaceted nature of city logistics. Lastly, these stakeholder categories reflect the current trends and developments in city logistics, such as the increasing use of Electric Vehicles (EVs), the importance of sustainability, and the role of technology [REF-29].

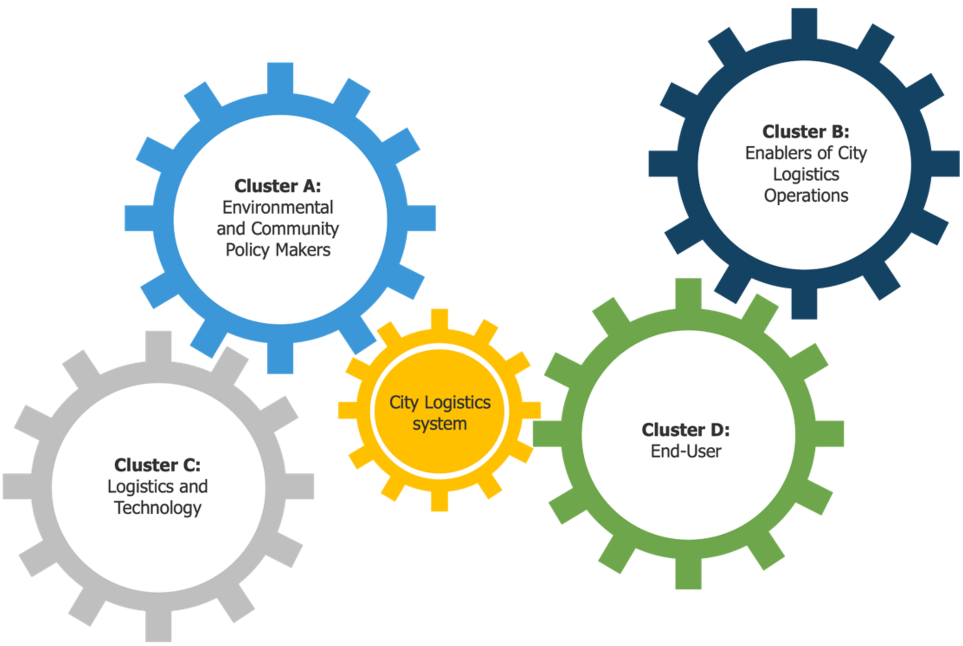

Figure 7: GREEN-LOG stakeholder clustering

GREEN-LOG's stakeholder categorisation into clusters can be seen in Table 3:.

Table 3: GREEN-LOG stakeholder clustering

Cluster	Stakeholder category	Description of stakeholder category
Cluster A	A1. Local government agencies	Responsible for creating regulations and policies that govern city logistics operations.
	A2. Environmental groups	Organizations that promote sustainable transportation and logistics practices.
	A3. Community groups/Citizens	Neighbourhood groups and other community organizations that have an interest in the impact of city logistics operations on their areas.
	A4. Emergency responders	First responders and other emergency personnel who navigate city logistics during emergency situations, such as natural disasters or terrorist attacks.
Cluster B	B1. Researchers and academics	Studying urban logistics and supply chain management.
	B2. Financial institutions	Banks and other financial institutions that provide financing for city logistics operations, such as loans for purchasing vehicles, equipment, and real estate.
	B3. Insurance companies	Insurance companies play a key role in managing risk in city logistics operations, providing coverage for liability, cargo, and other types of insurance.
Cluster C	C1. Businesses/Shippers	Retailers, e-commerce companies, and other businesses that rely on city logistics to deliver goods to customers.
	C2. Logistics companies	Provide the transportation, warehousing, and other services that are necessary for city logistics operations.
	C3. Technology companies	Companies that develop technologies such as autonomous vehicles, drones, and route optimization software.
	C4. EV manufacturers and charging infrastructure providers	As cities are increasingly looking to switch to EVs for last-mile deliveries.
Cluster D	D1. End users/Customers	Order products online, purchase goods from local retailers, receive emergency supplies or medical equipment.

3.1.1 Stakeholders' Goals and Needs

As previously shown in section 3.1, various stakeholders are involved in the process of goods delivery, each with their own unique objectives and requirements. Understanding the objectives and requirements of each stakeholder is essential to ensure efficient and sustainable urban freight transport systems. This can involve identifying shared interests and areas of cooperation, as well as addressing conflicting goals and developing appropriate regulations and policies. Table 4 elaborates on the goals and needs of each identified stakeholder category for better planning of their Urban Freight Transport (UFT) related actions.

Table 4: Stakeholder Categories, Goals, and Needs in City Logistics Operations

Stakeholder category	Goals	Needs
A1. Local government agencies	Develop and enforce policies and regulations that promote efficient and sustainable city logistics operations while minimizing negative impacts on the community.	Access to data and information on city logistics operations to inform policy-making and regulatory decisions.
A2. Environmental groups	Promote sustainable transportation and logistics practices that reduce the environmental impact of city logistics operations.	Access to information on the environmental impact of city logistics operations and opportunities to provide input on policy and planning decisions.
A3. Community groups/Citizens	Ensure that city logistics operations are conducted in a way that minimizes negative impacts on the community, including noise, pollution, and safety risks.	Access to information on city logistics operations and opportunities to provide input on policy and planning decisions
A4. Emergency responders	Ensure that city logistics operations can be safely navigated during emergency situations, such as natural disasters or terrorist attacks.	Access to real-time information on city logistics operations and infrastructure, as well as coordination with city logistics operators and other emergency responders.
B1. Researchers and academics	To better understand the challenges and opportunities of city logistics operations, and to develop and test new solutions that can improve efficiency, sustainability, and safety.	Access to data and information on city logistics operations, as well as funding and support for research and development activities.
B2. Financial institutions	To provide funding and support for city logistics operations, and to invest in new technologies and solutions that can improve efficiency and reduce costs.	Access to information and data on city logistics operations, as well as reliable risk assessment and analysis tools to inform lending and investment decisions.
B3. Insurance companies	To provide insurance coverage and risk management services for city logistics operations, and to promote safety and sustainability in the industry.	Access to data and information on city logistics operations, as well as reliable risk assessment and analysis tools to inform insurance coverage and pricing decisions.
C1. Businesses/Shippers	1. Timely and efficient delivery of goods to customers. 2. Cost-efficient transportation of goods. 3. Minimization of damage and loss to products during transportation.	1. Reliable and safe transportation services. 2. Efficient route planning and optimization. 3. Access to tracking and monitoring systems to ensure on-time delivery and minimize theft.

C2. Logistics companies	1. Timely and efficient delivery of goods to customers. 2. Cost-efficient transportation of goods. 3. Optimization of transportation routes to minimize fuel consumption and reduce carbon emissions.	1. Reliable and safe transportation vehicles and equipment. 2. Efficient warehousing and inventory management systems 3. Access to technology solutions to improve transportation efficiency and route optimization.
C3. Technology companies	1. Development of innovative technologies that improve transportation, management of warehouse, inventory and fleet as well as packaging efficiency and reduce environmental impact. 2. Expansion of market share in the logistics industry.	1. Access to funding and investment to support research and development of new technologies 2. Collaboration with logistics companies to test and refine new technologies 3. Government support for regulatory approval and integration into existing transportation infrastructure
C4. EV manufacturers and charging infrastructure providers	1. Expansion of the market for EVs and charging infrastructure. 2. Reduction of carbon emissions and air pollution in urban areas.	1. Government support for investment in charging infrastructure and incentives for the adoption of EVs 2. Collaboration with logistics companies and shippers to integrate EVs into their transportation networks 3. Research and development of more efficient and cost-effective EVs and charging infrastructure
D1. End users/Customers	1. Convenient and timely delivery of products and services 2. Access to a wide range of products and services 3. Affordable pricing 4. Reliability and quality of delivery 5. Transparent and accurate tracking of deliveries 6. Information on environmental footprint of deliveries	1. Ease of ordering and payment 2. Quick and efficient delivery 3. Access to a range of delivery options (e.g. same-day delivery, scheduled delivery, etc.) 4. Safe and secure delivery 5. Accurate and timely information on delivery status and tracking

3.1.2 Stakeholders' Relationships

The relationships between stakeholders in UFT can be complex and challenging due to their actors' diverse goals and needs. Any slight modification to the chain can have significant consequences. For example, the poor performance of a carrier can lower the quality of the overall system's services, leading to increased management and planning difficulties for regulators and reduced consumer satisfaction, thus damaging the credibility of businesses. To overcome these challenges and ensure successful implementation of city logistics plans, building partnerships and consensus among stakeholders is critical [REF-30]. National and local governments can play a crucial role in this process by conducting problem analysis and providing support for viable solutions [REF-31]. However, stakeholder relationships are likely to shift when faced with new challenges, leading to four possible outcomes that must be anticipated and addressed proactively [REF-32]:

- Conflicts: Conflicts between stakeholders are commonplace. They arise when the external impact of UFT activities on local communities is no longer acceptable to the broad community and regulators, who often attempt legal action to stop a project.
- Cooperation: Public-private cooperation is frequent, where private goals converge with the public interest.
- Competition: Competition is developed between shippers and freight forwarders with respect to access to urban real estate and the necessary facilities for their activities. Forwarders also compete to attract and retain customers in freight forwarding services.
- Co-opetition: This form of cooperation is usually adopted when one of the stakeholders is unable to handle a particular issue individually, and it benefits all parties involved.

The GREEN-LOG project aims to incorporate all four types of relationships, but it places particular emphasis on co-opetition, which entails a cooperative competition between organizations. This emphasis is based on the relevance of co-opetition in the project's four thematic areas, which are focused on: (a) Multi-stakeholder collaborations for shared CCs & optimized cargo-bike use, (b) Multimodal last-mile deliveries, (c) Last mile Logistics as a Service marketplaces, and (d) Next generation last mile delivery modes integrating AVs and delivery robots. Specifically, in the context of (a) Multi-stakeholder collaborations for shared CCs & optimized cargo-bike use, co-opetition can be applied by encouraging collaboration between different stakeholders, such as logistics companies, retailers, and local authorities, to establish a shared network of cargo bikes. While these stakeholders may compete in the market, they can collaborate to optimize the use of cargo bikes by sharing resources, infrastructure, and information. By co-opeting, they can collectively benefit from reduced congestion, lower emissions, and improved efficiency in last-mile deliveries. In the context of (b) Multimodal last-mile deliveries, co-opetition can facilitate the integration of different transportation modes for last-mile deliveries. Logistics companies and service providers may compete individually, but they can also collaborate to offer multimodal solutions. By combining delivery methods such as cargo bikes, electric vans, and public transportation, they can create more sustainable and efficient last-mile delivery networks. Co-opetition can help establish partnerships, share infrastructure, and coordinate operations to optimize the use of multiple modes of transportation. Moreover, co-opetition can be also applied in the context of (c) “Last mile Logistics as a Service marketplaces”. In these marketplaces, different logistics providers compete to offer their services to customers. However, they can also collaborate by sharing data, insights, and resources to improve the overall efficiency and sustainability of last-mile deliveries. Co-opetition can encourage the development of open platforms where multiple providers can participate, creating a competitive environment that benefits all stakeholders and promotes innovation in the delivery sector. Lastly, co-opetition can play a crucial role in the development and deployment of next-generation last-mile delivery modes, such as autonomous vehicles (AVs) and delivery robots. While various companies may compete to develop and commercialize these technologies, they can also collaborate to address common challenges, such as infrastructure requirements, regulatory frameworks, and safety standards. Co-opetition can facilitate knowledge sharing, joint research, and pilot projects, allowing different organizations to leverage their respective expertise and resources for the successful integration of AVs and delivery robots into the last-mile logistics ecosystem [REF-33].

3.2 Best Practices, Barriers and Challenges

3.2.1 Methodology of Systematic Literature Review

To carry out the research, the Scopus database was investigated exclusively. Scopus was selected because it provides the capability to create advanced queries and filter better the search. The desired goal is to identify the measures that have been researched extensively in the bibliography from the perspective of stakeholders. The review was scoped to include only articles which specifically use three groups of terms. Queries that were used in this review included words that are related to city logistics, and main stakeholder groups. The first group of words includes at least one of the terms "last mile", "city logistics", "urban logistics" or "urban freight transport". The second includes all the major stakeholders and the third one looks for words that imply that the article investigates the stakeholders' needs. The words should be present either in the title or in the keywords to ensure that they are the main subject of the article.

The final query is:
KEY ("last mile" OR "city logistics" OR "urban logistics" OR "urban freight transport") OR TITLE ("last mile" OR "city logistics" OR "urban logistics" OR "urban freight transport") AND TITLE-ABS-KEY (stakeholder OR retail* OR "public authorit*" OR "logistics provider" OR "3PL" OR “carrier”) AND TITLE-ABS-KEY (need* OR requirem* OR preferen*) AND (LIMIT-TO (DOCTYPE, "ar")) AND LANGUAGE (English) AND PUBYEAR > 2015 AND (LIMIT-TO (PUBSTAGE, "final")) AND (EXCLUDE (SUBJAREA, "VETE") OR EXCLUDE (SUBJAREA, "AGRI") OR EXCLUDE (SUBJAREA, "MEDI") OR EXCLUDE (SUBJAREA, "PSYC") OR EXCLUDE (SUBJAREA, "MATH"))

We included only peer-reviewed articles that were written in English and were published after 2015. With the initial query, 95 results were obtained (Figure 8). However, a few more filters were added to exclude fields that are unrelated to the subject.

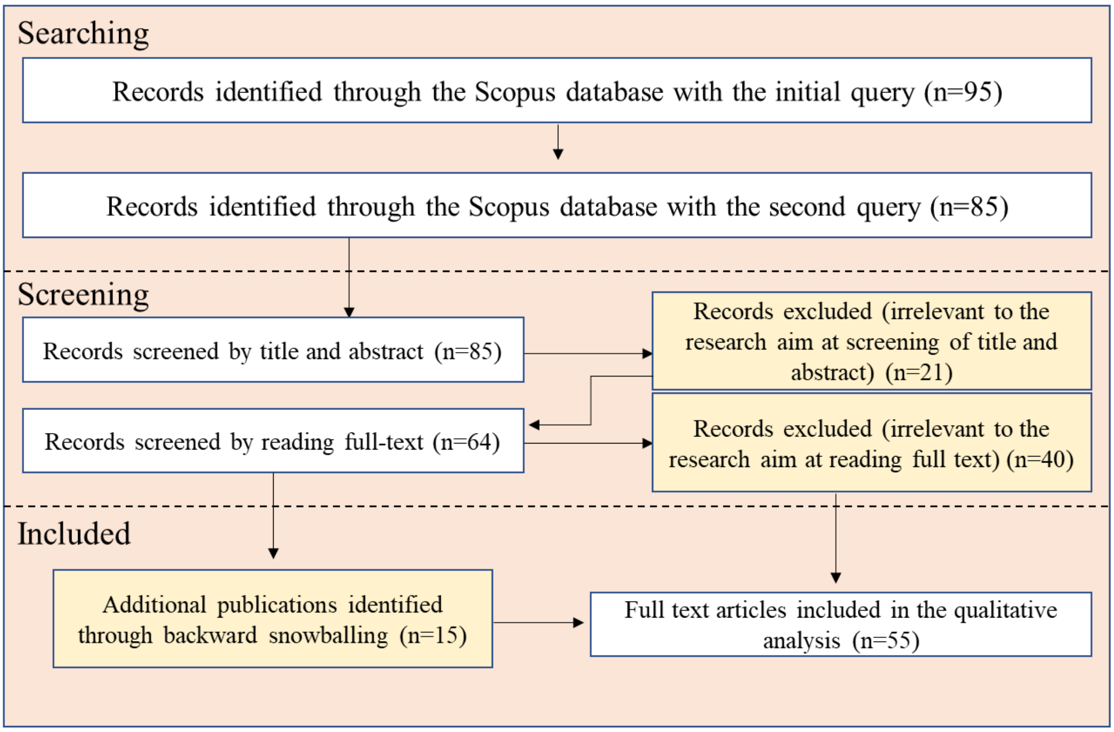

Figure 8: Methodology framework of the systematic literature review

The total number of results as of 10 April 2023 were 85. The next stage of the analysis was to screen the articles based on their titles and abstracts. This resulted in 64 articles that were further screened by reading their full text. During this process we identified the articles that either give the perspective of different stakeholders on different last mile measures or try to explore what are the added values and the challenges in relation to various last mile measures. Also, additional publications (n=15), which were not part of the generated results of the query but were identified following a process of backward snowballing were included. The final number of articles that were considered related to the research aims was 55.

As Figure 9 suggests, the 55 articles consider more frequently case studies / interviews followed by questionnaires/surveys and conceptualisation/simulation.

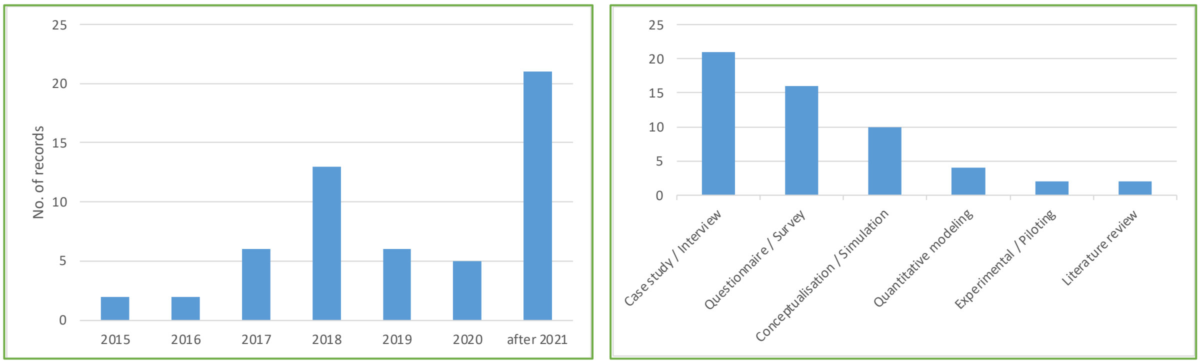

Figure 9: Yearly trend & Types of Analysis

VOSviewer was also used to identify keywords that are commonly used and the strength of their links. As Figure 10 shows, during the period from 2016 to 2019, EVs, greenhouse gas emissions, crowd logistics and off-peak deliveries were the main focus terms. Since 2019, sector's topics that have drawn attention are the microhubs, the parcel lockers and the automated transport systems.

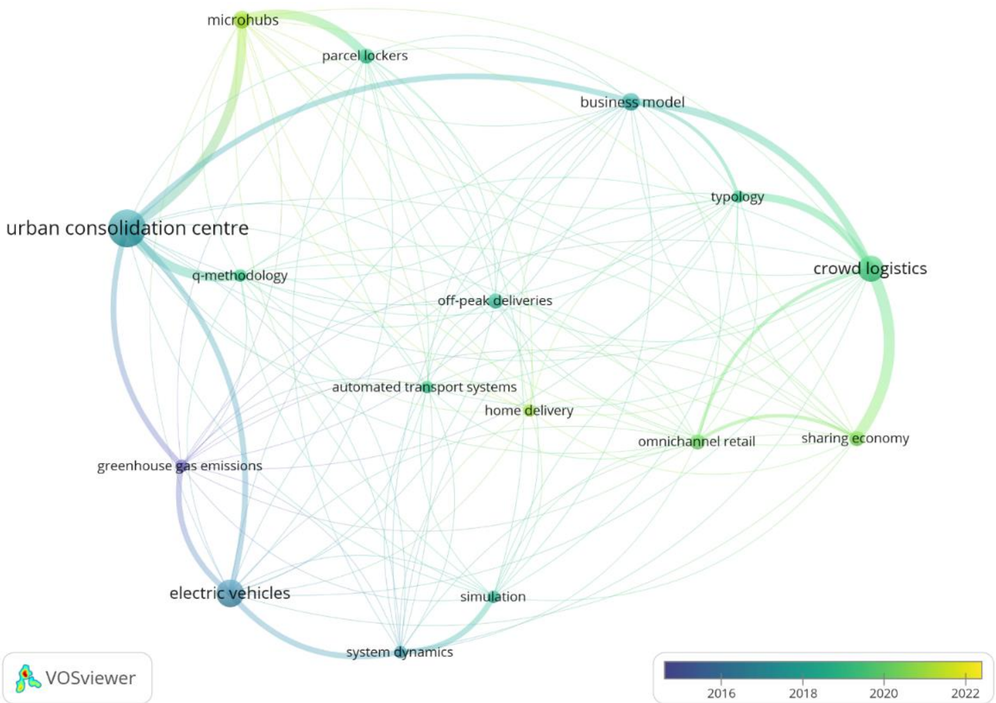

Figure 10: Highlighted keywords and links between them (VOSviewer)

3.2.2 City Logistics Solutions, Measures, Policies & Strategies

By identifying the key queries and completing the systematic literature review, we proceed to the next phase; focus on the most frequently researched last mile delivery solutions. These solutions were clustered into the following five (5) groups. More specifically, the groups are the following:

1. **Vehicle change**: (1) EVs diffusion, (2) Autonomous vehicles delivery, (3) Cargo bikes, (4) Droid delivery, (5) Drone delivery, and (6) Mobile depot.
2. **Customer movement**: (7) Collection points, (8) Click & Collect services, (9) Parcel lockers, and (10) Lock box.
3. **Consolidation**: (11) Urban consolidation centre, and (12) Microhub (microdepot).
4. **Delivery system**: (13) Access restrictions, (14) Exclusive lane for urban freight transport, (15) Off peak delivery, (16) Smart contracts, (17) Horizontal logistics collaboration, and (18) Dedicated parking spaces for loading/unloading.
5. **Crowdsourcing**: (19) Crowd Logistics, (20) Crowdshipping, and (21) Cargo hitching.

These groups are explicitly described in sections 3.2.2.1-3.2.2.5.

3.2.2.1 Vehicle change

EVs draw attention in the city logistics sector too, due to the plethora of advantages they provide. These include lower operating costs ([REF-34];[REF-35]), reduced noise, sufficient battery autonomy, and lower environmental impact, all of which are environmentally beneficial ([REF-36]). However, there are important barriers that limit their adoption, such as a lack of charging infrastructure, limited driving range, high initial investment, and a lack of government support and incentives ([REF-37];[REF-38]). From a technological standpoint, EVs are characterized by lower vehicle operational performance, immature maintenance and repair services, uncertain resale value, and uncertainty regarding future electricity prices ([REF-39]). Additional issues, such as safety concerns due to the quietness of electric motors, long battery charging times, limited cargo space, and the potential risk of battery self-ignition, need to be addressed and mitigated [REF-40]. Moreover, consumers are often hesitant to try new and unproven technologies [REF-41], while carriers express a greater interest in electric and fuel-efficient vehicles (EFVs) if they see improvements in operational parameters such as travel range, battery operation time, and an increase in charging infrastructure with more charging points and stations [REF-36]. The use of electric vans still raises some concerns among Logistics Service Providers (LSPs) regarding their competitiveness [REF-42]. Retailers, receivers, and shippers may be attracted to the environmental benefits of cargo bike deliveries, but they may also have concerns about the safety of deliveries and the additional transportation costs [REF-35]. Finally, policy makers consider providing incentives to encourage the purchase of eco-vehicles as one of the top policies [REF-16].

Moreover, autonomy has been a game-changing feature in last-mile delivery methods. The three most popular alternatives are ground vehicle delivery, drones, and sidewalk automated delivery robots. When considering the ground alternative, it is subject to fewer security restrictions than drones and requires an operator to supervise a cluster of vehicles. Ground vehicles can also provide Sunday deliveries even in countries with strict labour laws and can be utilized as parcel lockers when idle during the night, offering a significant cost advantage [REF-43]. As a result, they have the potential to revolutionize the market [REF-44]. Drones offer better accessibility to harder-to-reach areas [REF-64] and are naturally less constrained in terms of movement compared to delivery vehicles. The alternative of Sidewalk Automated Delivery Robots (SADRs) is a solution consisting of a single operator that can handle hundreds of them [REF-45]. SADRs are characterized by reduced emissions [REF-46] and lower labor costs [REF-43]. They may be more efficient than standard delivery approaches when the average delivery time per customer is high or when customer density increases. Additionally, integrating SADRs with vans can significantly reduce delivery times, on-road vehicle miles travelled, and costs [REF-47]. However, sidewalk automated delivery robots bring issues regarding their limited battery capacity, low travel speed, the necessity of driving on sidewalks [REF-45], and their size and weight limits, which can greatly decrease effectiveness [REF-47]. Many regulatory challenges have yet to be faced [REF-47], and they need to be coupled with assisting technology due to their compact size [REF-46] to avoid collisions with pedestrians or other vehicles [REF-48]. The widespread scepticism regarding the safety of these vehicles is a significant challenge, and if not widely accepted by the public, the development and introduction of Automated Ground Vehicles (AGVs) can result in a substantial waste of resources [REF-44]. On the other hand, drones could be limited due to noise, which can be more annoying to people than noise emissions from cars [REF-49]. Prohibitions related to their vicinity to airports by the Federal Aviation Administration (FAA) are also strong barriers. Moreover, a drone operator cannot be responsible for more than one unmanned aircraft at a time, making it challenging to synchronize the drone with the "mothership" to serve all customers in the minimum amount of time [REF-45]. Some policymakers expect self-driving vehicles to become a relevant part of urban traffic in the near future, while others are sceptical regarding the safety of these vehicles and their integration in urban traffic. Carriers, on the other hand, are uncertain about the scenarios in which these vehicles could be used [REF-48].

3.2.2.2 Customer movement

This cluster of solutions refers to organization schemes that allow a bundle of parcels to be delivered at a single location [REF-42]. The commercialization of non-utilized outdoor spaces could encourage consumers to shop in-store while collecting their goods [REF-36]. Customers have the flexibility to access their packages 24 hours a day, seven days a week, with low delivery costs [REF-50]. Parcel lockers offer advantages such as reduced travel distances, resulting in lower emissions, noise, and energy consumption. They also eliminate missed deliveries and facilitate easier returns [REF-36]. However, the success of parcel lockers relies on the willingness of customers to receive their goods from these automated lockers. It is a private initiative, and public authorities may have limited information about its impacts. The growth of e-commerce can lead to increased freight mileage due to the proliferation of parcel lockers. The implementation of this alternative requires the support and cooperation of residents, courier/delivery companies, and the owners of locations where the parcel lockers are installed [REF-36]. Despite the benefits of parcel lockers, there are some drawbacks, including bureaucratic and legal issues (e.g., involving local authorities in the implementation stage for permissions and site selection), loss of personal contact, and size limitations [REF-50]. Carriers are primarily focused on measures that maximize distribution efficiency, and therefore, they often utilize pick-up points and lockers for parcel receivers. Retailers argue that reducing failed first-time deliveries leads to increased customer satisfaction [REF-42]. However, major retailers face an additional challenge when they outsource their deliveries to multiple courier companies. Each courier company manages its own network of pick-up points, forcing these retailers to decide whether to choose only one express courier to offer the collection delivery point option, rely on multiple couriers and face coordination challenges, or outsource to white-label parcel locker networks and provide a seamless collection point solution for their customers [REF-50].

3.2.2.3 Consolidation

Urban consolidation centers, micro-hubs and parcel lockers are the most dominant examples of this cluster and promising solutions in a city logistics system. To begin with, Urban

Consolidation Center (UCC) is one of the most commonly implemented solutions in freight consolidation policies. The main objective of this measure is to establish transshipment centers where goods are gathered, consolidated, and dispatched in a more efficient manner [REF-35]. Van Rooijen and Quak [REF-51]define UCC as a facility "in which flows from outside the city are consolidated with the objective of bundling inner-city transport activities.". Several studies have explored UCCs and identified several pillars that contribute to its added value. Some studies have highlighted the increased vehicle load utilization and the reduction of freight transport kilometers compared to attended delivery, leading to a reduction in emissions, noise, and energy consumption. Additionally, improved reverse logistics, better inventory control, cost reduction, transfer of secondary activities from stores to the UCC, and environmental sustainability are considered significant benefits of implementing UCCs ([REF-52];[REF-53]).

On the other hand, challenges associated with UCCs include reliance on third parties and issues related to work allocation and revenue sharing, high initial costs, strict policy measures, dependence on public subsidies, and hesitation to participate due to the high level of uncertainty ([REF-54];[REF-55];[REF-56]). Moreover, the industry faces several deficiencies, such as a lack of a well-defined business plan, effective marketing campaigns, quantification of benefits for all stakeholders, and a cooperative culture and trust among all parties involved ([REF-57];[REF-53];[REF-58]).

Carriers have mixed opinions on UCCs. They appreciate the reductions in distance traveled and operating time, which directly benefit their businesses[REF-59]. Over time, through ongoing collaboration and to some extent, co-creation of urban freight transport policies, carriers can accept the need to be involved in UCCs [REF-60]. Additionally, many carriers consider UCCs as the best solution to alleviate traffic congestion in city centers [REF-76]. However, some carriers are hesitant to share volumes and data and would prefer to operate independently without involvement from public actors [REF-60]. Moreover, carriers express a higher degree of negativity towards urban distribution centers in comparison to other stakeholders. They raise concerns regarding (i) the potential loss of control over operations, (ii) legal liability for the goods being transported, as well as (iii) the risk of losing direct contact with the end customer [REF-16]. Retailers generally appreciate the transfer of secondary activities from stores to UCCs and show a positive attitude towards UCC implementation [REF-61]. However, opinions on efficiency vary, with some retailers perceiving it as low [REF-16]. Some retailers state that they would prefer only use pick-up points if carriers bear the costs, while others have a neutral stance and simply want to continue receiving the same service they currently enjoy. Policy makers view UCCs as highly efficient and consider them an effective measure to reduce emissions in city centers. However, they also recognize that implementing UCCs can be unfeasible due to cost constraints or lack of available space [REF-60].

Microhubs, also known as "micro-depots," are last-mile consolidation and distribution nodes located within or near urban neighbourhoods. They essentially function as smaller-scale UCCs. Microhubs facilitate delivery through a variety of environmentally friendly vehicles [REF-22]. According to Janjevic and Ndiaye [REF-62], they are "facilities that are situated closer to the delivery area and have a more limited spatial range for delivery than traditional UCCs."

Microhubs provide rapid and flexible delivery options [REF-22] and are situated in close proximity to end-receivers [REF-62]. They offer an eco-friendly alternative by reducing freight transport kilometers compared to attended delivery, leading to a decrease in emissions, noise, and energy consumption [REF-16]. The operation of microhubs allows LSPs to handle their business more efficiently when operated by a third party [REF-63]. However, there are certain barriers associated with microhubs. Their implementation requires acceptance of having a logistics facility in the middle of the city [REF-64]. They introduce an additional intermediate step, which can result in delays and additional costs in some cases [REF-62], such as for location selection and staffing [REF-65]. Moreover, microhubs require support from local authorities to ensure long-term sustainability [REF-63], as they have high fixed costs that they cannot always bear [REF-64]. In general, carriers tend to be more negative while retailers are more positive towards the implementation of microhubs [REF-16]. Retailers expect increased flexibility [REF-66], and some are willing to pay a higher delivery premium for green distribution [REF-22]. It has been noted that retailers would use a pick-up point if the carrier bore the costs [REF-16]. Policy makers anticipate that microhubs will contribute to reduced congestion and emission concentrations [REF-66].

3.2.2.4 Delivery system

This cluster has to do with solutions tailored to the urban transport system as part of the wider urban transport system and other complementary measures. An indicative example is the “Dedicated parking spaces for loading and unloading” which is a policy that offers convenience by reducing the need for second-row parking and promoting lower emissions. Carriers have mentioned it as a valuable complementary solution to other measures [REF-76]. On-street loading/unloading areas should be considered in the development of new urban freight policies [REF-59]. However, according to Trott [REF-67], urban carrier organizations find it less attractive due to increased delivery times and labor costs. It is believed that implementing a reservation system would have better potential to improve operations [REF-59]. Another study ranked an increase in loading/unloading bays among the top policies noted by retailers, as it addresses their main problems when receiving goods [REF-68]. Retailers also expressed positive views towards parking meters in the loading zone [REF-15]. However, research by de Oliveira & de Oliveira [REF-59] found that retailers did not consider paying to park freight vehicles as an efficient option. Policy makers perceive dedicated parking spaces as an effective way to avoid conflicts of interest in the marketplace [REF-15]. Government representatives consider reservation measures efficient and foresee their role as mediators or providers of incentives, mainly financial [REF-59]. It should be noted that the implementation of dedicated spaces may lead to illegal parking issues [REF-16].

Another example is the off-peak hours deliveries. The definition of off-peak deliveries is often assumed to refer to either the earlier hours of the day or the period after dawn, but there is no consensus in the literature regarding this. The reason for the lack of consensus is that times of high transportation demand vary significantly between cities. Therefore, determining off-peak hours mostly depends on noise emission standards or the business hours of establishments, and these hours can include weekends [REF-69]. According to the literature, off-peak deliveries have several benefits, including improved traffic conditions, reduced emissions [REF-70] and more balanced utilization of space ([REF-71];[REF-66]). They also provide transportation companies with increased competitiveness, enhance delivery reliability for recipients, and improve safety by reducing conflicts between trucks, cars, cyclists, and pedestrians, ultimately enhancing a city's liveability and attractiveness [REF-69]. However, there are some challenges associated with off-peak deliveries. Security issues arise due to handling goods deliveries at night, and there can be increased noise levels. Nighttime deliveries may involve wage increases, and unless fully automated solutions are implemented, they require staff to be available at inconvenient times [REF-66]. Therefore, municipalities should provide assurances regarding the continued allowance for nighttime deliveries [REF-71]. Carriers argue that the extra costs for wages and equipment are not crucial parameters. Retailers believe that off-peak deliveries increase the frequency of route services, making deliveries more efficient [REF-71]. At the same time, retailers also express concerns regarding the logistics of off-peak deliveries. They need to have personnel available to accept the goods during non-standard hours, which could require additional staffing. Alternatively, they may need to invest in costly automatic systems or provide access codes to the carrier. For instance, in the case of frozen goods, it is crucial to accept the delivery and promptly place the items in the appropriate location. This necessitates having personnel available during off-peak hours as well. Moreover, carriers are generally positive [REF-70], but uncertain about the reaction they might face from labour organizations [REF-66]. Many carriers are willing to adopt off-hour deliveries [REF-72], even though they anticipate increases in operating costs, equipment, and wages. They also express concerns that this could lead to increased risks and exposure to crime for both personnel and goods. Stakeholders emphasize that not all buildings and premises are suitable for technological solutions [REF-66], and they are less enthusiastic about measures that require behavioral changes and alterations to their business operations (Stathopoulos, et al., 2012). Policy makers believe that society could benefit from increased traffic speed and reduced emissions [REF-70]. Similarly, from the public sector's perspective, reducing traffic congestion during the daytime and promoting intelligent, innovative communication technology solutions are significant advantages when moving trucks from peak hours to off-peak hours [REF-71]. However, there is a concern that delivery vehicles could obstruct road maintenance. Finally, successful night and evening deliveries require appropriate signage for traffic and parking regulations specific to certain periods and areas [REF-66].

3.2.2.5 Crowdsourcing

Crowdsourcing solutions, such as crowdshipping, involves enlisting people who are already traveling from point A to point B to transport a package along with them and make a stop along the way to drop it off. This can include residents, taxi drivers, and delivery drivers with spare capacity who are already planning to make daily trips. They act as couriers, creating an informal logistics network [REF-77]. Some researchers present crowdshipping as a valuable alternative due to its high level of personalization, access to new products, and reduced operating costs [REF-73]. It also offers important benefits such as a reduction in trip kilometres compared to attended delivery, leading to a decrease in emissions, noise, and energy consumption, while also providing job opportunities [REF-73]. However, crowdshipping is associated with difficulty finding parking spaces [REF-74] and raises privacy concerns regarding the sharing of actual addresses with shippers [REF-75].

The success of crowdshipping depends on user participation, as a critical mass of couriers is needed to attract customers, and a critical mass of customers is needed to attract couriers [REF-73]. The system itself is scalable, both technologically and organizationally, requiring a large number of carriers and customers to be viable [REF-78]. Crowdshipping has been found to increase traffic accidents due to the increased number of cyclists and pedestrians involved [REF-76]. Unfortunately, it may also encourage dangerous driving behaviours and people drive more kilometres than they intended to, as earnings can be tied to the number of tasks delivered within a given time window [REF-73]. Most companies primarily rely on professional couriers or individuals dedicated to delivery within their crowdshipping schemes [REF-42]. Additionally, crowdsourced delivery often handles parcels individually, resulting in wasted time instead of aggregating them [REF-73]. Financial planning for crowdshipping should cover not only the initial phase but also allow for service rearrangement. The network is a crucial resource that needs to be established before initiating the service [REF-78]. Carriers find crowdshipping an attractive revenue model [REF-76] and believe it can reduce their operational costs [REF-75]. However, they are concerned about the current political constraints on crowd logistics [REF-78]. Policy makers are worried about the safety of transactions and the increased risk of road accidents [REF-75].

3.2.3 Barriers, Opportunities and Challenges

A collection of the barriers, opportunities and challenges that the authors came across during the systematic review is summarized in the current section.

Barriers in city logistics encompass several dimensions that hinder the widespread implementation of efficient and sustainable logistics systems. Technological barriers arise from limitations in infrastructure, vehicle capabilities, and connectivity, which affect the adoption and integration of advanced technologies. Data-privacy concerns involve the collection, storage, and use of personal data in logistics operations, requiring robust security measures and compliance with privacy regulations. Legal barriers pertain to the need for clear regulations and frameworks governing urban logistics activities, including vehicle restrictions, delivery time windows, and zoning regulations. Regulatory and institutional barriers involve complex permitting processes, coordination among multiple stakeholders, and alignment with urban planning objectives. Financial barriers encompass the high costs associated with infrastructure development, vehicle acquisition, and operational expenses, which may impede the implementation of efficient city logistics solutions. Social barriers include public acceptance, trust, and resistance to changes in traditional delivery methods, as well as concerns over job displacement and environmental impacts.

In contrast, city logistics presents various **opportunities** for enhancing logistics management and process planning. Optimized route planning, enabled by real-time data and advanced analytics, can improve delivery efficiency, reduce congestion, and minimize emissions. The use of alternative modes of transportation, such as EVs, cargo bikes, and microhubs, allows for sustainable last-mile delivery solutions, promoting environmental sustainability and reducing carbon footprints. Collaboration between stakeholders, including logistics companies, municipalities, and technology providers, can foster innovation, knowledge sharing, and the development of integrated urban logistics systems. Implementing smart technologies, such as Internet of Things (IoT) sensors, blockchain, and automation, can enhance visibility, traceability, and efficiency in the supply chain. Additionally, leveraging data analytics and artificial intelligence can provide insights for demand forecasting, inventory management, and operational optimization, leading to cost reductions and improved customer satisfaction. Overall, embracing these opportunities can contribute to more efficient, sustainable, and customer-centric city logistics operations.

As per the **challenges** that city logistics sector faces, these include coping with peak demand pressures and the necessary infrastructure investments to meet customer demands for timed delivery windows and traceability [REF-77]. Overcapacity in the sector, particularly due to the growth of B2C and C2C deliveries, adds to the challenges faced by parcel carriers. Additionally, the expectation of "free" delivery from customers puts pressure on carriers to maintain low pricing models. Meeting delivery windows and managing product returns also present difficulties, with high failure rates for first-time deliveries and a significant proportion of returns being shouldered by online retailers. Traffic conditions and limited logistics infrastructure further compound the challenges in the city logistics sector.

4 Introducing GREEN-LOG Living Labs

This section presents results from the first interviews in the introductory phase of the LL scoping stage presented in section 2. It provides a development of what is stated in the GA and presents a more in-depth overview of where and how the LLs place themselves initially into their local contexts and requirements, as a GREEN-LOG LL in the first phase of establishment. This overview forms a baseline and a starting point for the GREEN-LOG LL journeys the different pilot cities will undertake through coming co-creation and iterative activities during the life of the project. The interviews also provide an overview of the solutions that will be implemented, a more detailed presentation of the local contexts and key challenges the LLs have identified this far in the process.

4.1 LL #1 Athens (GR): Multi-stakeholder collaborations for shared MCCs and optimized cargo-bike use

The Athens LL aims at exploring and demonstrating multistakeholder partnerships through the design, deployment, and use of open shared MCCs, logistics hubs and white label schemes to pick up / deliver parcels with cargo-bike, electrically assisted bikes and EVs. It aims to establish a network of LSPs and local stakeholders, including businesses, to identify optimal places for deploying microCCs. On top of an existing fleet of cargo bikes, Greek LSPs that participate in this LL seek to design a new fleet of 10 cargo-bikes and examine the use of electric vans to comply with the limited traffic zone in Athens historic centre. According to the Sustainable Urban Mobility Plan (SUMP) issued in April 2021. DAEM, as the IT company of the city, will provide relevant spaces for microCC deployments, including parking spaces and public buildings. The capabilities of GREEN-LOG's augmented modelling platform will be exploited for identifying optimal locations.

4.1.1 Keywords

Scalability, citizen involvement, raise awareness on environmental issues, accountability, business stakeholder engagement, local topography cargo bike delivery, lockers, inter- and intra-organisational collaboration, co-design activities.

4.1.2 Local Context

The historical centre of Athens where the LL is to be set, is a strategic area with high density, a challenging topography and high complexity where operations need to be optimised to guarantee sustainability without compromising the physical environment which has significant symbolic value.

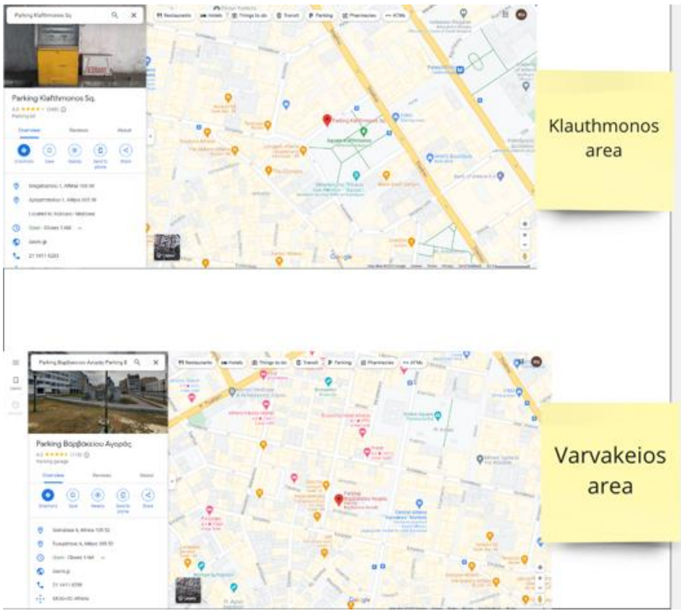

Figure 11: LL Athens's local context for their LL activities in the historical city centre of Athens

This LL is an opportunity for the existing partners to establish a working relationship. ELTA brings commercial and technical expertise regarding last-mile delivery; other partners come with experience in LL organisation and knowledge of some last-mile delivery points. DAEM will provide regular input for pilot design and implementation as well as further stakeholder involvement. DAEM, as partner in the Athens LL, will contribute to the engagement of citizens and other relevant stakeholders in collaboration with ELTA, AUEB and UAEGEAN. Moreover, a target is to engage citizens through an agenda of improving urban everyday quality of life. The goal is to create a working ecosystem that maximises diversity in stakeholders, including private companies, courier companies, end user organisations, academia, environmental organisations, stakeholders of the tourism industry, e-commerce companies (i.e., Skroutz). Apart from government agencies, like consumer associations, that can be contacted and engaged, there are also many citizen organisations that are active in environmental issues that would be relevant to mobilize. The focal point of this project lies with (especially smaller) courier services which are defined in this context to be urban transport and logistic services that act as an intermediates among a commercial body and the final receiver of goods, such as a product they have to deliver something intact, in good time and in an environmentally fashion and that focus specifically on the end user and the last mile delivery (some local examples include ACS, daily courier, cleverpoint, etc). In an ideal ecosystem, the LL initiative should spread to neighbouring municipalities within the Athens region, not only as a best practice example but as a concrete collaboration, which makes scalability a key question in this living lab.

4.1.3 Local Challenges

As representatives for public agencies, the primary partners in the project are challenged with anticipating the administrative procedures required and promoting a sustainability agenda inside the relevant public organisations as part of the LL. Athens municipality does not have authority over the traffic in large avenues, which are under the prerogative of the ministry of transport, but the city is responsible for the traffic management in the rest of the streets in the center of the city where the GREEN-LOG Athens pilot is going to be implemented. Hence the challenge is to expand the LL to the city avenues. The existing topography and infrastructure of the city is not provisioned for all micro-mobilities since Athens is a hilly area and specialized cyclists/micromobility lanes are not foreseen. Thus, the challenge will be to provide the relevant infrastructure and to implement e-bikes that can be used in uphill routes.

Key challenges are to provide a centralised system that offers added value in comparison to existing last mile delivery points, to create stakeholders and citizens enrolment through concrete actions perceived as beneficial, legitimate and interesting. The upcoming task is to involve and find a private courier service in addition to ELTA to replace DHL and potentially pivot to several smaller partners.

4.2 LL #2 Barcelona (ES): Multimodal last-mile deliveries

The aim of Barcelona LL is to identify how city logistics can be facilitated and improved from rail station locations, considering combinations of cargo-bikes, boxes, locker and other solutions in a range of urban contexts.

Cycle logistics operator VANaPEDAL operates from a hub located at Estació de França in central Barcelona. Its core business is delivering parcels for 3rd Party Shippers to receivers in the city centre. It now offers a next-day (24h) service to local businesses to deliver parcels city-wide; various types of vehicles are being trailed to extend the catchment service. Orders are handled via the Cycle Logistics operator's portal, and opportunities to develop and apply the GREEN-LOG augmented intelligence modelling platform will be investigated. The extension of the service catchment alongside the collaborations it has established with shippers (such as FedEx and DHL Express) offer opportunities to combine cycle logistics with lockers at station locations within the city. Cooperation with local businesses interested in developing box+vehicle solutions for city-wide deliveries of refrigerated goods will be also investigated.

FGC's rail services extend far beyond the City of Barcelona, offering a wide typology of stations, some of which already have intermodal facilities (park&ride, controlled bike parking, etc.). The rail operator and the metropolitan authority ATM are interested in examining how stations facilities can be improved to facilitate sustainable logistics.

4.2.1 Keywords

Scalability, exchange of best business practices, logistics at rail station locations, local businesses and mass transit passengers, cargo bikes, lockers, micro-hub, Light Electric Vehicles (LEVs).

4.2.2 Local Context

VANaPEDAL is working on innovations aimed at consolidating a viable medium-sized cargo-bike business (employing more than a dozen couriers riders). GREEN-LOG is an opportunity to trial and bring to market those solutions that bring added value to local businesses and other stakeholders. Finding cargo-bike peers internationally to identify transferrable business models and best practices is a key benefit of GREEN-LOG, as is the collaboration with other local stakeholders to identify synergies and best practices. The City of Barcelona has established seven cargo-bike hubs and aims to equip each of the 10 districts with such services (VANaPEDAL's hub is the longest-established of these hubs). ATM and Ferrocarrils, as public transit operators, had shown interest to learn about possibilities for intermodality and to prioritise between lockers (as in the Greek case) or cargo bike hubs (such as in the Oxford Living Lab). For VANaPEDAL, the expectations from clients will determine the object of the LL (for example testing feasibility of 8h delivery).

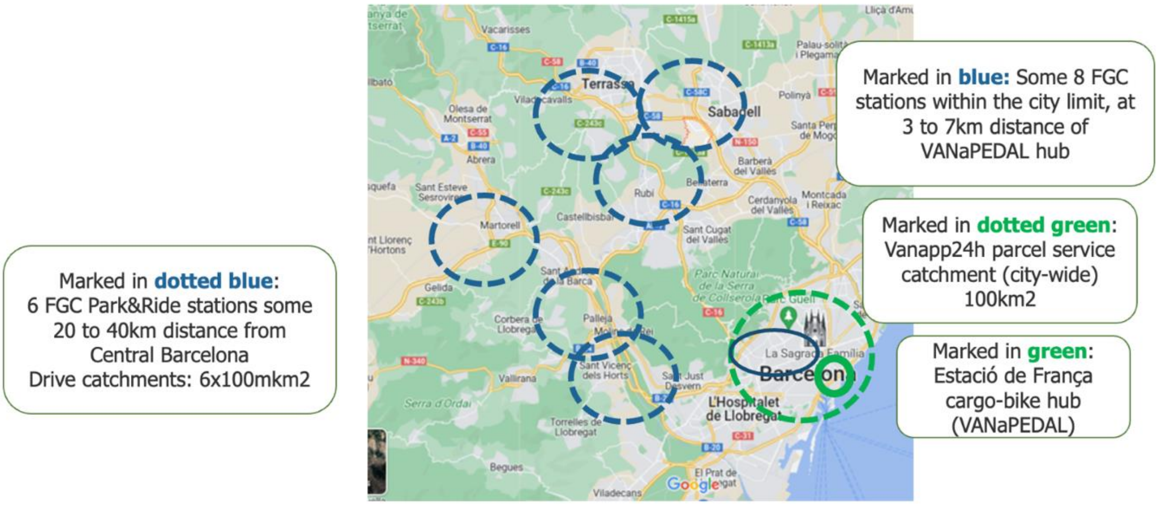

Figure 12: LL Barcelona's local context for their LL activities

4.2.3 Local Challenges

Establishing its own portal is a pivotal step forward for a Last-Mile Operator like VANaPEDAL – a key move to becoming both green and digital. The company engages with local businesses in a new way; their needs (city-wide catchments, types of goods, etc) become apparent, and this brings challenges to find the best combinations of solutions (vehicles, boxes, and lockers).

The suburban area presents additional challenges. Stations are concentrators of passenger movements that bring new modal interfaces into play; park&ride, electric scooters, lockers, cargo-bikes. Technology help configure how passengers' access not only the mass transit service but also those of other goods and services at the station premises.

4.3 LL #3 Flanders (BE): Last mile Urban Logistics as a Service.

The objective is to develop a functional Logistics-as-a-Service (LaaS) platform where urban logistics data is used to link demand (e.g., urban freight shipments, on-demand requirements, storage requirements) and supply (e.g., the provision of sustainable logistics services, warehouse space, need for certain type of vehicles) in order to improve the sustainability of city logistics. The data gathered and lessons learned will then be formalized within the development of SUMPs beyond the GREEN-LOG project. After establishing a baseline situation mirroring the current urban freight situation, the city partners from Mechelen, Leuven and Gent will build upon signed agreements for collaboration with LSPs operating in their vicinity, to recruit zero-emission last mile carriers that will service demand on the GREEN-LOG platform. Several iterations will provide data on pricing mechanisms, necessary stakeholder interactions and data/IT requirements for a wider implementation and demonstration towards the wider Flemish urban logistics landscape (other LSPs, shippers, cities, levels of government) to encourage a sustainable, integrated and regional LaaS implementation.

4.3.1 Keywords

(Intercity) scalability, citizen involvement, accountability, sustainable living lab outcomes, business stakeholder engagement, engaging key gatekeepers (i.e., university), cargo bike delivery, inter- and intra-organisational collaboration, inter-project learning.

4.3.2 Local Context

The Flanders LL draws its originality from the collaboration of several medium-sized cities in the Belgian region of Flanders at a crucial turning point for urban freight. The zero carbon emission zone policies are a common thread between the cities, focusing on the climate neutral city with active mobility creating a liveable city, which tends to resonate with parts of the population. The participating municipality representatives are complementary in terms of experience and stakeholder networks and have an established working relationship, with additional support from VIL.

Figure 13: LL Flanders' local context of the three cities of Mechelen, Leuven and Gent

A key objective is involving the whole chain of the ordering process including supplier, LSPs providers and consumers. Due to the limited availability of warehouse locations, adding real estate actors or LSPs with existing hubs would be an asset. Belgian manufacturers and retailers and business associations are relevant stakeholders; individual shopkeepers must be engaged through concrete trade-offs beyond their business association. In Leuven, wij.leveren is a community of local shop owners who are already invested in thinking about the sustainability of the last mile. Promising partnerships to involve from the start include: the city innovation and development in Leuven, existing cycle logistics operators in all cities, a group of citizens that have manifested interest in the subject, City depot.

4.3.3 Local Challenges

Finding actors that are active in all cities is one first step towards finding transversal questions. However, every city needs to maintain the freedom to conserve their own providers. With limited internal resources for research, city partners are committed to a bottom-up, research-in-action approach developing applicable practices with tangible results for residents. Based on their extensive experience, consolidating this type of living lab approach requires a long-term approach. To engage the stakeholders, it is imperative from the outset knowledge about their needs. Involving industry stakeholders may be facilitated by a system operating in all cities. All partners must retain their autonomy with tenders and purchasing; however, involving purchasing department involved early on could be beneficial.

A core challenge is to designate a technology provider to develop the system. Involving the fluctuating but important student population requires adaptation to the academic calendar. Long term subsidies and zero carbon zone enforcement could support the dynamic pricing model beyond early adopters and beyond the experimental phase until it comes up to scale.

4.4 LL#4 Oxfordshire (UK): Next generation last mile delivery integrating cargo-bikes and AVs

A moveable Micro Delivery Hub as well as a Micro Consolidation Hub will be demonstrated in the city of Oxford. Configurations to be demonstrated include new customized cargo-bike designs with increased volume and weight capacity which can be dynamically deployed as mobile depots showing how CAV and cargo-bikes can work together, leading to increased efficiency and reductions of delivery cost per parcel. Moreover, Pedal & Post will work with OCC to identify suitable locations and make use of public spaces and parking spots where converted containers can be placed and act as Micro Consolidation Hubs for cargo bike based last mile deliveries or sites for dynamically deployed Micro Delivery Hubs. The GREEN-LOG LaaS marketplace will connect suppliers and consumers and be support rapid delivery services using cargo bikes and improve load pooling in the Oxford local market.

4.4.1 Keywords

Land use, sustainable living lab outcomes, cargo bike delivery, micro consolidation hub, micro delivery hub, public stakeholder engagement/engaging key gatekeepers (i.e. University), inter-project Learning.

4.4.2 Local Context

The Oxford LL will build upon and leverage an existing cluster of motivated stakeholders who are already activated. Amongst them, they provide a considerable knowledge base concerning last-mile delivery and its social, economic, and technical implications. One of the site's unique assets is the existence of a framework for the living lab in the form of the Zero Carbon Oxford Partnership (Z-COP), uniting the city and county council, the University of Oxford as well as several other organisations, and businesses throughout the city. One of the sprint groups comprising of the Z-COP is the Last Mile Freight Group which aligns with the objectives in GREEN-LOG. The University of Oxford and the colleges together form the largest landholders and one of the major parcel recipients in the city. The university and colleges are interested in sustainability goals, including creating efficient delivery and providing attractive living environments for staff and students. Moving around 8000 parcels a week, the internal delivery service makes them a partial competitor. The County Council's Local Transport and Connectivity Plan, approved in 2022, creates a favourable environment locally for GREEN-LOG, by encouraging zero emission last mile goods movement, freight consolidation, and cycle freight established as policy. As a cycle courier employer (23 full-time employees), Pedal & Post has previously established itself as a vocal advocate for cycling infrastructure as well as a policy changer as well as a credible local business partner.

Figure 14: LL Oxfordshire's local context of Park & Ride sites suitable for setting up moveable hubs.

4.4.3 Local Challenges

Identifying tangible benefits for internal and external stakeholders is an important next step. Defining specific groups of citizens interested in freight transport sustainability objectives is challenging because the broader goals (air quality, noise etc.) concern the entire public. However, citizen implication is required to determine 'user' expectations. Identifying specific locations for demonstrations will enable more targeted engagement through local users. There is a delivery disconnect between suppliers and consumers who wish to access products offered by those suppliers. The goal is to fill this gap by establishing dialogue throughout to avoid gaps in citizen feedback in engagement and consequent legitimacy or participation issues. More punctual implication appears more realistic for the county council, i.e., strategy and policy input early on and output towards the end of the project. The key challenge at present is land use and site identification since the LL is situated in a highly competitive real estate market and the existing Pedal & Post depot is working at capacity; one suggestion is to develop lockers as last mile endpoints for which mobile hubs offer flexibility. Providing datasets for the University of Wolverhampton requires a realistic number of sites. Another core challenge is to increase the efficiency of cargo bike deliveries on a larger scale, including national parcel carriers.

4.5 LL #5 Ispra (IT): Next generation last mile delivery integrating delivery robots

A multi-modal delivery service will be implemented in the European Commission's Joint Research Centre (JRC) in Ispra, pending the formalisation of a collaboration agreement with JRC. Cargo bikes (Measy) and drones (Yape) provided by E-NOVIA will be used in the pilot test. Yape will provide a food & beverage delivery service from the selected catering facilities to the selected offices. The implementation of the full service will involve the deployment and operation of a software platform to manage the service (developed within the consortium) Yape operators to manage the droids, GREEN-LOG marketplace. The aim is to collect orders, and optimally assign them to the vehicle (droid or cargo bike).

4.5.1 Keywords

Testbed/proof of concept, drone delivery, cargo bike delivery, stakeholder engagement, iterating technology/friction for technology.

4.5.2 Local Context

The experimental complex at JRC offers promising conditions for testing technical implications in delimited space with identifiable stakeholders and pre-existing expertise in experimental or LL approaches. Stakeholders aim for a test bed to provide a proof of concept for a technological innovation of unified platforms for multimodal delivery. These experimental ambitions should be harmonised with a more iterative, co-creative LL approach. Aligning visions about the character of the project and thinking about solutions for user involvement is thus a first step objective for this project. User implication will be contingent on the selected pilots; other stakeholders are the riders for the delivery bikes, either through internal resources or an external Italian delivery company. A crucial stakeholder on the business side is Yape.

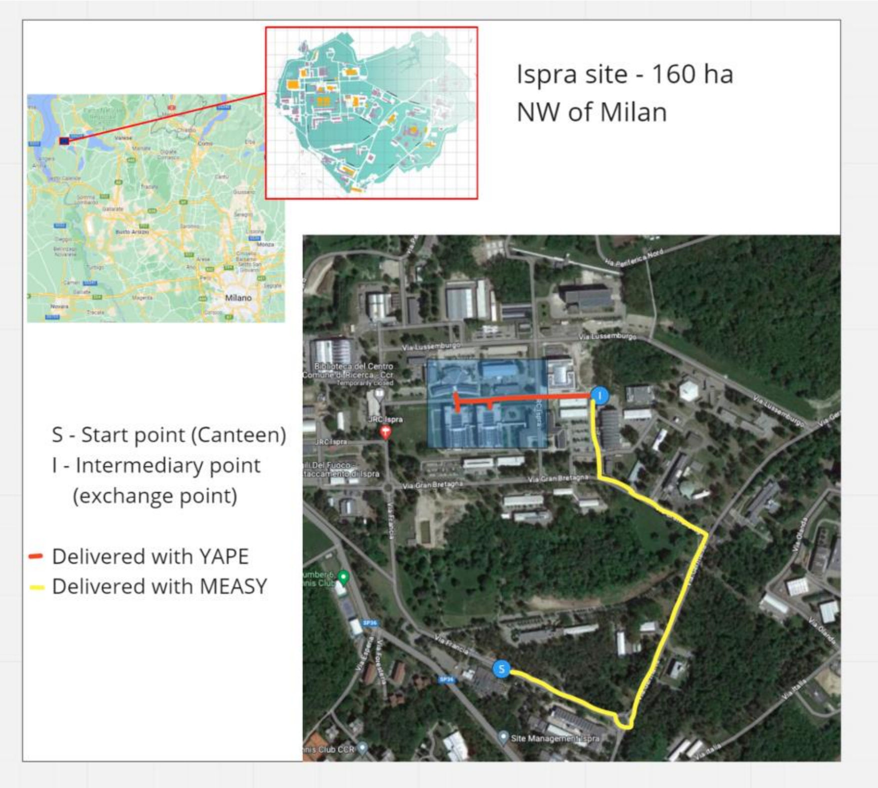

Figure 15: LL Ispra's local context for their LL activities is placed in the European Commission's Joint Research Centre

4.5.3 Local Challenges

A key challenge in this context is engaging stakeholders over time and scaling the technological confrontations beyond the controlled JRC space, which makes it an important task to identify potential long-term benefits and tangible outcomes for different users and stakeholders. While the technical questions are comparatively advanced in this project, they are also the source of some challenges: for example, drones only cover small, controlled spaces, and might prove challenging to integrate with bikes.

5 LL Scoping

After the first initial interview, the second phase of the LL scoping stage took place through a series of digital Meet-Ups presented in Section 2.

Meet-Up 1: An interactive digital Meet-Up with the each of the Living Labs was organised individually, to elaborate on the goals and visions, the main barriers and the existing and new stakeholders to be invited. We also did a prioritisation of what would be the next steps to establish the GREEN-LOG LL in each of the sites.

Meet-Up 2: All these activities went into a joint Meet-Up 2 where the LLs co-created a collaborative structure with involved and informed stakeholders and identify different users and their possible user journey's while interacting with the suggested service.

Meet-Up 3: Finally, the LLs presented the results from their scoping activities in Meet-Up 3 for the WP1 partners and the projects follower cities.

Below we present the results of these scoping activities in a way that gives an overview across the different LLs visions and goals, main challenges and success factors, main barriers, and organisational and collaborative structure. We have also aggregated and clustered the key questions that the LLs have identified as relevant to have as foundation for coming cross-LL activities and trading zones. Finally, we present the LLs tentative user journeys ideated by the different LLs.

5.1 Visions and Goals

Each of the Living Labs was invited to collaboratively discuss and present their goals and visions on a shared digital work-frame (in the MIRO software) and in this section we present the result from these meetings.

Table 5: LL goals identified by core teams in GREEN-LOG's Living Labs.

Living Lab	What does it want to achieve?
LL Athens	Improve citizens quality of life. Raise awareness on green innovative solutions. Promote Athens as a green tech implementation hub.
LL Barcelona	Identify and test IT tools and improve last mile logistics/Digitize last mile solutions and try different tools and use cases. Find a use case where Public Transport network can participate in last mile delivery solutions. Greener and more efficient last mile logistics – improve and optimize last mile logistics.
LL Flanders	More sustainable city logistics (less driven kilometres and less vehicle movements, visible changes in the city). Connecting supply and demand for both sender and receiver, with a technological solution that is data driven. Sender's and receiver's role being effectively included in the last-mile logistics. Awareness of societal costs of last/first mile deliveries.
LL Ispra	Demonstrate the use of a multimodal delivery service with robots and riders in a city-like environment to achieve a sustainable delivery process.

	Mixing the technology of Yape and Measy in a unique delivery service. Obtaining a multimodal delivery to reach a regular service offered to the Ispra community which could be transferable as much as possible to a city-like case. Use of Ispra site to facilitate the promotion of innovation.
LL Oxfordshire	Development of last mile freight infrastructure to support climate goals whilst enabling growth and economy. Real world demonstration and data collection of the possibilities and benefits of using micro consolidation including simulation of CAVs. Understand the feasibility, potential, and societal response to micro consolidation. Long-term space to continue collaborative innovation and testing green logistics solutions among a wider group of stakeholders.

5.2 Main Challenges and Success Factors

This section constitutes a conclusion of how the Living Labs define the local requirements to succeed. The challenges and success factors defined in previous sections are consolidated in the Table 6 and Table 7.

Table 6: Main challenges for identified by core teams in GREEN-LOGs Living Labs

Living Lab	Main challenges
LL Athens	Raise awareness to final consumers. Convince the market and the users of e-bike solutions. Effective communication and collaboration among the stakeholders. How to succeed close to zero emissions deliveries in a central city like Athens.
LL Barcelona	Urban logistics business models. Recruiting local business customers. Find use cases to test and reach local stakeholders (not involved in the consortium). Reach a multiplicity of stakeholders.
LL Flanders	Defining the pilot by translating theory into practice (Research vs Implementation). Creating the Technology that supports the needs. Stakeholder engagement/involvement – defining added value for all involved stakeholders.
LL Oxfordshire	Getting necessary resources together and overcoming technical issues in the time available whilst adapting in rapidly developing field Identifying and gaining permissions to use of a site that meets all requirements in the right location. Directly involving all stakeholder categories including citizens to co-design solutions that are a win for all.
LL Ispra	Integrate different technologies like Yape droids and cargo-bikes for efficiency increasing, extending routes length and providing a flawless and transparent user experience at the same time. To engage and involve users in the LL. Establish agreements and resolve administrative and procedural aspects.

Table 7: Main success factors for identified by core teams in GREEN-LOGs Living Labs

Living Lab	Main success factors
LL Athens	Usability of solutions. Engagement of competing courier services. Sustained collaborations beyond the project. Co-design activities that make participants collaborate Effective communication of benefits of solutions. Develop or use an existing app for customers. Gain public acceptance.
LL Barcelona	Connection to the rest of the GREEN-LOG project. Demonstrate that this service is useful for and of interest to local businesses. Develop a user-friendly interface. Critical mass in terms of a fleet of riders and types of bikes able to serve a city-wide delivery service. To find win-win situation among involved stakeholders Commitment of stakeholders.
LL Flanders	Time to talk and do iterations with stakeholders. Technology that gives more insight in the societal cost of city logistics and can help to achieve a behavioural change. User-friendly technology accessible for all stakeholders and that can last beyond the project.
LL Oxfordshire	Financial sustainability and effectiveness of solutions. Successful implementation and feedback to improve and adapt if needed. Collaboration between partners in data sharing & strong teamwork/effective communication.
LL Ispra	Ensure timely collaboration of the parties involved. Definition of the common project objectives and KPI. To involve all the stakeholders and work together, especially the final users to get feed-back on the UX.

5.3 Main Barriers

In relation to the goals and visions presented in section 5.1 and 5.2, each of the LLs discussed and compiled the main barriers they could identify at this present stage.

Table 8: Main barriers for identified by core teams in GREEN-LOGs Living Labs

Living Lab	Main Barriers
LL Athens	Lack of infrastructure and regulation on micro mobility In order to expand and replicate the solution, concern should be given to the implementation process of the micro consolidation centres
LL Barcelona	If the passenger train cannot be used for logistic purposes. Lack of economic viability. Lack of alignment between stakeholders both internally and externally. Slow and difficult decision-making processes for public entities. Operators loosing clients/money during trial-phase.

	Lack of understanding of the LL trial-error approach. Conflicts of interests related to multiple stakeholders.
LL Flanders	Finding one common ground/solution for all 3 cities: overcome the differences in cities. Resistance to involvement of end-receivers/shop-owners/traditional LSPs/political representatives. Time to bring in all stakeholders in all cities to define LL.
LL Oxfordshire	Procurement issues and processes: delays, and value for money. Problems finding suitable site with good cycle access. Too slow development of technology. Difficulties in buy-in in couriers and national parcel carriers outside of consortium. Social, legal and political barriers. Problems with involving the right partners.
LL Ispra	System setup (control room installation, internet connectivity). Paths identification physical barriers (sidewalks, steps). Final users' involvement. Use case and KPI definition. Delivery robot traveling without interfering with other road users. Administrative coordination between stakeholders. Technical integration of the solution. How to offer a continuative service and manage corner cases (how to guarantee the delivery if technical faults arise, which area to implement the delivery service, where to put logistic bases, customer engagement etc).

5.4 Organisational and collaborative structure

The different LLs were facilitated to develop an organisational and collaborative structure based on which stakeholders are included in the core team (full time on the project), the involved team (regularly providing input or helping to move work forward), and the informed team (wants to stay up date and will provide input when necessary).The procedure of establishing this structure followed an iterative process, including the following steps and the figures below serve as indicative examples of the different steps and at the same time represent the work done to establish a first version of collaborative and organisational structure for their Living Labs. These structures were developed based on the same template but then refined in different styles as shown below and will be iterated on during coming trading zone activities across the LLs.

Firstly, the LLs were invited in Meet-Up 1 to describe which stakeholders were involved according to the clusters presented in the Knowledge Base (see Figure 7 in section 3). The LLs were asked to write up the already existing stakeholders with blue notes and new/wanted stakeholders with green notes. In Meet-Up 2 the LLs were then invited to iterate on this first list of stakeholders by moving them into the structure of core, involved and informed teams. While the first activity reinforced the LLs to identify which clusters of stakeholders are still missing, the second activity supported them to formulate to what extent these stakeholders were expected to be engaged. Figure 16 shows how the second round of these activities were staged in Meet-Up 2 through the example of LL Athens.

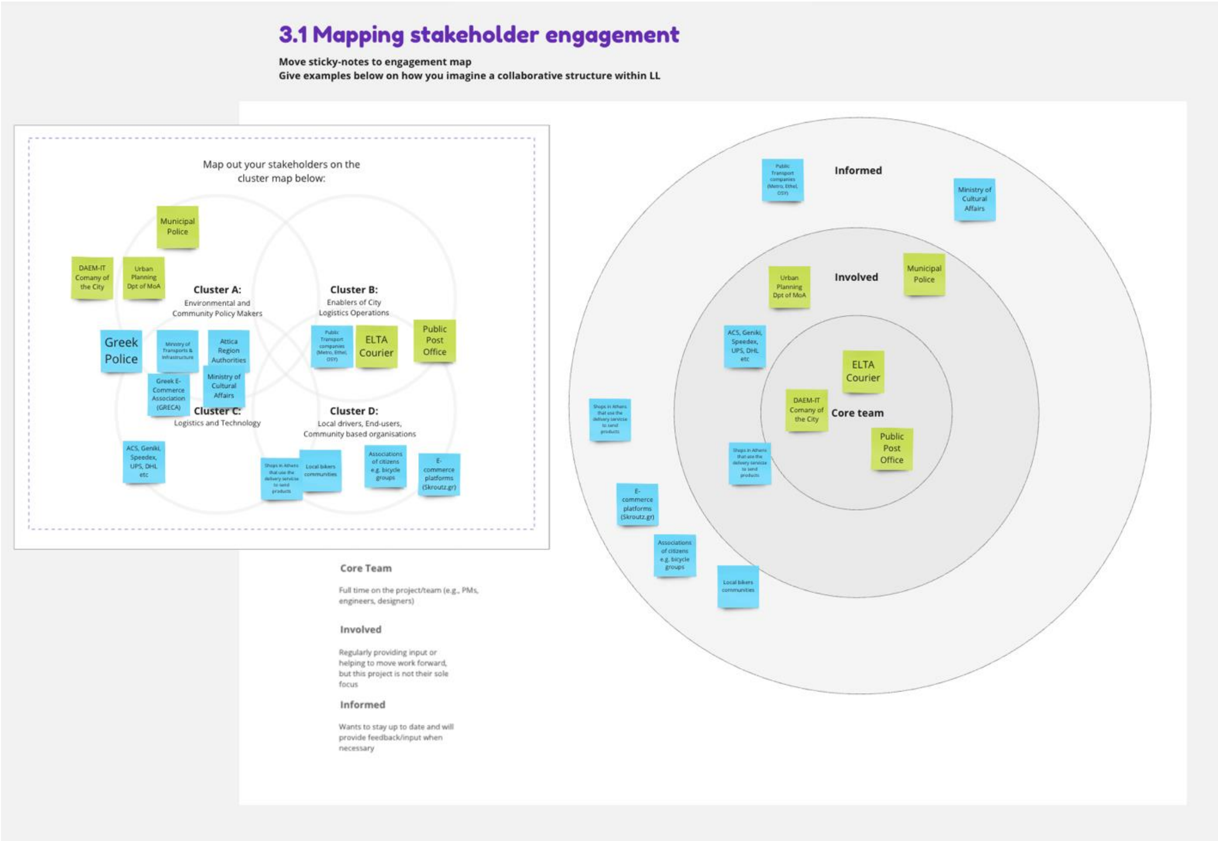

Figure 16: LL Athens MIRO board after been facilitated to organise local stakeholders by clusters and levels of engagement.

After the activities being carried out, the LL participants were asked to migrate the organisational structure to present it at Meet-Up 3. Figure 17 shows how LL Barcelona chose to represent the structure and Figure 18 shows the result from LL Oxfordshire.

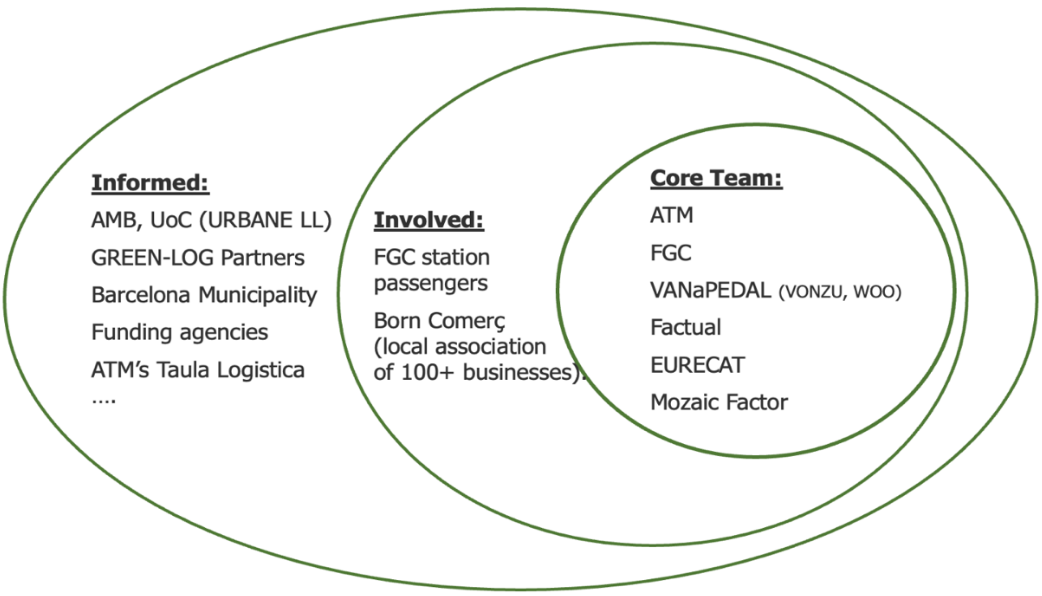

Figure 17: LL Barcelona's organisational structure developed and migrated from their MIRO board.

Figure 18: LL Oxfordshire's organisational structure with task descriptions, developed and migrated from their MIRO board.

During Meet-Up 3, the LLs were also asked to present the collaborative structure of the LLs as shown in indicative examples in Figure 19 and Figure 20. Figure 19 shows how LL Flanders have presented their collaborative structure by indicating meeting frequency and Figure 20 shows how LL Ispra present their collaborative structure through a flowchart.

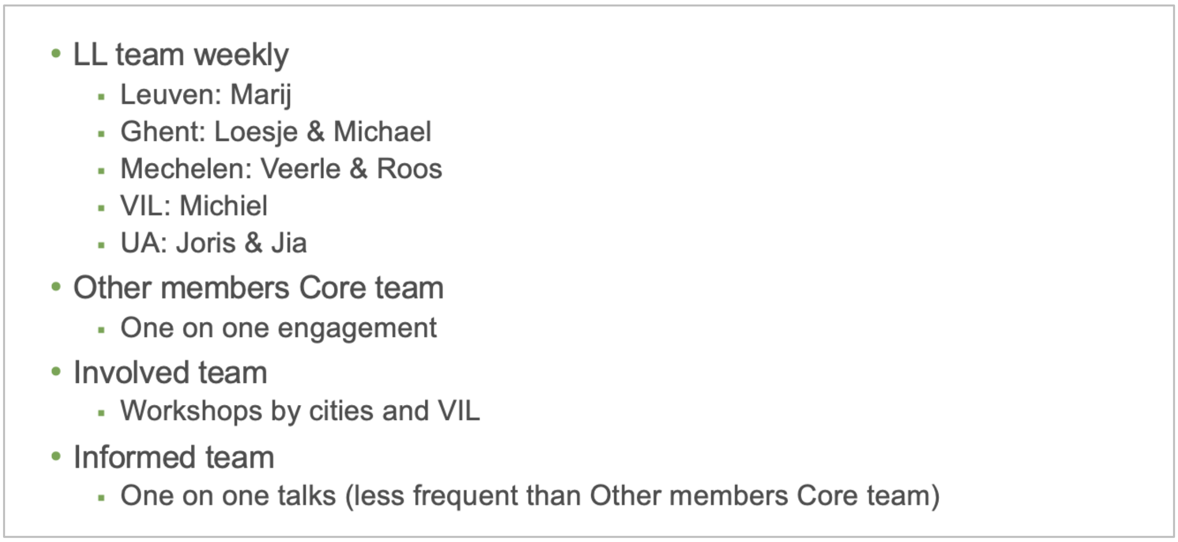

Figure 19: LL Flanders' collaborative structure indicating meeting frequency, developed and migrated from their MIRO board.

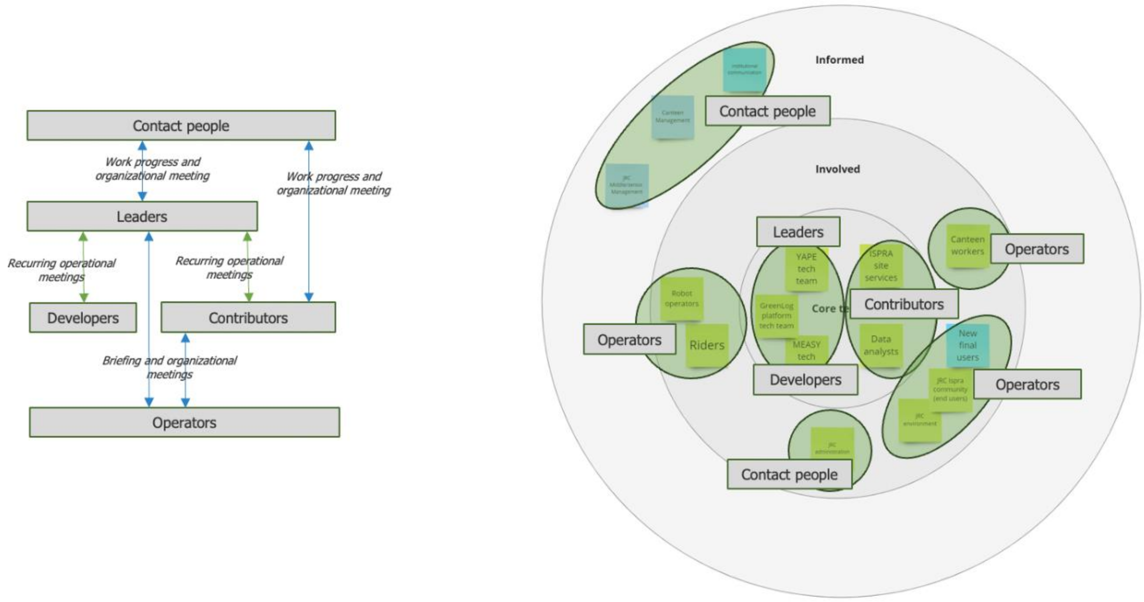

Figure 20: LL Ispra's collaborative structure presented as a flowchart, developed and migrated from their MIRO board.

5.5 Tentative User journeys

Each of the LLs were also facilitated during the scoping face to develop a human-centred approach to the delivery solutions by identifying possible users and their interactions with the solution through so called "User Journeys". Typically, a User Journey refers to a design tool that presents the complete sequence of interactions and experiences that a user goes through while engaging with a product or service, from initial awareness and engagement to final conversion or desired outcome. User Journeys are useful for understanding and empathizing with users, identifying pain points and opportunities, and informing the design and optimisation of products or services.

At this stage in the GREEN-LOG project, this activity was primarily based on so called 'proto personas'. A proto persona is a preliminary and generalised representation of a potential user, often based on assumptions or limited research, used to guide early-stage design decisions. This activity resulted in tentative User Journeys to be used for staging coming user involving co-creation activities and defining user requirements. These tentative User Journeys were also done to serve as communication tools for co-creation activities in task 1.3 and 1.4 in WP1 and to be used for technical solution ideations with WP2 and WP3 (see figure 1 above). That is, the tentative User Journeys was introduced to facilitate the LLs to concretise and communicate their local delivery solutions into coming engagements with LL stakeholders, GREEN-LOG task leaders and citizen engagements. Below we will present the tentative User Journeys as they were presented by the LLs at Meet-Up 3 by LL Barcelona in Figure 21, LL Flanders in Figure 22, LL Oxfordshire in Figure 23, and LL Ispra in Figure 24, while discussions about Athens LL User Journey are ongoing.

LL Barcelona aims at determining how sustainable city logistics can be realised/improved from railway station locations by cargo-bikes that are presented in this video (LINK) and Figure 21 below.

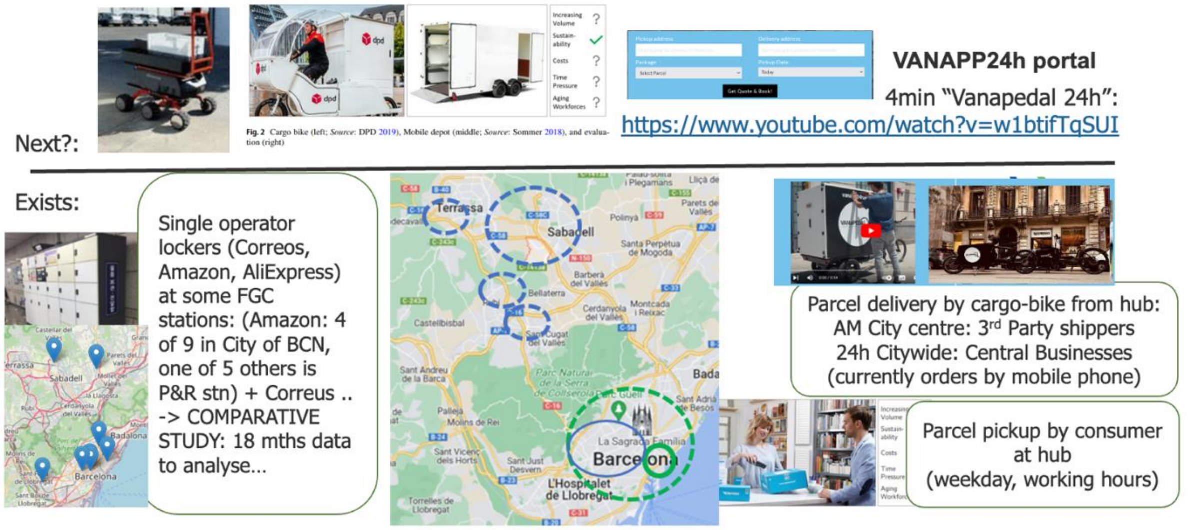

Figure 21: LL Barcelona's tentative User Journey presents how cargo bikes in the green dotted zone can be used for deliveries in relation to railway stations marked in blue.

LL Flanders aims at developing a Logistics-as-a-Service platform to link demand and supply between Citizens and local shopkeepers, see Figure 22 below.

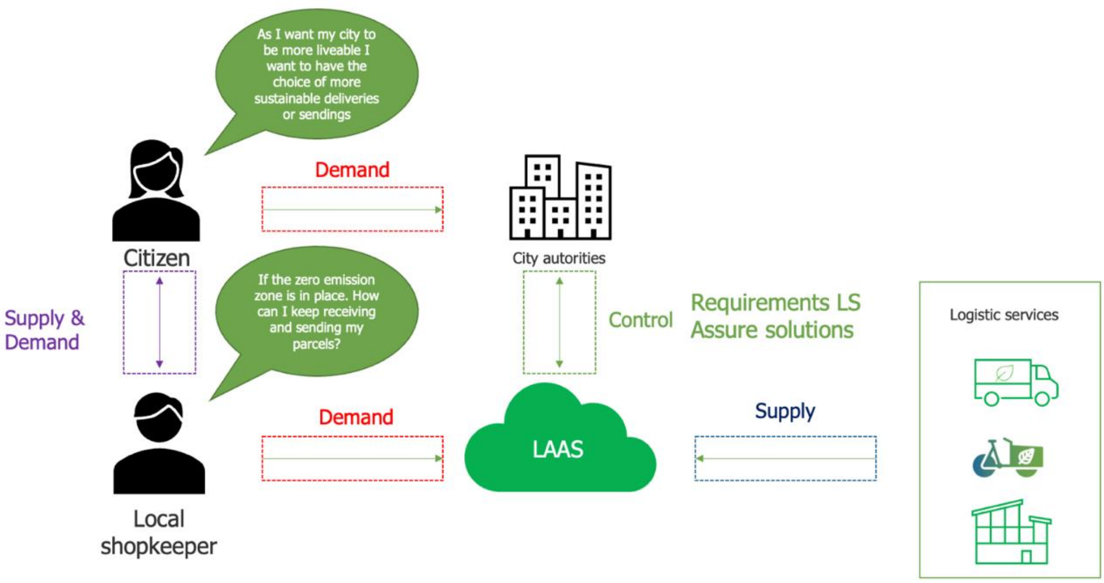

Figure 22: LL Flander's tentative User Journey presents how citizens and local shopkeepers can be served by a Logistics-as-a-Service platform.

LL Oxfordshire aims at developing moveable micro consolidation hubs and micro delivery hubs to support last mile cargo delivery as presented in Figure 23 below.

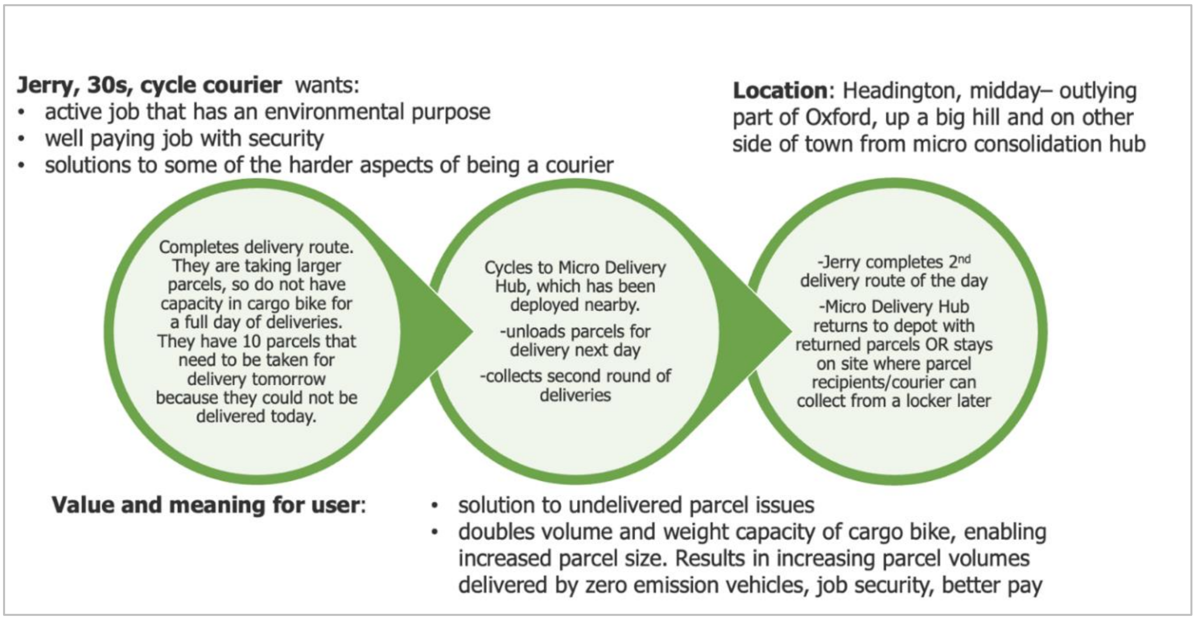

Figure 23: LL Oxfordshire's tentative User Journey presents Jerry, a cargo bike courier in his 30s, and his interaction with a moveable micro delivery hub.

LL Ispra aims at developing a delivery platform that combines a booking system with delivery robots, see Figure 24 below.

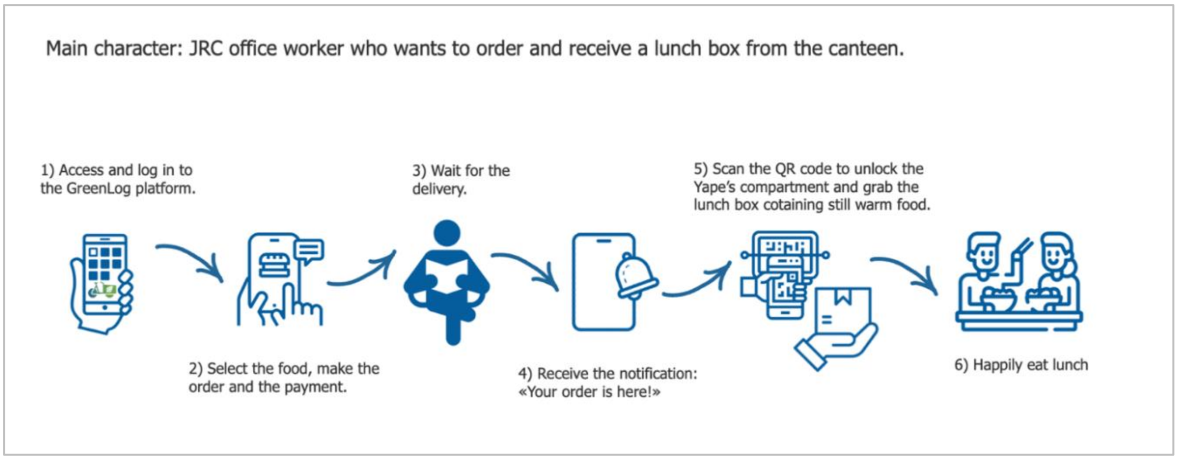

Figure 24: LL Ispra's tentative User Journey presents how an office worker orders a lunch box from the canteen delivered by a delivery robot service.

5.6 Aggregated Key Questions

Through the interactions with the LLs, we have aggregated and clustered the initial key questions raised by the LL-teams. These key questions concerned maintained engagement, stakeholder involvement, citizen engagement, translations, scaling, LL sustainability, cross LL collaborations and can be found in section 5.6.1 - 5.6.6. These key questions will form the foundations of coming supportive structure for cross-collaboration between the LL in GREEN-LOG trading zones.

5.6.1 Questions about Stakeholder Involvement

How to build and maintain stakeholder implication in the project?

How to ensure that Living Lab outcomes, relationships and engagements persist beyond the time of the project?
How to know which private partners and businesses best to integrate and how?
How to extend dialogue and shared understanding to more stakeholders than those initially invested in GREEN-LOG?
How to provide a concrete tangible tool or service that users can experience and evaluate and that provides stakeholders with something to gain?
How to generate and organise public stakeholder implication on a realistic timeframe?

5.6.2 Questions about Citizen Engagement

How to meaningfully and durably involve citizen participation?
How to bridge the gap for consumers, producers etc. towards a greener transportation solution and durably transform the supply chain towards sustainability beyond the logistics providers?
How to motivate and raise awareness with the end users? with technology affordances or with a pedagogical approach?
Awareness and engagement have to precede implementation.
Is citizen involvement possible in the context of a controlled space with pre-existing technological solutions?

5.6.3 Questions about Translation, Implementation and Effects

How are the theoretical tools for co-creation put into concrete practice?
How to put existing business ideas and existing policy objectives into practice, i.e., how to use partnerships for implementation and scaling?
How to evaluate and test the impact of local business policies on supply chain behaviour and sustainability?
What is a working definition of a hub? How is a hub different from a micromobility rental station? How to scale from 2 existing cycle delivery hubs to further ones?
How to start from solutions to identify possible contributions from technology, rather than starting the thought process with the technology?
How to translate policies, concepts and goals into concrete socio-technical and material practices?

5.6.4 Questions about Scaling

How to upscale the solutions that are produced in an iterative, co-creative process?
How to generate flanking policy; one of the challenges is to integrate sustainable transport into the political agenda?
How to identify and develop transversal questions, technical applications and actors across different sites and groups within and between city regions?
How to extend a locally situated working living lab or Last Mile concept to wider contexts?
How to scale from locally situated and experimental processes to wider application contexts?

5.6.5 Questions about LL Sustainability

How to sustain the living lab beyond the time of the project?
How to create durable long-term stakeholder and citizen engagement?
How to provide tangible durable benefits for involved actors?
How to generate lasting policy support and infrastructural investment to consolidate LL outcomes?
How to secure resources to continue support for established practices?
How to create tangible solutions and human centred design to consolidate engagement and build persistent change through living labs?

How to sustain satisfaction with diverse stakeholders?

5.6.6 Questions about Cross LL Collaboration/Trading

What learnings can be generated through collaboration and communication across Living Labs?
What are relevant future 'trading zones'?
What are best practices and mindsets and how best to evaluate and share them?
How to track how solutions are implemented and what works?
Establish a shared online tool to collaborate with other living labs and
Produce key questions for everyone to collaborate on and answer the same set of questions at regular intervals throughout the process of the project to track progress and variations.
How to learn from solution implementation processes from other living labs?

6 Conclusions

This deliverable presents the result of the first six months work in the GREEN-LOG with task 1.1 and task 1.2 to deliver a 'Knowledge Base of Last-Mile Solutions and GREEN-LOG requirements specification' according to the specification of Deliverable 1.1 in the Grant Agreement (GA). The primary goal is to form a baseline both in relation to documented best practices (task 1.1) as well as in relation to the actual five LL that are going to lead the pilots (task 1.2). The report presents a thoroughly made literature review and the results of a tailored GREEN-LOG LL scoping process in which we have established a joint starting point for coming activities for LL co-creation and co-learning through the life of the project. The baseline is formed through aligning goals, barriers and key challenges and questions, as well as establishing core, involved and informed teams of stakeholders in each LL. The solutions each of the LLs have set out to implement has also gone through a first iteration through the lens of possible user journeys and local sites.

We are following the structure for orchestrating Participatory Design projects presented in Smith and Iversen (2018), where the different phases in the project are characterised by dimensions of Scoping, Developing and Scaling. The GREEN-LOG LLs have now moved through the first Scoping phase with co-exploration and the emergence of relevant participants and defining key questions with a focus on fostering dialogues and common understandings among stakeholders and researchers. The next step in task 1.2 is to move the LLs into a Developing phase and working collaboratively with stakeholders to engage iteratively with the technological solutions at different levels of abstraction. As a first step we will do this by creating both generic and context-specific activities and frameworks aligned with involvement of citizens and local stakeholders to experiment and co-develop their own implementation practices.

We consider our results R1.1 Knowledge base of best practices, lessons learnt, and impacts and R1.2 The GREEN-LOG Urban Living Lab methodology and LLs creation to be verified through the KPIs; a) more than 30 last mile interventions and best practices analysed and documented and b) five Urban Living Labs established.

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