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DELIVERABLE

D4.2 – Evaluation of first round of Demonstrations

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Executive Summary

This deliverable evaluates the first round of demonstrations conducted across five European cities—Athens, Barcelona, Ispra, Flanders, and Oxfordshire—each testing innovative logistics approaches and technologies developed by GREEN-LOG and tailored to the local urban and peri-urban contexts.

The evaluation methodology utilized a mixed approach, including pre- and post-demonstration questionnaires, a continuous monitoring tool, and specific Key Performance Indicators (KPIs) to capture the effectiveness of implemented solutions. Major solutions demonstrated included multimodal transport integration, autonomous delivery robots, moveable consolidation hubs, mobile delivery hubs, smart lockers, and a Logistic-as-a-Service (LaaS) platform.

Athen's pilot employed simulations to compare shared versus independent last-mile deliveries, significantly reducing travel distance and CO_2 emissions through shared electric vehicle operations and smart lockers. Barcelona focused on multimodal solutions integrating public transport and cargo bikes, alongside testing autonomous delivery robots within a railway station environment. Despite some challenges in navigation, robotic solutions proved viable for indoor logistics operations. In Ispra, meal deliveries via combined cargo bikes and autonomous droids highlighted strong user acceptance and satisfaction despite minimal improvement in delivery times. Flanders tested consumer behaviour through LaaS, achieving considerable consolidation of deliveries and indicating positive user acceptance of sustainable logistics methods. Ghent and Leuven, facing initial implementation challenges, redirected their approaches to data-driven insights and stakeholder engagement, preparing effectively for the subsequent round of demonstrations. Oxfordshire demonstrated robust logistics solutions, including predictive demand tools, optimized routing services, mobile and moveable consolidation hubs. The Mobile Delivery Hub notably improved courier efficiency by significantly reducing reloading times and journeys, while the Moveable Consolidation Hub demonstrated strong potential for parcel consolidation and emissions reduction.

Overall, GREEN-LOG's first-round demonstrations provided useful insights on the effectiveness of the developed solutions, confirming their potential scalability and operational feasibility. The identified challenges and the feedback provided by the relevant stakeholders/actors are used for the refinement of the use cases and as well as the further development and refinement of the GREEN-LOG solutions for the second round of demonstrations.

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Definitions, Acronyms and Abbreviations

Acronym/ Abbreviation	Title
ACS	ACS SA
AIMSUN	Aimsun SLU
ARAD	Municipiul Arad
ATHENS	Dimos Athinaion Epicheirisi Michanografisis
ATM	Autoritat del Transport Metropolità
AUEB	Athens University of Economics and Business – Research Center
BYOD	Bring Your Own Device
CAV	Connected Autonomous Vehicle
DMP	Data Management Plan
E-NOVIA	e-Novia SPA
EUT	Fundació Eurecat
FedEX	FedEx Express Greece
FEED	Mastiha World Ltd.
FGC	Ferrocarrils de la Generalitat de Catalunya
GDPR	General Data Protection Regulation
GENT	Stad Gent
HALM	Hogskolan I Halmstad
HELSINBORG	Helsingborgs Kommun
INTRA	NETCOMPANY – INTRASOFT SA
KPI	Key Performance Indicators
LaaS	Logistic-as-a-Service
LEUVEN	Stad Leuven
LEV	Light Electric Vehicle
LL	Living Lab
LSP	Logistic Service Provider
MCC	Micro-Consolidation Centre
MCH	Micro-Consolidation Hub
MECHELEN	Stad Mechelen
MOBY	Moby X Software Limited
n/a	Non applicable
OCC	Oxfordshire County Council
PEDAL	Pedal & Pour LTD T/A Pedal & Post
POLIS	Promotional of Operational Links with Integrated Services, Association Internationale
SME	Small and Medium Enterprise
SULP	Sustainable Urban Logistic Plan
SUMP	Sustainable Urban Mobility Plan
UAEGEAN	Panepistimio Aigaiou
UOA	Universiteit Antwerpen
UOW	University of Wolverhampton
VANAPED	Van-a-Pedal
VIL	Vlaams Instituut voor de Logistiek VZW

WP	Work Package
ZEZ	Zero-Emissions Zone

1 Introduction

The GREEN-LOG project aims at accelerating sustainable city logistics via the implementation of real-life solutions in multiple and heterogeneous last-mile delivery ecosystems. More specifically, the GREEN-LOG approach is centred around the concept of innovative co-creation in Living Labs (LLs), i.e., demonstration cities where solutions are designed, and scenarios are discussed and tested between several stakeholders. The five cities and areas where the approach is being deployed and validated are: Athens (Greece), Barcelona (Spain), Flanders (Belgium), Oxfordshire (UK) and Ispra (Italy). Each LL embodies different urban and peri-urban contexts in terms of logistic services, as well as varying economic and social backdrops.

1.1 Document scope and objective

The objective of this report is to assess the performance of the first round of GREEN-LOG demonstrations by analysing their impact on logistics efficiency, sustainability, and stakeholder engagement. The evaluation is based on data collected through structured instruments, including pre- and post-pilot surveys, a monitoring tool, and the calculation of key performance indicators (KPIs). The report provides insights into the effectiveness of the demonstrated GREEN-LOG solutions and highlights areas for improvement, contributing to the iterative development of the project's logistics innovations.

1.2 Document structure

The document is organized into seven main sections:
Section 1: Introduction – Outlines the objectives of this deliverable within the broader GREEN-LOG LL approach.
Section 2: Evaluation Approach – Describes the instruments used to collect the required data for assessing GREEN-LOG solutions during the first round of demonstrations.
Sections 3–7: Pilot-Specific Evaluations – Present detailed assessments of each LL, including key activities, demonstrated solutions, stakeholder feedback, and preliminary KPI estimates.
Section 8: Conclusions and Future Work – Summarizes key findings and provides recommendations for the next phase of GREEN-LOG activities based on its findings.

2 Evaluation Approach

This section outlines the approach used to evaluate the impact of the first round of GREEN-LOG demonstrations, detailing the data collection instruments and monitoring tool employed to evaluate the implemented GREEN-LOG solutions. The evaluation was designed to measure the extent to which the demonstrated solutions achieved their intended objectives across multiple levels—ranging from project-wide impacts to site-specific assessments within individual Living Labs (LLs).

2.1 Evaluation Instruments for 1st Round of Demonstrations

To systematically measure the effect of the GREEN-LOG solutions during the first round of demonstrations, several evaluation instruments (see Figure 1) were developed to guide the data collection process and analysis, taking into consideration the evaluation framework and the defined KPIs documented in Deliverable D1.3 [REF-01]. The instruments are designed to accommodate different evaluation levels while capturing a range of impacts, including user acceptance, operational efficiency and sustainability benefits.

More specifically, to support the collection of primary data from pilot participants, pre- and post-pilot surveys were designed to target them. Additionally, a monitoring tool was implemented to enable continuous tracking of pilot partners' activities, gathering insights from the first round of demonstrations to inform the further development of GREEN-LOG solutions by the project's technical partners. A shared spreadsheet was also used for collecting baseline values and project-related pilot KPIs. The data collected through these instruments facilitated the calculation of key performance indicators (KPIs) relevant to the solutions demonstrated in each pilot area and enabled the evaluation of GREEN-LOG solutions from the perspective of their users.

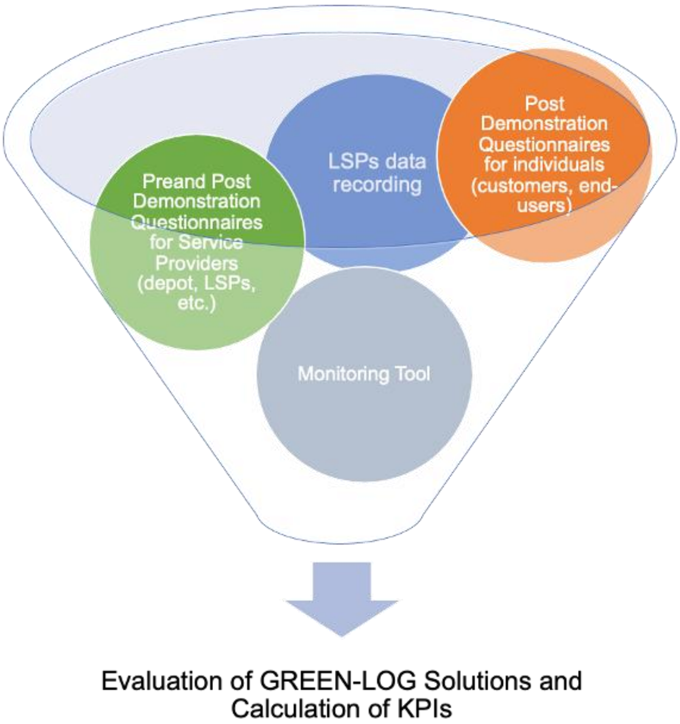


Figure 1: Evaluation Instruments

2.2 Pre- and Post-Demonstration Questionnaires

To measure the pilots' impact, a set of structured questionnaires was developed and administered to pilot participants.

The survey instruments targeted two key stakeholder groups: a. End-Users Survey: This post demonstration questionnaire was designed to assess customer perceptions of sustainable urban logistics solutions, including awareness, service acceptance, delivery performance, and perceived neighbourhood improvements following the implementation of GREEN-LOG solutions (see Annex I); and b. Service Provider Survey: Two separate surveys (pre and post demonstration) were deployed for couriers, depot managers, and micro-hub managers. The Pre-Pilot Survey allow us to establish a baseline by collecting data on job satisfaction, operational efficiency, logistics service levels, and existing challenges, while the Post-Pilot Survey allow us to measure the changes introduced in work conditions, delivery performance, coordination effectiveness, and overall service improvements following the pilot implementation (see Annex I).

Moreover, a dedicated survey for e-commerce shopkeepers was developed for Oxfordshire, to assess the impact of the GREEN-LOG platform on business operations, sales performance, logistics efficiency, and customer satisfaction. This provided insights specific to the commercial sector (see Annex I).

2.3 Monitoring Tool

In addition to the structured surveys, a monitoring file was developed as a tool for continuous documentation of pilot activities. This served multiple purposes:

- Tracking pilot progress and capturing key activities.
- Documenting challenges encountered and assessing operational bottlenecks.
- Identifying emerging requirements to inform technical refinements of the GREEN-LOG solutions.
- Facilitating structured communication between pilot partners and technical teams to ensure that lessons learned were integrated into project developments.

The monitoring tool was established at an early stage to enable real-time tracking of demonstrations and provided a structured way to document stakeholder interactions, task progress, and operational adjustments. These included logbooks, issue reporting mechanisms, and regular stakeholder meetings to discuss observed challenges and refine technical solutions accordingly.

As shown in the Figure 2, it was designed to emulate a roadmap.

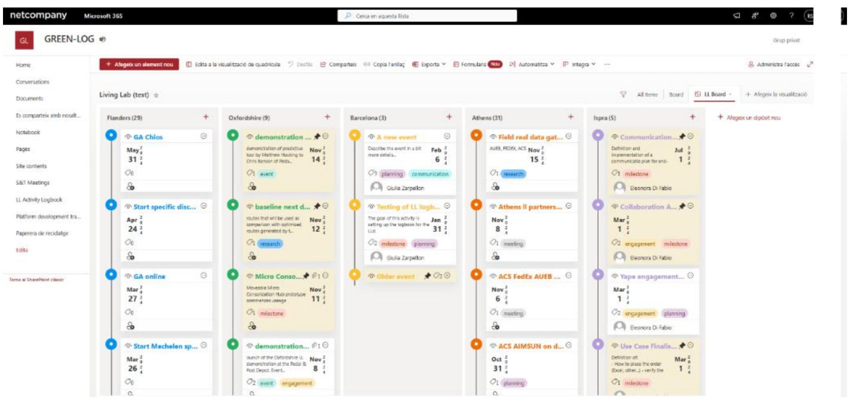


Figure 2: LSPs Monitoring Tool

The complete list of events registered can be found in Annex II.

2.4 Baseline Values of GREEN-LOG KPIs

A crucial component of the evaluation methodology is the collection of baseline data prior to pilot implementation that allows the impact assessment of the GREEN-LOG solutions in alignment with the defined KPIs. The GREEN-LOG KPIs were selected based on their relevance to the participants in each LL, ensuring that local priorities were adequately represented. A shared spreadsheet was developed allowing pilot partners to provide the values of the baseline KPIs and progressively add input on the new values observed during the pilot demonstrations.

3 Evaluation Results for the Athens Pilot

This section presents the evaluation results of the Athens pilot activities during the first round of demonstrations, detailing the key activities and solutions demonstrated, an evaluation of the pilots based on participant feedback and the calculation of relevant GREEN-LOG key performance indicators (KPIs).

3.1.1 Key Activities and Solutions Demonstrated

The first round of the Athens Living Lab demonstrations focused on **simulation-based analysis.** The only real-world operational component was the **use of smart lockers**, which functioned with actual shipments. The primary objective of this phase was to assess the efficiency of a **shared last-mile delivery model**, where **ACS** and **FedEx** collaborate using a **white-label electric vehicle** and a single driver, in comparison to independent operations where each company performs deliveries separately.

The Key Activities of the Athens pilot involved:

1. Simulation of Shared vs. Independent Delivery Operations
    - The demonstration examined the operational efficiency of two scenarios:
        - Scenario A: ACS and FedEx performing last-mile deliveries separately.
        - Scenario B: ACS and FedEx sharing a common white-label vehicle, optimizing their routes collaboratively.
    - The AUEB routing algorithm was applied consistently across both scenarios to ensure direct comparability.
2. Use of Smart Lockers in Real Conditions (see Figure 3)
    - While vehicle-based deliveries were simulated, the smart lockers at predefined locations (e.g., Serafeio, Klauthmonos) were fully operational and handled real shipments.
    - Customers were notified upon parcel arrival and could retrieve their shipments.
3. Real Data Analysis for Performance Evaluation
    - Both ACS and FedEx provided real operational data to AUEB for algorithm development and simulation.

Figure 3: Smart Lockers at Serafeio and Klauthomonos parking station

The illustration of the envisioned solution to be implemented and tested by GREEN-LOG is depicted in Figure 4. The left part illustrates the demonstrated scenario (Scenario A) where a shared vehicle is going to the individuals' addresses. At scenario B (right part) the vehicle stops at specific stops and the recipients pick up the parcel

(10' walking isochrones, described in the picture). At the first round of demonstrations, we simulated only scenario A.

Scenario A **Scenario B**

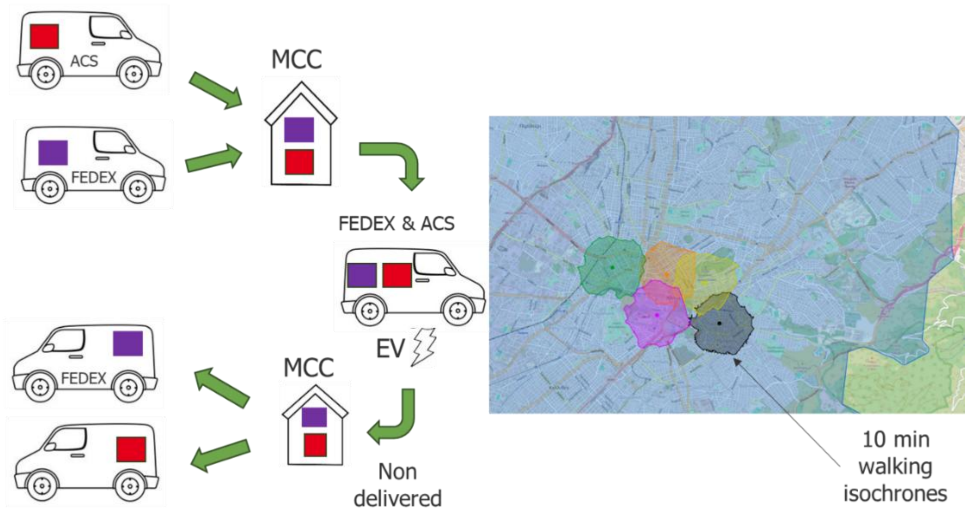


Figure 4: Envisioned GREEN-LOG solution for Athens LL

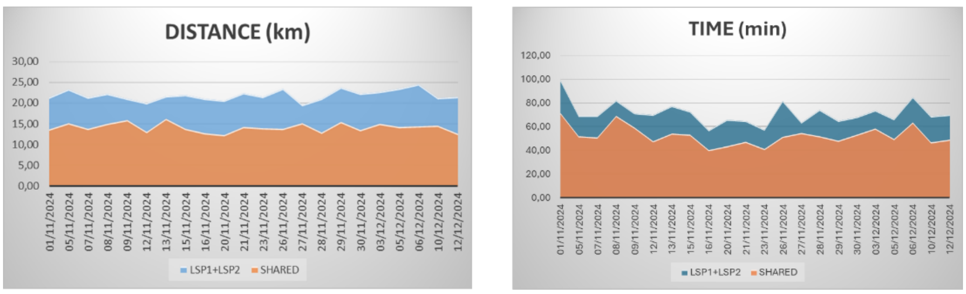
3.1.2 Evaluation of the First Round-Preliminary KPI Estimates

The key performance indicators (KPIs) measured included:

- Route efficiency: Distance travelled per delivery.
- CO_2 emissions reduction: Estimated environmental impact of shared vs. independent operations.
- Delivery times: Impact of consolidation on customer service times.

The results, visualized in the charts, were derived by comparing simulated shared operations with the baseline of independent delivery operations over the same period.

As it can be seen in the below graphs (Figure 5 & 6), a significant reduction in both kilometres driven (-35%), travel time (-26%) and number of stops (-12%) was observed through the simulated scenarios in the first round of demonstrations.



- 35,18% -26,51%

Figure 5: Distance and travel time

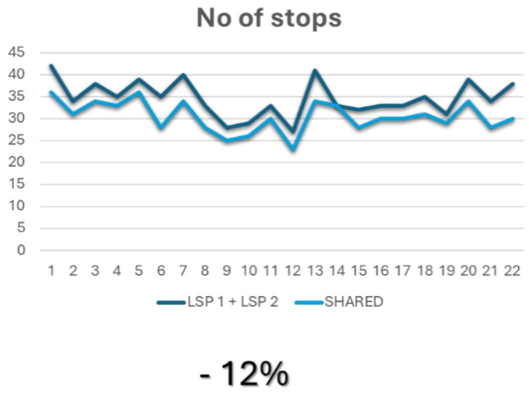


Figure 6: Number of stops

The graphs below illustrate the load shared by ACS and FEDEX as part of the first round of demonstrations (Figure 7 & 8).

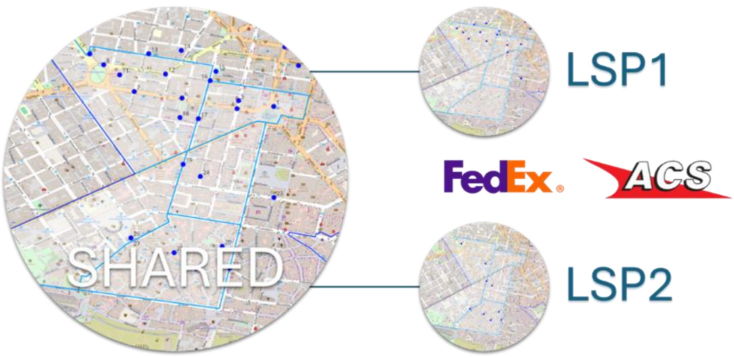


Figure 7: illustrate the load shared by ACS and FEDEX

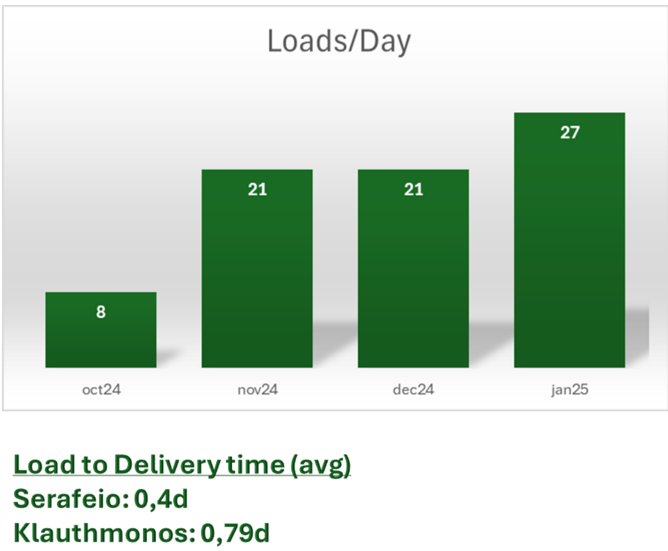


Figure 8: First round of demonstrations

4 Evaluation Results for the Barcelona Pilot

This section presents the evaluation results of the Barcelona pilot activities during the first round of demonstrations, detailing the key activities and solutions demonstrated, an evaluation of the pilots based on participant feedback and the calculation of relevant GREEN-LOG key performance indicators (KPIs).

To better understand the activities performed during the first round of demonstrations, it is relevant to provide an overview of the targeted scope to be demonstrated during the project. The differential element in Barcelona LL with respect to the other LL's is the inclusion of public transport as a facilitator to keep low emissions, reduce traffic congestion and extend the range of operation of small e-cargo bike LSPs. In that sense, the maximum scope is depicted in Figure 9. As it can be seen, it involves collaboration between two LSPs operating in different areas connected by a railway operator, multimodality also at local level and inclusion of a robot to minimise the impact of idle times in the train segment of the journey searching for economic sustainability of the service.

Figure 9: Overall scope of the Barcelona LL

The target for the first round was to identify any operational barrier that may arise to the rider in the transfer to the train and in the train journey itself, the operational barriers for the robot to operate in the train station and on the train, and to test the usability of the components of GREEN-LOG solution to be used in the LL. It is out of the scope of the first trial to address the interaction between the two LSPs that are meant to collaborate since the second LSP (La Terrassenca) went out of business during summer.

4.1.1 Key Activities and Solutions Demonstrated

4.1.1.1 Multimodality

Purpose and scope

As previously mentioned, one of the key elements of Barcelona LL is the integration of public transport in the logistics activity. In particular, the public transport to be included is a railway line operated by FGC that serves the city and connects to other medium towns in the Barcelona Metropolitan Area.

The activity envisioned for the first round of demonstrations has been to use the train to reach the upper part of the city. As depicted in Figure 10, the new area to be served has an elevation of 200 meters above sea level. On the other hand, VANAPED hub and its traditional area of operation is less than 30 meters above sea level which implies a remarkable slope for riders to overcome.

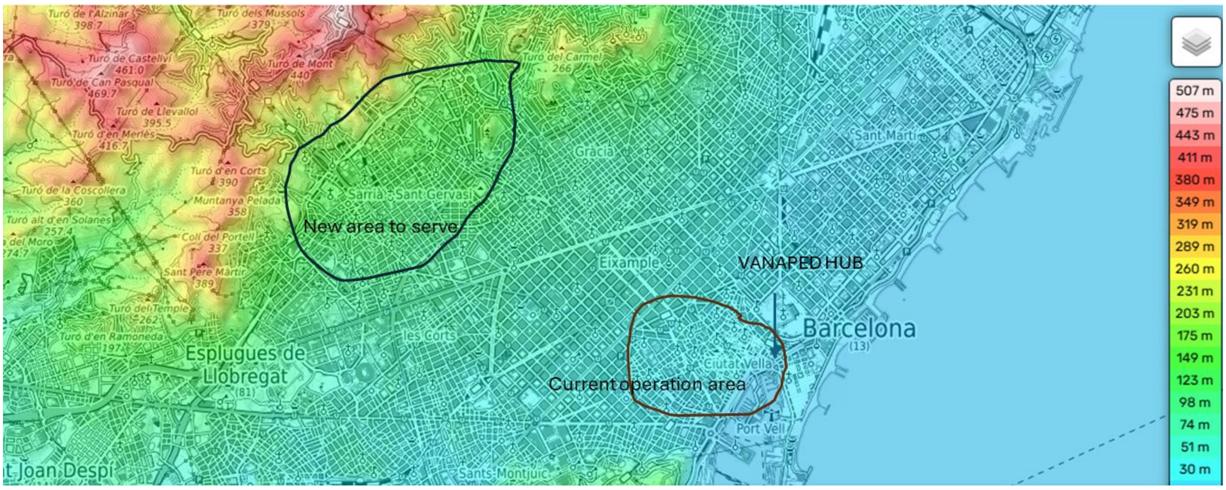


Figure 10: Topographic map of Barcelona (source: https://es-es.topographic-map.com/)

The setting

VANAPED operation area is in the district called Old Town in Barcelona. In this sense, there is not yet demand coming from the targeted area (Sarrià-Sant Gervasi). In fact, it is expected from the demonstration activities to elucidate whether operating in this area is a good business model for VANAPED. For the purpose of the demonstration activities, the demand has been created artificially and the parcels delivered were fake parcels.

The multimodal route (Figure 11) includes the following segments and transport modes (table 1):

Table 1: Transport modes

#Segment	From	To	Transport mode
1	VANAPED hub	FGC Plaça Catalunya train st.	e-Cargo bike
2	FGC Plaça Catalunya train st.	FGC Sarrià train station	Train
3	FGC Sarrià train station	drop-off locations and back to FGC Sarrià train st.	On foot
4	FGC Sarrià train station	FGC Plaça Catalunya train st.	Train
5	FFGC Plaça Catalunya train st.	VANAPED hub	e-Cargo bike[1]

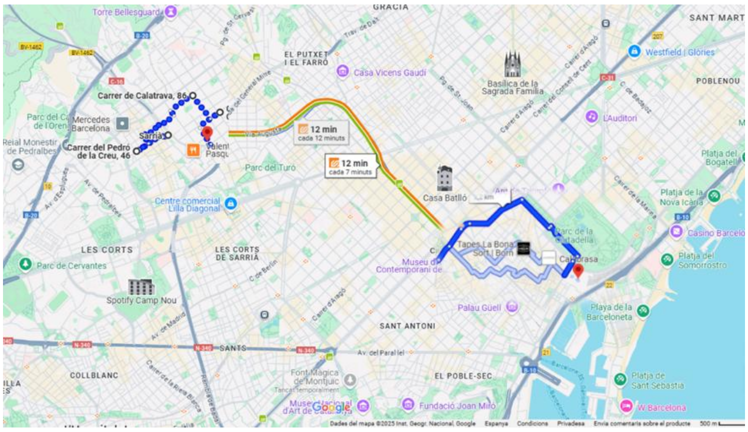


Figure 11: Multimodal journey according to Google Maps

Tests

It is also of interest of this first round to compare the performance of different transport modes. Thus, the following tests have been conducted:

1. Multimodal route to deliver one parcel to location 1 in Sarrià-Sant Gervasi district
2. Multimodal route to deliver 4 parcels to 4 different locations in Sarrià-Sant Gervasi district
3. E-Cargo bike route to deliver 4 parcels to 4 different locations in Sarrià-Sant Gervasi district
4. E-Van route to deliver 4 parcels to 4 different locations in Sarrià-Sant Gervasi district

The route has an elevation gain of 129 m, as depicted in Figure 12 (according to Google Maps)

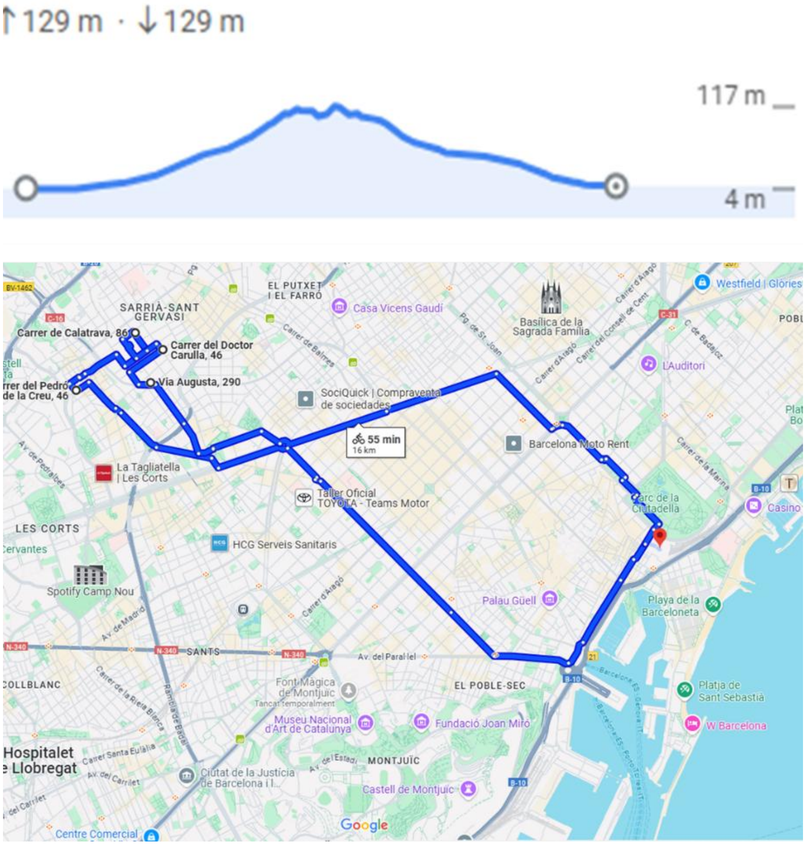


Figure 12: Templatise bike route (source: Google Maps)

Two different types of bikes were used, as depicted in the pictures below (Figure 13). The biggest one (left) was used for the multimodal route. It is heavier and suitable for flat/short distances and has a larger capacity. The bike was parked outside the station and secured with a chain and padlock. For the hilly route (delivery with bike only), a lighter bike was used (middle). The van used is an electric van of medium size (right).

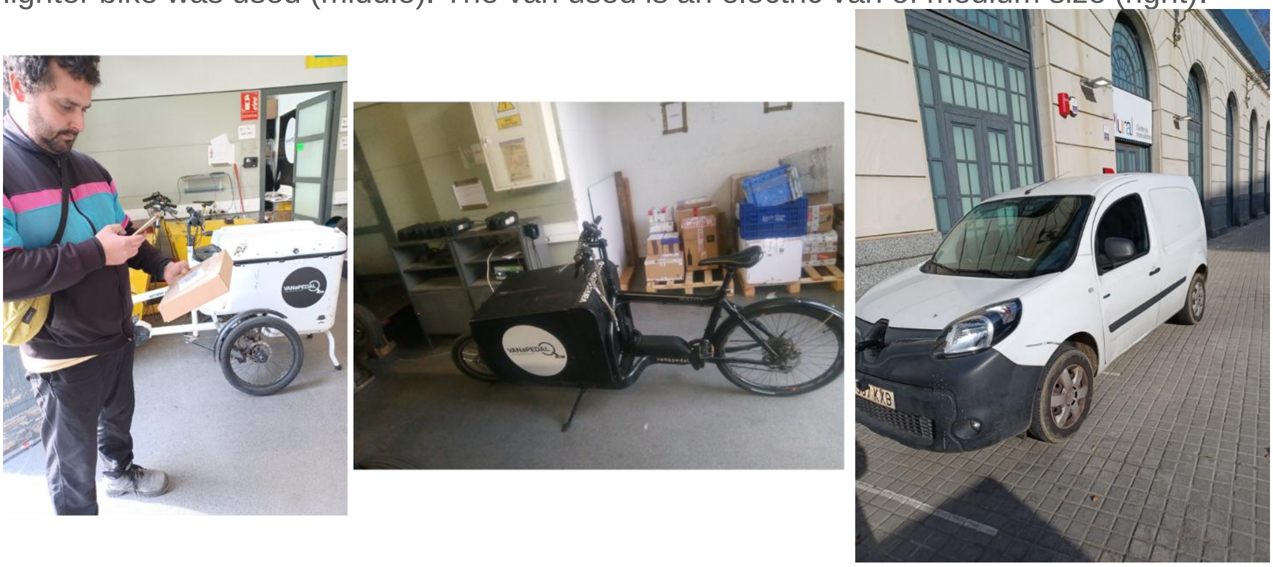


Figure 13: e-bikes and e-van used in the trials

4.1.1.2 Testing of GREEN-LOG components

It is the aim of the LL to test 3 components of the GREEN-LOG solution ecosystem:

- BYOD SDK & App
- The day-to-day optimization module
- AIMSUN simulation framework (in combination to the day-to-day optimization module)
- The Data Space

The purpose of the BYOD App is to keep track of the parcels and record the duration of each segment of the journey to check the accuracy of the simulation framework. For that purpose, the list of events available have been customized to fit to the multimodal routing. The list includes:

- Departure from depot Vanapedal
- Arrival to depot Vanapedal
- Departure from MCC
- Arrival to MCC
- Arrival at intermodal hub
- Departure from intermodal hub
- Parcel delivery successful
- Parcel delivery failed
- Parcel pickup successful
- Parcel pickup failed
- Parcel handover rider2rider successful
- Parcel handover rider2rider failed
- Parcel handover rider2robot successful
- Parcel handover rider2robot failed

A label was attached with a plastic envelope to each box corresponding to the parcels to be delivered, as shown in the picture below. The label contains a QR code and the parcel ID (Figure 14).

Figure 14: Parcel with QR code label

The day-to-day optimisation module provides the route to deliver the parcels (fake demand has been generated). A route for each mode has been generated (multimodal,

only bike, only car). The travel times have been obtained from the simulation framework.
During the trials, there was not a complete integration of all the intervening components. Only the BYOD and the Data Space worked together. The demand was generated randomly using the Barcelona network model. The information of the parcels was introduced into the Data Space using a script. From them, the mobile app (BYOD) retrieved the information from the parcels and updated the status according to the node of the root reached. Working off-line, the Day-to-day optimization module generated the routes for each transport mode.

4.1.1.3 Autonomous vehicles/Droids

Purpose and scope
For the multimodality approach, it was identified the need to minimize idle times during the train leg of the route. In this sense, the focus of the **Barcelona pilot** was to test the use of an autonomous delivery robot in a train station environment, evaluating how it performs key tasks involved in an indoor last-mile delivery operation. The trials were carried out at the **FGC train station facilities in Sabadell** and aimed to assess the robot's ability to navigate autonomously, interact with existing infrastructure like elevators and trains, and move safely through public spaces.

The scope of the tests covered all the main phases of a **typical indoor delivery** workflow. From navigating the station to handling vertical and horizontal movements, and interacting with transport infrastructures, the trials reproduced the different steps that a robot would need to perform during a real delivery. This allowed for a **complete evaluation** of the robot's potential to operate reliably and independently in this type of setting.

The setting
Sabadell – Rambla station is an old railway station of the FGC S2 line, located in the city of Sabadell, about 25 km from Barcelona. Nowadays, Sabadell - Rambla is out of operational railway service, but, since 2018, it is used as a Railway Professional Development Centre, so it is used as a space to provide training on railway operations, carry out simulations with police and firefighters, and other types of tests. The space perfectly replicates a functioning station, allowing the simulation of a real scenario, with elevators enabled, a real train inside, and the possibility to simulate the opening and closing of wagon doors just as they would happen on an operating train.

Robotic Platform
The robotic platform selected for these demonstrations was the **RBVogui** robot (Figure 15) developed by **Robotnik**, a robust and modular mobile robot tailored for logistics, inspection, and research applications. RBVogui is built on an **omnidirectional base**, which provides enhanced maneuverability in constrained or crowded environments. This capability is especially valuable in environments where:

- **Precise positioning** is required.
- **Sideways movements** (lateral translation) are useful for alignment.
- **Smooth navigation** is critical in shared spaces to avoid abrupt turns that could be hazardous for pedestrians.

The RBVogui used in the GREEN-LOG trials was equipped with the following sensor suite:

- Two **Livox MID360 LiDAR** sensors, mounted on opposite sides of the robot to provide full 360-degree environmental perception. These LiDARs are compact, reliable, and include **integrated IMUs**, enhancing **Simultaneous Localization and Mapping (SLAM)** performance and environmental awareness. They served as the **main sensors for environment sensing and comprehension**, supporting both mapping and real-time obstacle detection.
- An **OAK-D LR RGB-D** camera from **Luxonis**, capable of providing synchronized RGB and depth data streams. The camera was used for perception tasks involving object and features detection, crucial for interacting with elements in the environment.
- A **custom-designed transport box**, mounted on the robot, representing the cargo area for last-mile delivery payloads. The box was specifically designed to test spatial integration, safety during motion, and the robot's ability to manoeuvre while carrying goods.

The software stack is ROS2-based and includes implementation of navigation and control modules that enable real-time sensor fusion, autonomous path planning, and high-level task coordination.

Figure 15: EUT Droid

Tests

These activities focused on testing the feasibility and performance of autonomous robotic systems for last-mile delivery tasks in public transport environments. The main objective was to assess the capabilities of an autonomous delivery robot navigating through complex indoor spaces such as train stations, including interaction with typical infrastructure elements like elevators or trains.

The test list was designed to evaluate all the key capabilities required for a complete autonomous delivery operation inside a train station. Each test addressed a specific segment of the delivery workflow, with the overall set forming an integrated validation of the robot's readiness for deployment. The following components were tested:

1. **Autonomous Elevator Interaction**
The robot autonomously navigated to designated elevator areas (Figure 16), identified elevator doors using the RGB-D camera, and positioned itself accurately in front of the doors. It then waited for the doors to open, verified the elevator's availability, and safely entered without human intervention. Once inside, it remained still during the elevator ride and exited autonomously at the destination floor when the doors opened again.

Figure 16: Autonomous Elevator Interaction

2. **LiDAR-Based SLAM and Autonomous Navigation**
Using LiDAR and IMU data, the robot performed SLAM to generate a detailed map of the environment (Figure 17 & 18). Based on this map, several waypoints were defined—such as elevator lobbies, corridors, and train platforms. The robot was then instructed to navigate autonomously between these points. Throughout the operation, it used real-time **transferability analysis** and **collision detection and avoidance mechanisms** to ensure safe, smooth navigation in semi-structured public spaces.

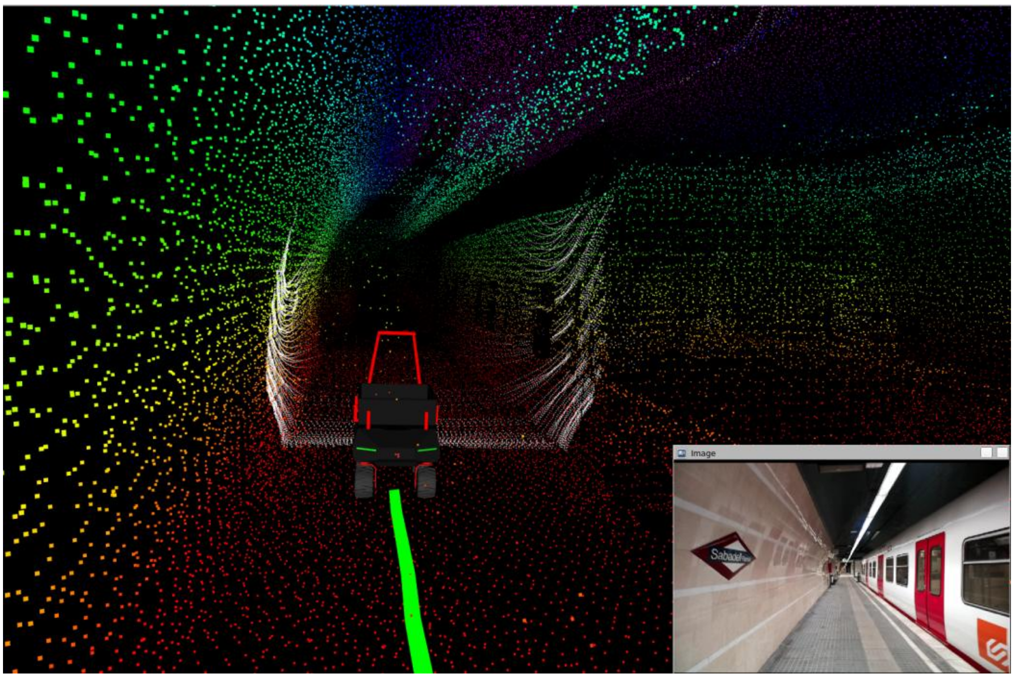


Figure 17: LiDAR-Based SLAM and Autonomous Navigation

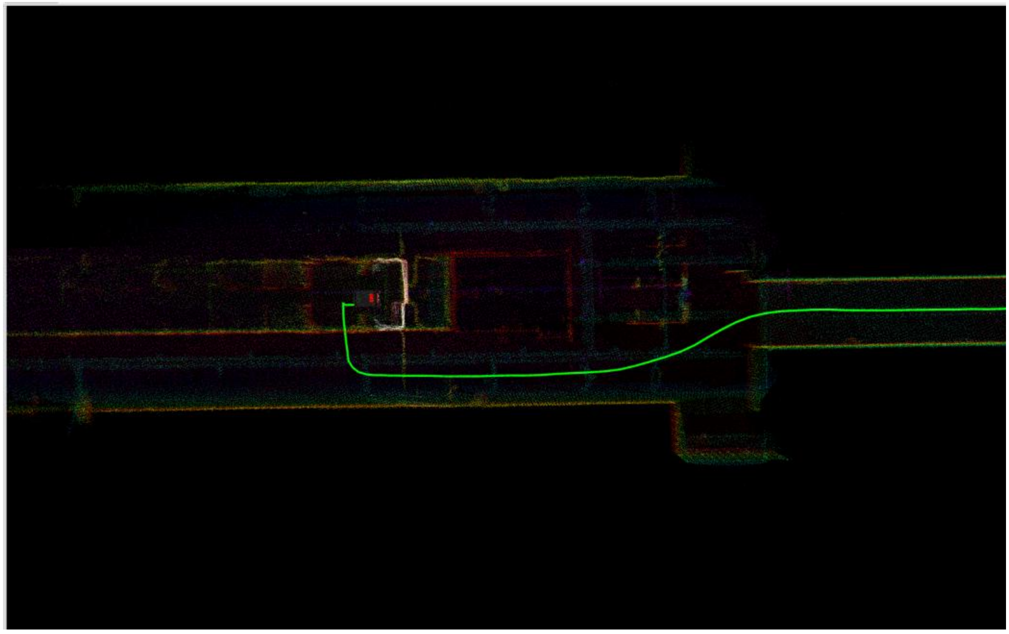


Figure 18: Detailed map of the environment

3. **Autonomous Train Boarding**
   A key element of the pilot was to validate the robot's ability to **autonomously enter a metro train**. After navigating to the correct position on the platform—aligned with where the train doors would open—the robot waited and used the camera to detect door opening (Figure 19, 20, 21 & 22). Upon detection, it advanced into the train, manoeuvring precisely to a predefined parking position designed to minimize obstruction and disturbance for passengers.

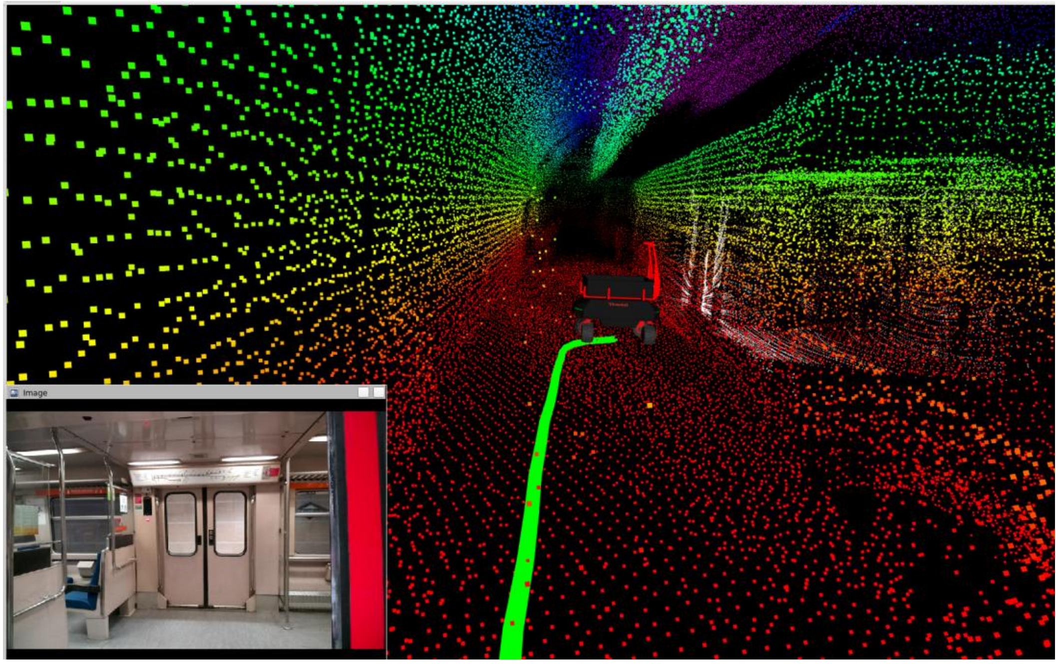


Figure 19: Door opening detection (1/4)

Figure 20: Door opening detection (2/4)

Figure 21: Door opening detection (3/4)

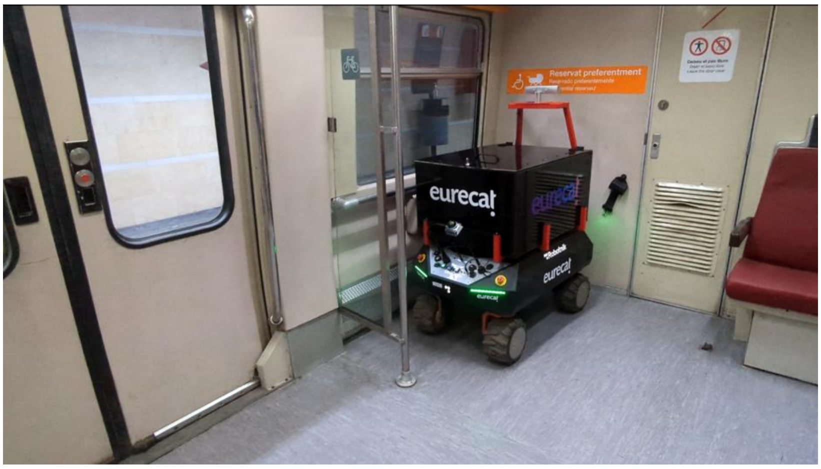


Figure 22: Door opening detection (4/4)

4.1.2 Evaluation of the First Round

4.1.2.1 Multimodality – Assessment

As mentioned before, the same route to deliver 4 parcels was performed with different transport modes. The rider/driver was instructed to use the BYOD device app to register an event each time they arrived/departure from each node of the route.
During the first tests some drawbacks were identified and amend before being able to extract useful information. For instance, during the first bike trip part of the data was not properly stored in the data base. Once realized, the software was fix, but unfortunately, part of the data was lost.
Also, during these first tests, it was seen than recording the status of each parcel in each node was too time consuming and cumbersome, especially between transport modes. Thus, for the following tests, only at the beginning of the route (VANAPED hub) and at the respective delivery locations the scanning was done for each parcel. In the intermediate nodes, only one of the parcels was scanned. This led to define an improvement for the next version of the app, to allow to register an event for a group of parcels.
The transition between transport modes in the multimodal route was smooth. The trip was done in off-peak hours although the train frequency was quite high (waiting times less than 6 minutes) since 3 different lines serve the area.
The e-bike was parked outside the station, since the dimensions of the bike make it difficult to access and find a storage place.
During the first test the scanning process often failed. The possible reasons are the type of lighting inside the office or bad connection. However, after some training and for the following tests the app worked fine.
It was also noticed that for one of the trips (multimodal) the rider forgot to register one of the events (arrival/departure from the station).
The following table (Table 2) compares the actual versus the calculated (day-to-day optimization) times for the different options.

Table 2: Multimodal route evaluation results

Event	Transport Mode	Actual Time	Measured interval (sec)	Simulated Time	Simulated interval (sec)
Departure from Vanapedal hub	Cargo bike	15:27:26	0	16:00:00	0
Arrival at intermodal hub	Cargo bike	15:40:43	797	16:15:00	900
Departure from intermodal hub	Train	15:54:52	849	16:15:00	0
Arrival at intermodal hub	Train	16:08:29	817	16:26:00	660
Parcel 1 drop-off	on foot	16:08:29	0	16:37:00	660
Parcel 2 drop-off	on foot	16:17:11	522	16:56:00	1140
Parcel 3 drop-off	on foot	16:27:55	644	17:07:00	660
Parcel 4 drop-off	on foot	16:33:42	347	17:18:00	660
Arrival at intermodal hub	on foot	16:39:07	325	17:33:00	900
Departure from intermodal hub	Train	16:44:00	293	17:33:00	0

Arrival at intermodal hub	Train	16:46:29	149	17:44:00	660
Arrival at Vanapedal hub	Cargo bike	16:59:35	786	17:59:00	900
SUMMARY			**1:32:08**		**1:58:48**

The actual time taken is shorter than the simulated one. It was observed that the rider did not wait about 2 minutes to simulate the interaction with the receiver of the parcel (as it was instructed to), while the simulator considers this service time it. Another difference is that the order in which the parcels were delivered was not the same as that calculated by the day-to-day optimization module. In this case, it is not of major importance because the route was basically a square and it was indifferent where to start. It might be considered an adjustment of the walking time in the model since it is observed that the rider walked faster. Yet, the waiting time at the station should be added in the model; on average it should be estimated as 4-5 minutes although this will depend on the hour of the day (linked to train schedule).
It would have been interesting to repeat the trips several times to get more statistical representative results. That was not possible due to time constraints and resources availability. However, the segment train offers low time deviations due to fulfilment of schedules and high frequency of trains serving the area. The bike and walking segments offer even less variability (Table 3), only traffic lights have a certain impact on the duration of the segment.

Table 3: e-cargo bike (only) route evaluation results

Event	Transport Mode	Actual Time	Measured interval (sec)	Simulated Time	Simulated interval (sec)
Departure from Vanapedal hub	Cargo bike	15:15:51	0	16:00:00	0
Parcel 1 drop-off	Cargo bike	16:14:53	3542	16:57:00	3420
Parcel 2 drop-off	Cargo bike	16:27:55	782	17:02:00	300
Parcel 3 drop-off	Cargo bike	16:30:22	147	17:14:00	720
Parcel 4 drop-off	Cargo bike	16:34:27	245	17:22:00	480
Arrival at Vanapedal hub	Cargo bike	17:09:18	2091	18:19:00	3420
SUMMARY			**1:53:27**		**2:19:12**

The calculated time is approximately 25 minutes higher than the actual time taken to deliver the parcels. After discussion with the providers of the simulation framework, it was determined that the model does not consider elevation, meaning that the time to go to Sarrià-Sant Gervasi district is the same as the time needed to come back. That is not the real situation since the way for is all upwards, while the way back is all downwards. As it can be observed from the registered time, there is a noticeable difference: the way upwards took 59 minutes, while the way back took 35 minutes.
Cargo bike travel times are not heavily affected by traffic conditions using bike lanes; thus, it cannot be expected major deviations from the measured times repeating the same routes.

Table 4: e-van (only) route evaluation results

Event	Transport Mode	Actual Time	Measured	Simulated Time	Simulated

			interval (sec)		interval (sec)
Departure from Vanapedal hub	e-Van	15:32:17	0	16:00:00	0
Parcel 1 drop-off	e-Van	16:07:31	2114	16:39:00	2340
Parcel 2 drop-off	e-Van	16:23:18	947	16:46:00	420
Parcel 3 drop-off	e-Van	16:28:08	290	16:55:00	540
Parcel 4 drop-off	e-Van	16:34:32	384	16:59:00	240
Arrival at Vanapedal hub	e-Van	17:11:58	2246	17:41:00	2520
SUMMARY			**1:53:27**		**1:40:48**

The simulated times are shorter than the actual ones. That depends on the traffic situation. The test was performed on a Friday afternoon. There was not especially heavy traffic but still it may have had an impact. It would have been interesting to repeat the same route on different conditions, but it was not possible due to limitations on use of the resources (driver + e-van) considering they were not serving real demand. In any case, car travel times are extensively estimated by third-party routing applications that have access to thousands of trips; it was not the main focus of GREEN-LOG to accurately estimate the motorised (car/van) travel times (Table 4).
Overall learnings:

- Some adjustments need to be made to the BYOD to make it more user-friendly, simplifying the available options and allowing for changing the status of a collection rather than individually.
- Some adjustments need to be made in the network model (slopes, waiting times at station)
- Apparently, the multimodal option is the fastest (even quicker than the e-van). However, it must be mentioned that the location of the delivery points was chosen to make the walking segment quite convenient. In a preliminary test, a fifth delivery point was inserted into the route that results on 40-minute extra walking time.
- To make the business model sustainable, the number of parcels to be delivered in a trip should be much higher, since the overhead to reach the area is about 40 minutes (80-90 minutes considering both ways).

4.1.2.2 User's feedback

During the trials, the riders were asked about the experience in terms of app usability and operation. No major complaints or shortcomings were detected. In the case of the multimodal option, they were surprised by the short waiting times. No complaints or disturbance from the train passengers were reported either. However, it is worth to notice that the volume of the parcels was small, and no big bags were carried by the rider.
In the case of the e-bike route, the rider mentioned that the outward journey was hard (in fact he was still sweating when he arrived at the depot), but the return journey was very easy.

4.1.2.3 Autonomous vehicles/Droids

The trials showed that the robot could perform each of the tested tasks reliably. It was able to move through the station on its own, detect and interact with elevators and train doors, and adjust its position when needed with good precision. Each part of the process was tested separately, and the results confirmed that the robot can handle these types of actions when carried out individually.

One of the most positive aspects was the stability of the navigation, even in tighter spaces where maneuvering becomes more demanding—like inside elevators or on the platform close to the train. The robot reacted safely and smoothly to changes in the environment, and obstacle avoidance worked consistently. While there were people present during some of the tests, their movements were limited and did not fully reflect the kind of human flow that is typical in a real train station.

During the trials, a couple of areas for improvement were identified. In some cases, the robot experienced delays in detecting door openings, particularly when lighting conditions or reflections interfered with the RGB-D camera's perception. While this did not impact safety, it introduced slight delays that would need to be addressed in real-world operations with tighter time constraints. Additionally, **localization issues were observed in very long and visually repetitive corridors**, a known phenomenon referred to as the *hallway effect*. In these situations, the SLAM system occasionally struggled to maintain accurate positioning due to lack of distinctive features. These issues are expected to be mitigated through further **tuning of LiDAR data filtering** and **adjustment of SLAM module parameters**, tailored to improve robustness in such challenging environments.

Moving forward, the goal is to bring all these capabilities together into a more complete and realistic delivery scenario. This means allowing the robot to perform the full operation with just one initial command from the user, instead of triggering each part separately. Future tests will also include more natural human presence to better understand how the system behaves in environments shared with passengers.

A particularly important next milestone will be to test the robot's behaviour with **moving trains**, rather than static ones. This includes detecting train doors as the vehicle arrives and stops on the platform, even when the alignment is not perfectly predictable. The robot will need to adapt its positioning in real time and board safely under stricter timing and spatial constraints. These tests will bring the system much closer to a realistic deployment scenario, helping us to better understand its limits and potential in a live transport setting.

5 Evaluation Results for the ISPRA Pilot

This section presents the evaluation results of the Ispra pilot activities during the first round of demonstrations, detailing the key activities and solutions demonstrated, an evaluation of the pilots based on participant feedback and the calculation of relevant GREEN-LOG key performance indicators (KPIs).

5.1.1 Key Activities and Solutions Demonstrated

In the Ispra pilot, customers place their orders through the platform system (Figure 23), selecting their preferred lunch and delivery times. The order must be placed by 10.30 a.m. on the delivery day. The canteen prepares and packages the meals, which are transported by Measy cargo bike to an intermediate point, where Yape droid take over, optimizing deliveries based on proximity, route, battery and user preference.

Platforms used for this scenario:

- Canteen orders platform
- Yape platform
- BYOD (Data Space)
- AIMP (Next test phase)

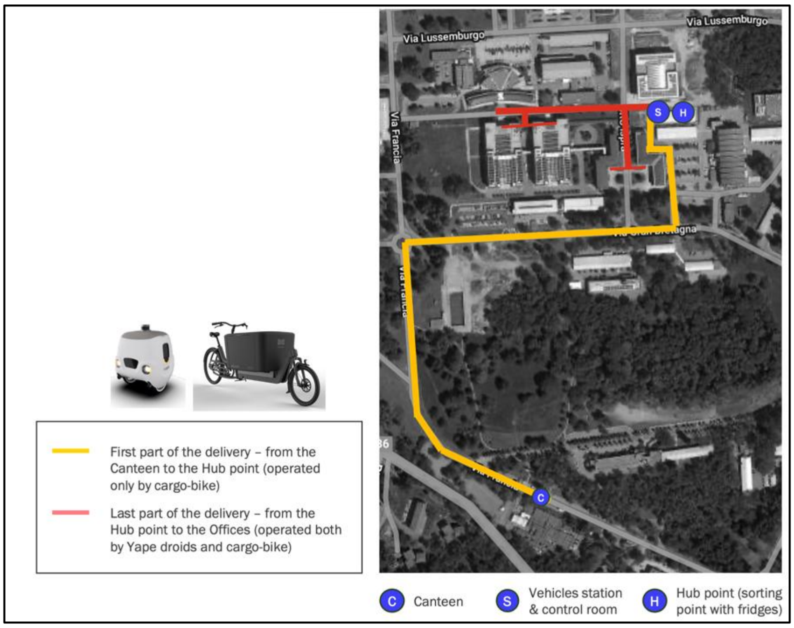


Figure 23: ISPRA pilot area-delivery routes

The photos below (Figure 24 & 25) depict the process followed for: 1. Pick up order; and 2. Delivery.

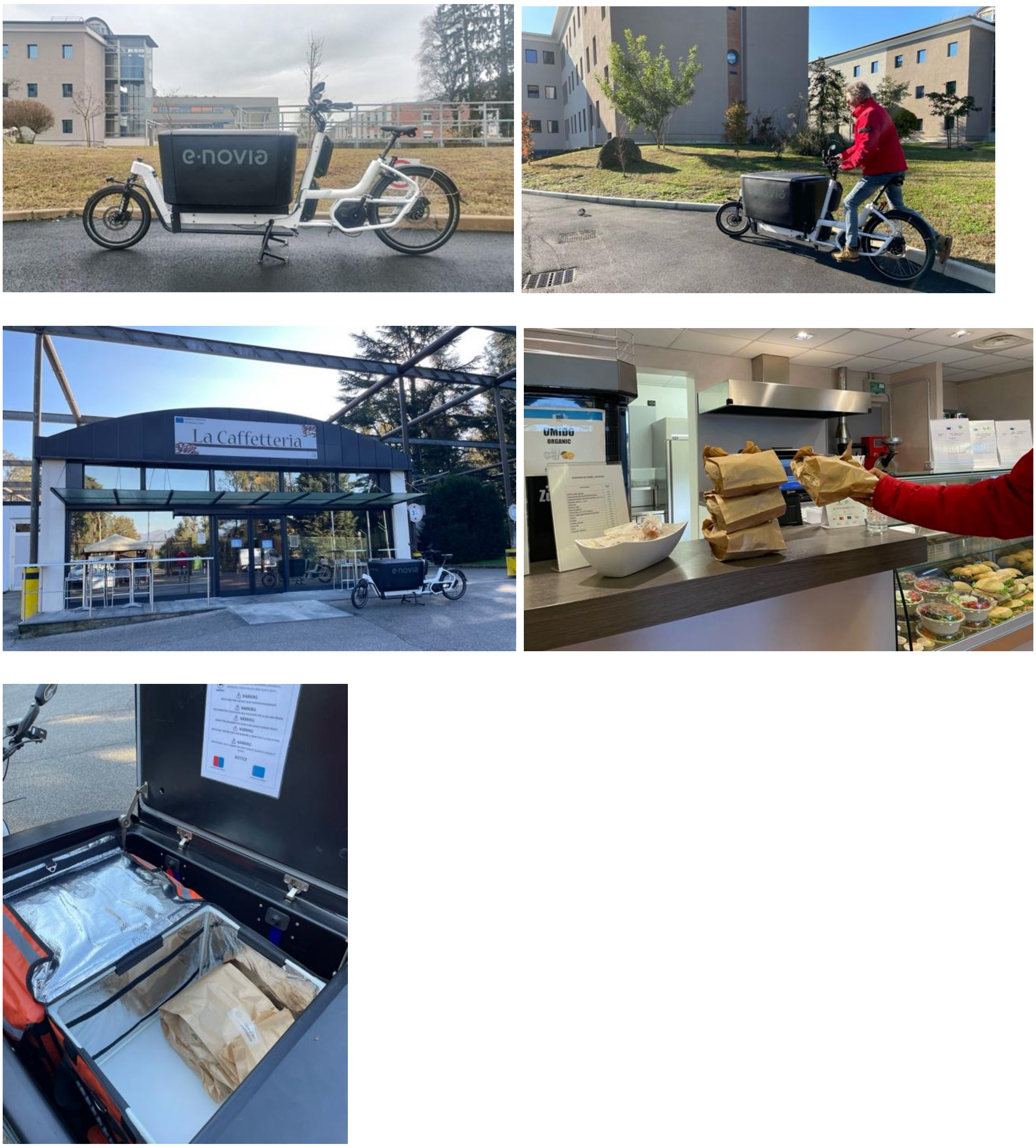


Figure 24 Pick up order

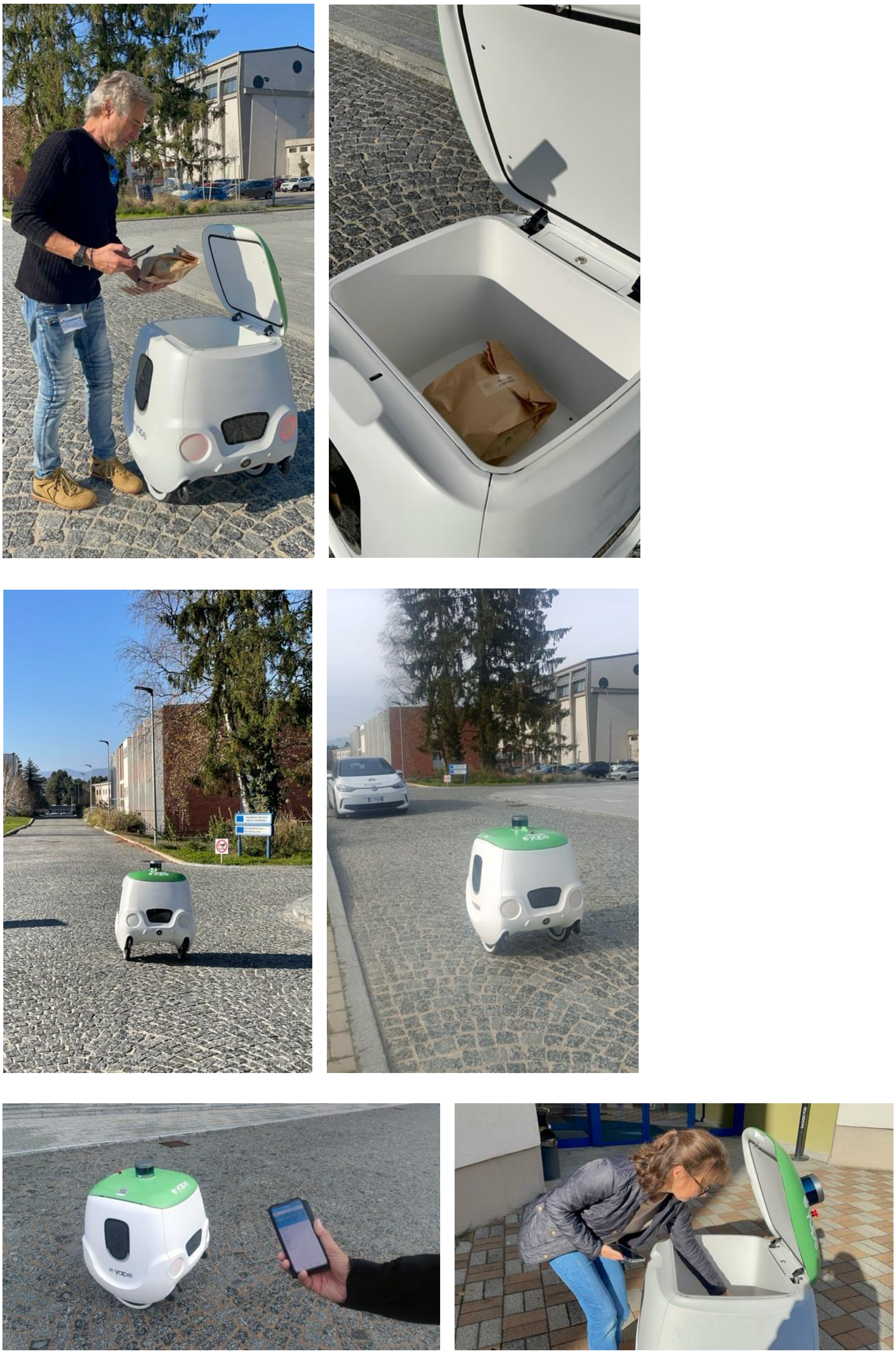


Figure 25 Delivery

During the first round of tests, the bring your own device platform was used to update the parcel status during the tests. Meetings were made to deep down the current use case of Ispra and the platforms used on each activity (Yape + BYOD platform). Data was uploaded in the Data Space and shared for the AIMP. BYOD updates were verified with MOSAIC and will be used in the next test phase.

5.1.2 Evaluation of the First Round

The first round of Ispra pilot demonstrations involved two phases, one in 2024 and another one in 2025. As it can be seen in Figure 26 there was no significant improvement in the delivery time.

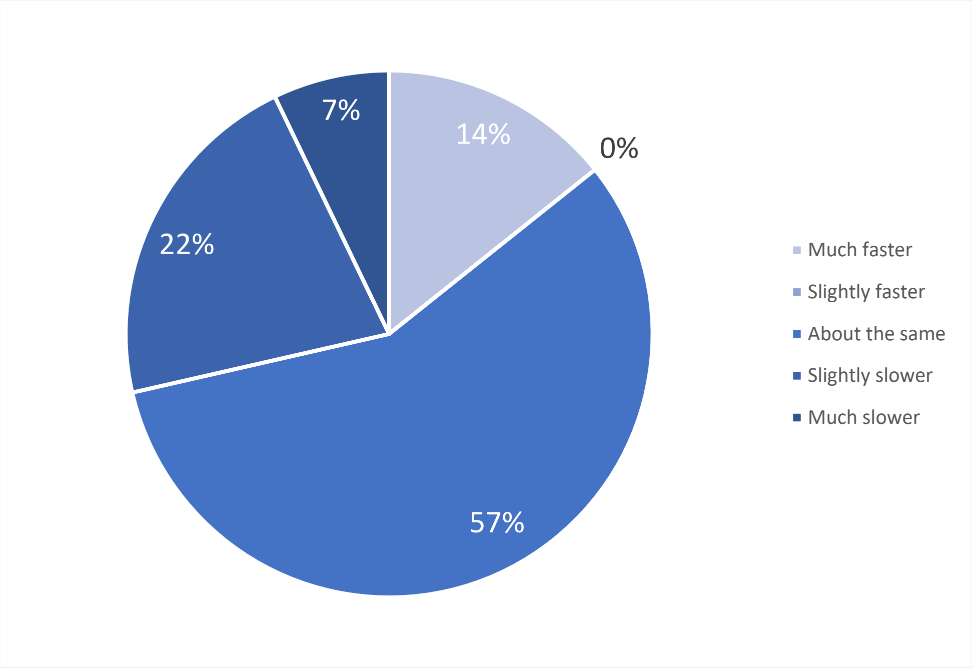


Figure 26: Time travelled per delivery compared to traditional methods

Concerning the overall satisfaction from the solution demonstrated in Ispra, more than half of the participants were satisfied, (Figure 27: Appreciation of GREEN-LOG solutions) while almost all of them (93%) were in favor of maintaining the delivery service in the long run (Figure 28).

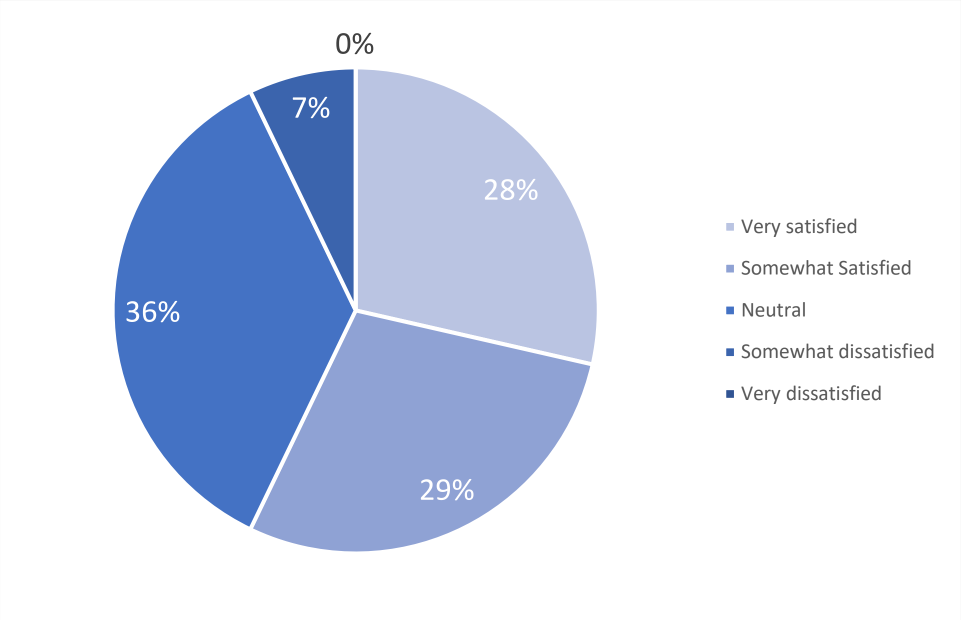


Figure 27: Appreciation of GREEN-LOG solutions

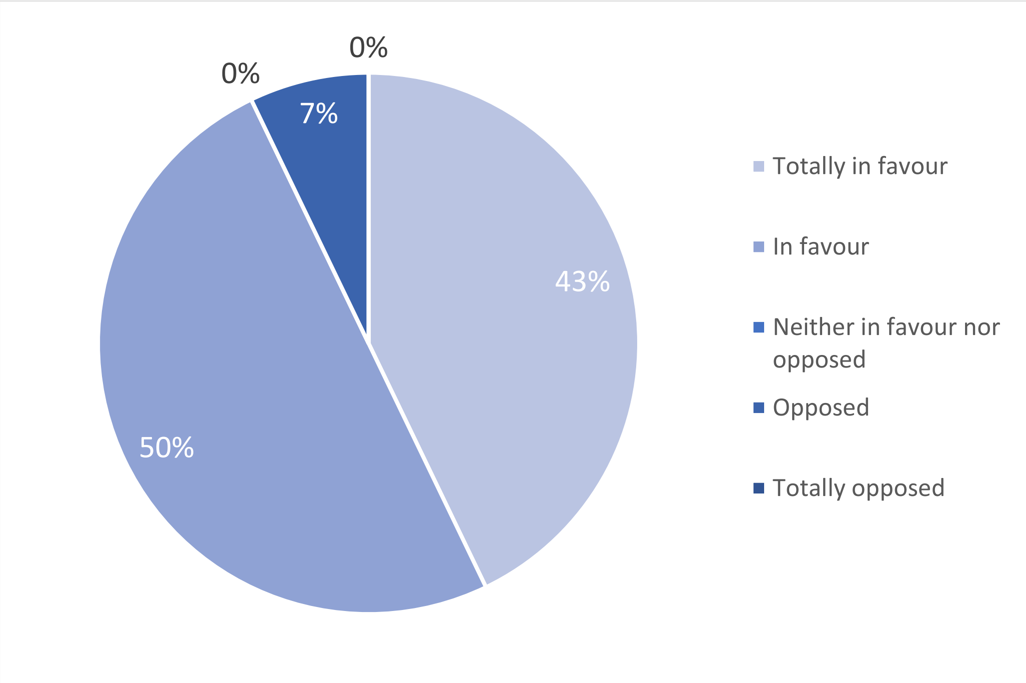


Figure 28: Possibility of long-term implementation of the service

6 Evaluation Results for the Flanders Pilot

This section presents the evaluation results of the Flanders pilot activities during the first round of demonstrations, detailing the key activities and solutions demonstrated, an evaluation of the pilots based on participant feedback and the calculation of relevant GREEN-LOG key performance indicators (KPIs).

6.1.1 Key Activities and Solutions Demonstrated

The Flanders Living lab combines three of the 13 Flanders 'center cities', meaning they are cities with a relatively high number of inhabitants (Ghent is the 2nd biggest city, Leuven the 4th and Mechelen the 6th biggest city of Flanders) and which play a central role in areas such as economy, employment, healthcare, education, culture and recreation. By combining three center cities, the living lab aims to enlarge the scaling potential as well as create uniformity / standards in urban logistics over cities. This approach can give some relative delay as cities have different visions and challenges, yet by combining all three cities (and the University of Antwerp, as well as Vil – the innovation platform in logistics for Flanders), the insights gained are immediately of a higher level. For instance, use cases proposed in one city were already proposed and explored in other cities, and this knowledge could be taken along in the development of use cases.

The common framework for the Flemish pilot is testing a Logistics-as-a-Service (LaaS) system. LaaS, as introduced by Beckers et al. (2023[2], targets a better integration of the consumer within the last mile. The consumer is broadly defined as the user of logistics services, which can be in any B2C or B2B context. The underlying assumptions are that a better connection by building a Marketplace where demand for logistics is connected to supply of logistics, is visualized with a clear view on financial (and social) costs: (i) improves the logistics quality, such as decreasing failed deliveries; (ii) allows for better informing all the players in a logistic flow on logistics decision making, increasing its awareness of different impacts; and (iii) allows for nudging the user towards more solutions that would improve the overall sustainability of the logistics system. The Flanders living lab will be the first actual implementation of a LaaS system, hence, it serves as a first validation of the underlying assumptions. The overall objective of the living lab is to increase consolidation by nudging bundling of goods (B2B or B2C). By leveraging information into a dynamic pricing scheme, the Flanders living lab strives for data-driven optimization of the last mile. The assumption is that more demand for one route/logistics service resolves in a lower price and higher volume for green last mile. The system allows policymakers to enter business rules to steer the optimization and insights by all users can bring new cooperations. As such, the focus of living lab lays on consolidating shipments and on testing business models where sustainable logistics is economically feasible.

Figure 29 summarizes the way the Flanders living lab will attempt to connect the user – which can be any receiver of logistics services – to the logistics operators. For example, a consumer of transport services registers its shipments on a platform. This platform then matches the demand with services that can be supplied by one or more carriers. Via dynamic pricing (step 3) and/or other nudging methods (step 4), these logistics services are then presented with a certain price, order, leaf, etc, to the user, who acts as the final decision maker. This way the decisions are based on financial pricing, but also on social costs.

[2] https://doi.org/10.1016/j.retrec.2023.101354

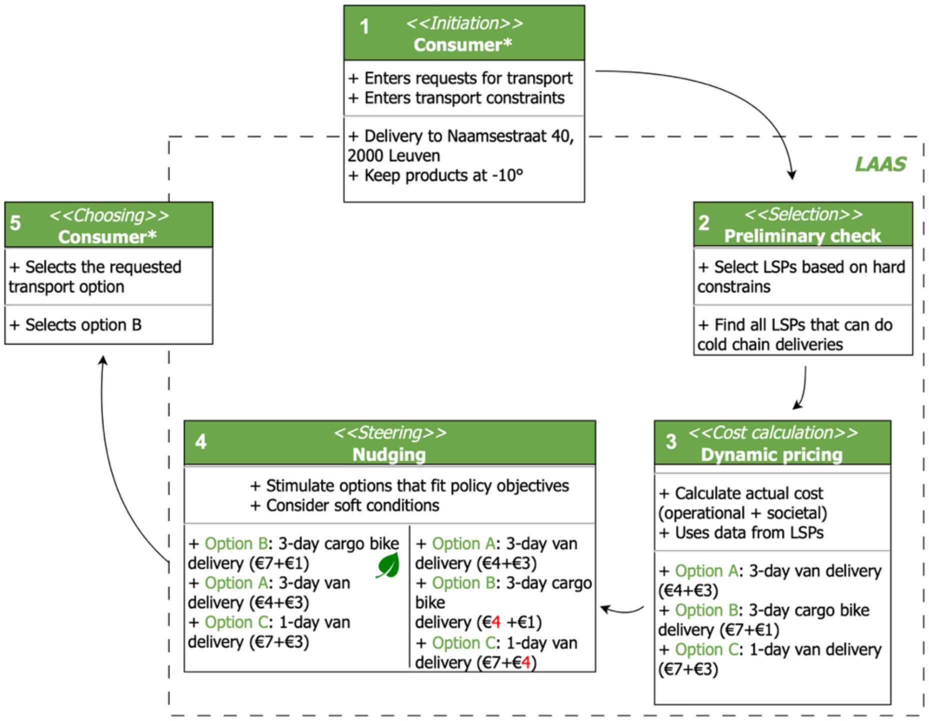


Figure 29: LaaS flow in the Flanders case

The living lab is be departed in three use cases, three stand-alone tests of the LaaS-platform.

1. Use case Mechelen: nudging consumer behaviour towards sustainable delivery methods in e-commerce.
2. Use case Ghent: upscaling collaborative business models for green last-mile logistics, in waste collection and in local businesses.
3. Use case Leuven: operational insights on sustainable delivery methods for LaaS

6.1.1.1 Mechelen First Demo

The demonstration in Mechelen focused on the research questions: 'What if we put the consumer at the center and stimulate them to make more sustainable choices? To what extent can they influence the way parcel deliveries are made?'
After extensive meetings (weekly meetings with work package 3, weekly meetings with the living lab partners) Mechelen defined the use case as followed: inhabitants who order online select a city center hub as delivery address (the center of Connact, who gives space to two cargo bike delivery companies: Cargo Velo and EcoKoeriers). Once arrived, the parcel gets notified into the LaaS, which notifies the inhabitant of the arriving of their package. Then, the inhabitant can choose when the delivery can happen. The LaaS-system tries to convince the inhabitant to take the most efficient, green choice possible by introducing dynamic pricing, nudging principles. As such, the set-up in Mechelen can be qualified as a level 2 LaaS (Beckers et al., 2023).
The specifications of the requirements for the LaaS were discussed during the meetings with WP3 extensively, and development started in the spring of 2024. The city of Mechelen searched and found a neighborhood called Tervuursesteenweg, with approximately 100 inhabitants willing to test the LaaS. Two LSP's (Eco Koeriers and

Cargo Velo) were subcontracted to perform the logistics operations. They delivered the parcels from the city hub to the homes of the inhabitants.
The development of the LaaS took some delay: the start of the demonstration was foreseen in September 2024, however in October, the platform was not yet ready for use. Since the living lab felt it could no longer wait without losing the interest of the participants, the UoA provided the living lab with a simple beta version of the LaaS to start the demonstrations. This way, the principles of the LaaS could already be tested, even if it did not have the extensive functionalities that the LaaS provided.
The LaaS was ready at the end of December, and the switch towards the LaaS was made at the beginning of January 2025. During the testing, the functionality of Rideal nudging with credits was added to the demonstration, as well as the possibility of using a locker as delivery option. The demonstration ran until half of February.
The results are extensively discussed in point 6.1.2, as the Mechelen demonstration was the most extensive demonstration of the living lab in round 1 of the demonstrations.

6.1.1.2 Ghent First Demo

The initial idea was to test the LaaS platform by collecting organic waste of retailers in the sector of hospitality, retail or catering in the city center. The incentive was the change in legislation, by which the retailers had several challenges in storage of their waste. To make the collection of the waste more sustainable, we also needed to engage last-mile operators who use zero-emission vehicles and the waste companies operating in our city.

After the discussion at the Culinary Council on 11/12/2023, Ghent started to engage participants. They found two interesting projects and had discussions with retailers. In 2024, they started to engage the waste companies, by bilateral meetings. The most interested party was the collector of household waste in Ghent, who also collect industrial waste in the city center. However, it was discovered that the conversations with the waste companies were a political sensitive matter.

During the bilateral meetings with all the stakeholders the living lab discovered other challenges, which were not completely foreseen during the set-up phase:

- The sector of industrial waste collection is a very competitive market, with low margins. These margins are extra low on the collection of organic waste. The only existing solution now is using big vehicles, although it is not an agile and sustainable way of collecting waste in city centers. Engagement of stakeholders is essential to set up a use case, because of big competition (which was also political sensitive) they couldn’t easily engage.
- The collection of waste is heavy on legislation. The waste fractions need to be collected separately and cannot be picked up while delivering goods. Bundling is not an option. The use case was oriented towards bundling and accelerating sustainability. It was clear, we couldn’t deliver on this goal.
- The only waste collector in the Ghent city center, who picks up organic waste by using bicycles, was not interested in participating in GREEN-LOG. At that moment they also didn’t comply with legislation on collecting waste. The collector of household waste tried to put up a cooperation with them because they believe in other agile and sustainable ways of collecting waste, but these meetings were not successful. The business model was financial not feasible and trust among both companies was not able to grow.

In August 2024, Ghent had a meeting with the project manager of GREEN-LOG to explain the situation and conclude they couldn't proceed with the use case. These were the reasons:

- A model shift in sustainable logistics for waste collection was not feasible because the living lab didn't have a logistics player in place who could pick up waste by using zero emission (or low emission) vehicles. To be able to test sustainable ways of waste collection, it would have required a lot more investment, financial and labor, than what was foreseen in the project.
- Bundling of goods was impossible because of the legislation. Reducing the number of kilometers driven was not possible.
- Testing if nudging or dynamic pricing would work in this use case was not an option. The market was not ready, and it would have become instable during the second demonstration phase. The LaaS, even with dynamic pricing, wouldn't be an upgrade due to the already existing contracts between waste collectors and retailers, which already include flexible pick up.
- The political sensitivity was discussed but made it a terrain where everybody should tread carefully.

In this challenging environment, Ghent couldn't continue with their original use case. Two things were decided in order to proceed:

- Describe the learnings in setting up the original use case. They are in Annex III of this deliverable.
- Building a new use case for the second demonstration phase. Ghent found a challenge in the same group of engaged stakeholders, namely the retailers in the Culinary Council. In the broad group of the Culinary Council there are local food producer who do their deliveries themselves or have difficulties in organising their logistics, especially in a green and sustainable way.

During the description of the learnings in case of waste collection and sustainable logistics, Ghent worked further on the new use case. These steps were taken:

- 4/9/2024, 5/9/2024 and 10/9/2024: meetings with Living Lab Flanders partners to check the KPI's and the goal of the LaaS in function of engaging local food producers.
- 17/9/2024: Meeting with colleagues of the Department of Economics regarding the stakeholders of local food producers. First consultation about the foreseen challenges of the stakeholders and the match with GREEN-LOG - LaaS platform.
- 30/9/2024: Meeting with the local traders of the Culinary Council who prepare the Culinary Council. Ghent asked questions about their challenges in their logistics flows and updated the group about the learnings regarding the original use case about the waste collections.
- 21/10/2024: Pitch of the new use case during the Culinary Council.
- 31/10/2024 and 6/11/2024: bilateral meetings with local food producers, who are interested in participating during the second demonstration phase.

After a clear vision about their challenges and what the value of the LaaS could be for the local food producers, Ghent decided to define all requirements and technical features of the LaaS with the technical partners. This way, the local food producers would know in detail what the LaaS was offering them, before signing a statement of commitment. This was done during the months of December 2024 until March 2025.

- 6/1/2025: Meeting with Living Lab Flanders partners to talk in depth about the new use case and preparation for the second demonstration phase.
- 23/1/2025: First meeting with the Project coordinator of the LaaS platform to check the feasibility of the use case.
- 30/1/2025: Presentation of new use case at the General Assembly of GREEN-LOG, with the agreement to meet with the technical partners to define all requirements.
- 24/2/2024: Mini workshop about the use cases in the pilot of Flanders, led by WP1, to align all partners for the second demonstration phase. In this mini workshop the use case of Ghent was fully discussed.

The technical possibilities and requirements are clear after these meetings. Extra local food producers can be engaged and will be informed at the next Culinary Council with a local producers' market, on the 31/3/2025. At the same time the open call for LSP's is prepared, who will perform the deliveries. The result of the description of this new use case can be found in Annex III.

6.1.1.3 Leuven First Demo

Leuven focused on getting insights into bike logistics, to prepare for the second demonstration round. These data driven operational insights should give answers to the question: which price setting and volume is viable for a LaaS with multiple LSP's?

Leuven combined demand data from local shops with supply data from cycle logistics providers (Cargo Velo and Urbike, both active in the inner city of Leuven). Three large datasets were retrieved between September and October 2024:

1. We.deliver platform demand & supply data: shopkeepers ordering pick-ups and last mile players supplying logistics
2. Datasets cycle logistic providers Urbike & Cargo Velo (tendering, Non-Disclosure Agreement, export of the data, meeting with Urbike and Cargo Velo to understand datasets correctly)

The research questions definition by the University of Antwerp (living lab partner) and Leuven focused on the following: quantitative, qualitative questions focusing on price setting & constant capacity (critical mass) for Demo 2:

- Gaps in volume: when and where is the Logistic Service Provider (LSP) not (yet) efficient?
- realistic pricing (without funding) through better understanding of additional business
- realistic set-up of multiple logistics players for drops in Leuven: is a LaaS set-up with multiple players viable, given the current volumes?
- Data-driven insight for more attractive pricing and minimal needed volume => additional flows needed (+ where to find them, e.g. reverse logistics), consolidation needed

In addition, the following actions were taken:

1. Analysis of the datasets by UoA
2. Additional dialogues with shopkeepers on new opportunities to boost volumes for cycle logistics providers (learnings from the Ghent use case on reverse logistics like waste)
3. Validation of analysis results during meetings with cycle logistics providers (and additional questions)
4. Datasets were made available to other project partners in case components needed to be tested with real data (e.g. demand prediction)

While building up to the data analysis in Demo 1, a call for proposals promoting zero emission city logistics was proposed to Leuven, in which the Flemish government (VLAIO) would co-finance the rent for an Urban Consolidation Centre (UCC) in Leuven. The proposal of the city of Leuven was submitted on 15/10/2024 and approved by VLAIO with a score of 87/100 on 9 December 2024.

With the project funding, the city of Leuven would provide logistics space for the last mile towards local commerce and hospitality. This could be used as a transshipment hub, where goods are transferred from one means of transport to another for further distribution, to make last-mile deliveries more efficient and safer. The last-mile players that would be linked to the GREEN-LOG platform (Logistics-as-a-Service) in Demo 2 through this UCC would benefit, among other things, from affordable space in an interesting location for cycle logistics. Two locations were examined and indicated as viable options.

During the drafting of the project proposal, it was already apparent that local logistics players Urbike and CargoVelo and catering suppliers such as Go Fresh, Kort'om Leuven, Long, Atelier César, Foodsprint, Méditeranée, Driessen were very interested. They all indicated that an urban logistics hub with a refrigerated/freezer cell would enable further scaling up of sustainable deliveries. Each of them also signed a Letter of Interest (LOI).

Due to additional questions and comments from the Leuven City Council (Mayor and Aldermen), the grant has not yet been accepted by the city of Leuven as of 01/03/2025. Due to this delay, it is no longer possible to get the Urban Consolidation Centre equipped in time for the start of Demo 2. In other words: consolidation on the outskirts of the city via the LaaS in cooperation with last-mile players connected to the UCC is no longer an option for Demo 2.

However, the discussions that have been started with these last-mile players have pointed out various logistics flows that are far from optimal: polluting kilometers are driven in vans that are not optimally filled. In shaping the use case for Demo 2 (ongoing), we are using these mapped flows as a basis, with the aim of bundling optimally, increasing load factors and shifting trips in urban environments to emission-free vehicles adapted to this environment (cargobikes). Micro hubs could substitute the lack of consolidation space (UCC).

6.1.2 Evaluation of the First Round

Ghent Evaluation:

For the evaluation of the Ghent use case, we refer to the document about the learnings in the use case in Annex III. Here is a brief overview of the learnings about setting up a use case in a European City:

• To develop a use case that is feasible, there should be partners present in the city who can cooperate. If you don't have a partner, you need to have a budget to set it up from scratch.

• If you work in a political context, engagement of Alderman or your board is needed in an early stage. This is ideally set up before officially engaging partners.

• When considering potential partners, it's important to assess how much flexibility you have to experiment within the goals of the project. Any actions should carefully consider current legislation as well as upcoming regulatory changes. Additionally, you don't want to disrupt existing experiments or cooperations by starting up a use case. Instead, in alignment with the goals of the project, the use case must support these existing experiments or cooperations. Knowledge about the existing networks regarding the use case in your city is essential to determine how the project can support this network.

• To start a use case, you need preliminary engagement of stakeholders. Although this is difficult to achieve, the basic interest of all your stakeholders must be known.

Leuven Evaluation:

The evaluation of the Leuven pilot focuses on the data analysis of the operations of the cargo bike companies in Leuven.

• **Overview**: The overview of the efficiency of the Belgian cargo bike delivery operations
is shown in Figure 19 below. Delivery trips are categorized into three types based on the number of stops per trip. A long trip includes a higher number of stops with no return trips in between, while a short trip contains fewer stops and a shorter duration. A short trip with pick-ups includes intermediate pick-up operations, with collected parcels delivered on later trips or later days.

Figure 30 shows the distribution of trips across different cost ranges per delivery stop. Among short trips, some are efficient, costing €2-3 or €3-4 per stop, but a significant number falls within the €4-6, €6-10, or even exceed €10 per stop. Long trips, which have a higher stop density, mostly fall within the €2-3 or €3-4 cost range per stop, though a few also reach €6-10 per stop. These results suggest the variability in cargo bike delivery trips' efficiency, with many trips proving to be relatively costly per stop. Although cargo bike companies engage in additional operations such as project management, TMS utilization and sector consultation, maintaining overall operational efficiency remains challenging.

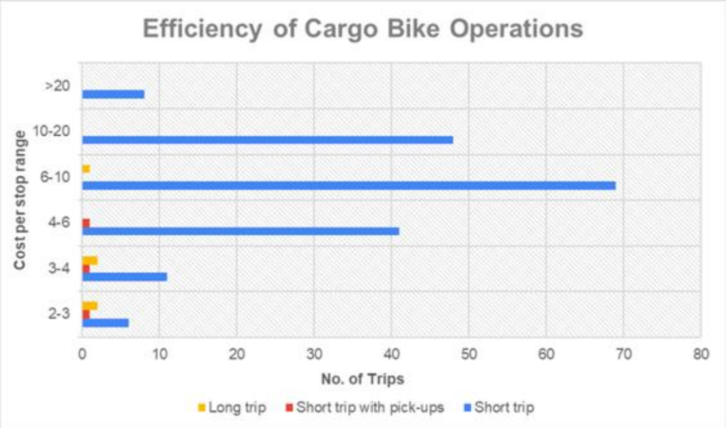


Figure 30: Efficiency of Belgian Cargo Bike Operations

• **We.Deliver Data Analysis:** Insights from the We.Deliver data are shown in Figure 31.

and Figure 32 below. Figure 31 indicates that the We.Deliver volumes within Leuven's local businesses are relatively small compared to the total volumes. Figure 32 shows that the number of shops that order deliveries varies throughout the week, but some patterns could still be detected, like how the volumes are relatively larger on most Fridays. These results suggest the consolidation potential for local deliveries within Leuven.

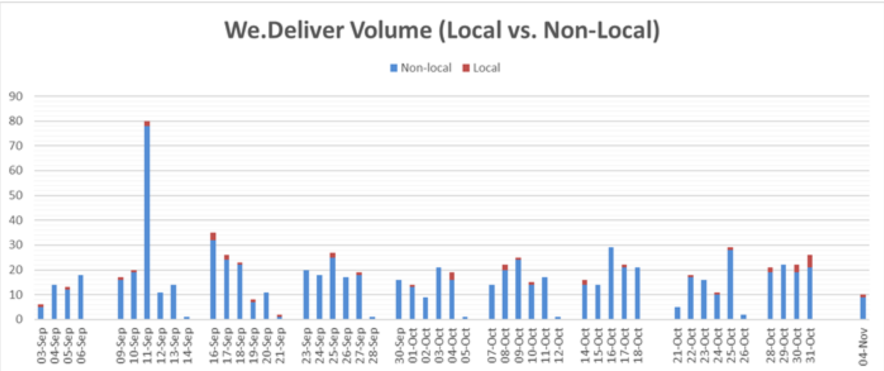


Figure 31: We.Deliver Volume (Local vs. Non-Local)

Figure 32: We.Deliver - No. Of Shops that Order Shipments Per Day

• **Consolidation Potential via LaaS:** Figure 33 below shows cargo bike company 1's capacity utilization of every delivery round in September and October 2024. Most of delivery rounds utilized less than 50% of the cargo bikes' capacity, indicating inefficiencies in the delivery operations and insufficient delivery volumes.

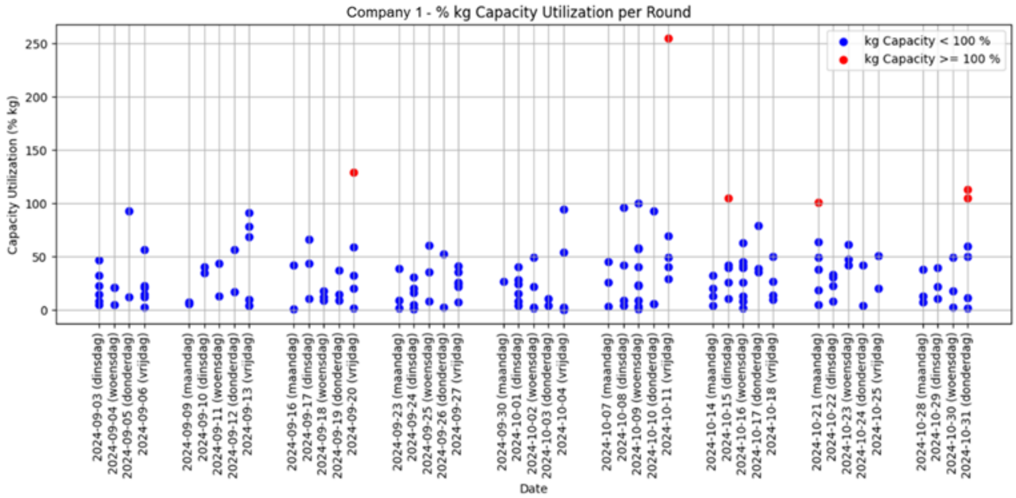


Figure 33: Company 1 - % kg Capacity per Round

Figure 34 below shows the number of tours Company 1 conducted for Client 1, a major client that requires cooled trailers for the deliveries, from Sep to Oct2024 in the neighborhoods of Leuven. It can be noted that the LaaS model offers potential for consolidating deliveries across different neighborhoods, as Company 1 currently operates in multiple areas daily. Aside from geographical considerations, an additional consolidation opportunity is that the cooled trailer remains largely unused between 11 AM and 3 PM, resulting in underutilized cold chain resources and potentially more available drivers. Leveraging this time window for additional activities could potentially improve overall efficiency. For example, it could be utilized for food surplus pick-ups, as conceptualized for Demo 2 in Leuven, enabling Company 1 to maintain a consistent capacity for its cold chain resources. Another potential improvement is the implementation of mixed rounds to increase the load factor of delivery tours, especially since, as noted in the previous section, the cargo bikes' capacities remain largely underutilized. Figure 35 below shows the locations of Company 1's delivery stops and its delivery routes for Client 1, while Figure 36 shows the potential pick-up and delivery points for Demo 2 in Leuven. Notably, these potential pick-up and delivery points fall within the same service area as the locations of Company 1's existing delivery stops and locations of the tours for Client 1. Therefore, it is possible to implement the mixed runs of Company 1 in Demo 2 in Leuven.

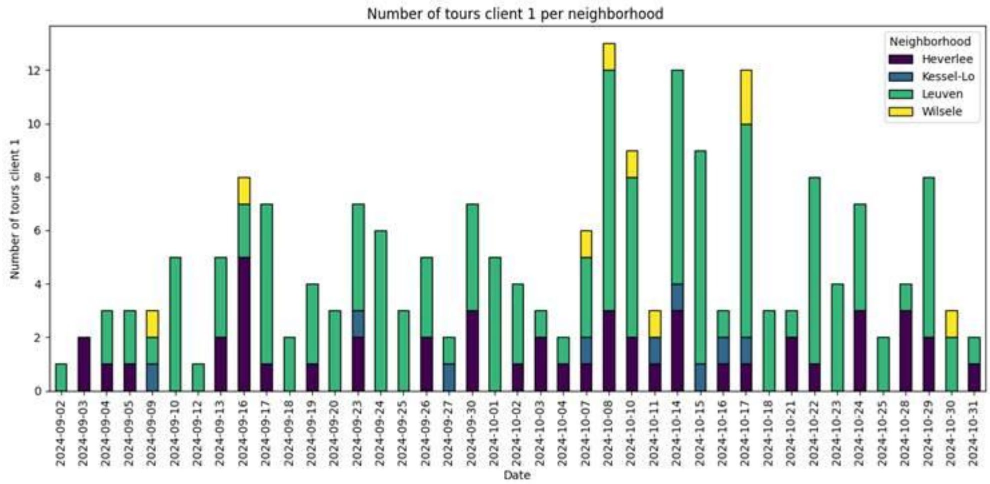


Figure 34: Number of Tours Client 1 per Neighborhood of Company 1

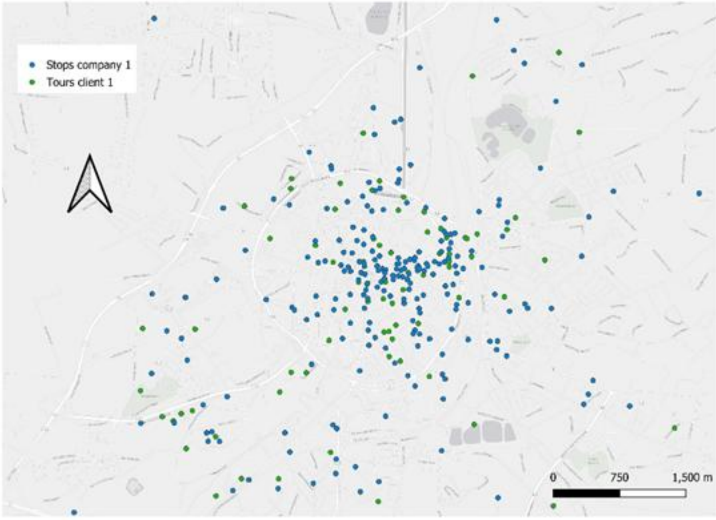


Figure 35: Locations of Stops of Company 1 and Locations of Tours for Client 1

Figure 36: Locations of Potential Food Surplus Pick-up and Delivery Points in Demo 2 Leuven

Figure 37 and Figure 38 below show the demand-driven vs. supply-driven consolidation potential via LaaS. When demand is evenly distributed between cargo bike LSPs (in this case, Company 1 and Company 2), a constant delivery capacity can be achieved by summing their average delivery volumes for each weekday, as shown in Figure 26. A more realistic representation of delivery volumes is shown in Figure 27: by combining the actual daily volumes of both LSPs, an optimal daily volume is achieved, represented by the bright red line. However, this volume fluctuates throughout the week. A more consistent capacity, as indicated by the dark red line, could potentially be achieved through the LaaS's application by effectively nudging users' delivery choices. Maintaining a constant capacity across delivery rounds will significantly improve the efficiency for the LSPs.

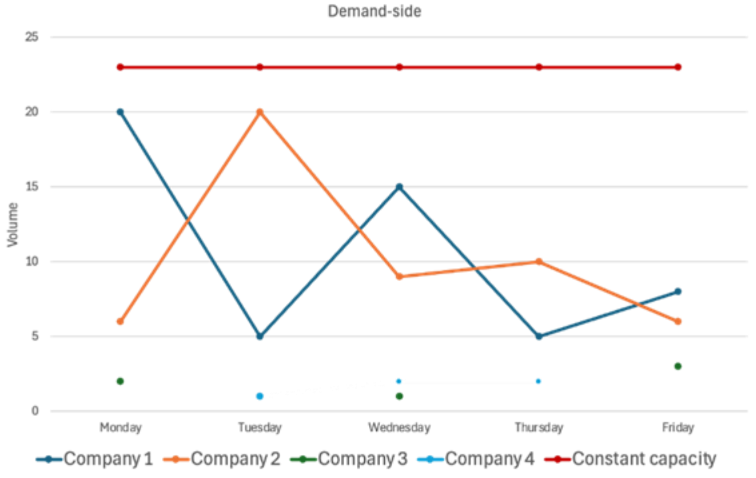


Figure 37: Demand-Drive Consolidation Potential

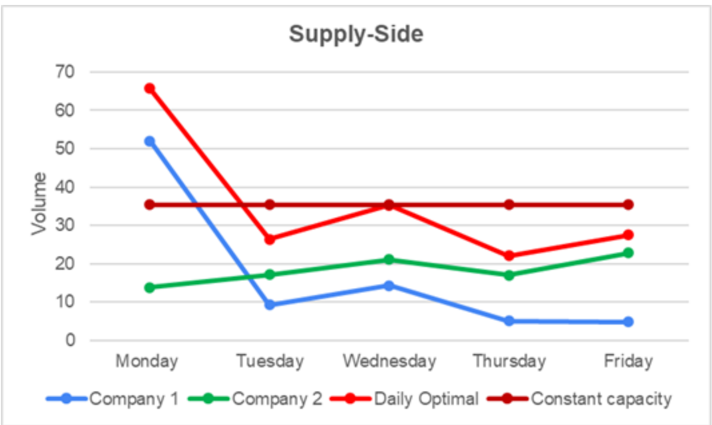


Figure 38: Supply-Driven Consolidation Potential via LaaS

Mechelen Evaluation:

The evaluation of the Mechelen pilot focuses on the data analysis of the pilot results and feedback of the LaaS users from the intermediate survey and the end survey.

• **Overview:** During the pilot's running phase, there were 58 unique LaaS users and 497 parcels delivered through the LaaS, and 94 cargo bike trips generated in total. The average number of orders per user made falls mostly between 4~8, indicating a high engagement level of the participants. The demographic feature of the participants shows that the active users are mainly 25~34-year-old females with 1 child in the household. What is also observed is that the number of web shops the users shop on reaches up to 181 during the pilot running phrase, with the Belgian e-commerce portal Bol.com (31% of total orders on the LaaS) being the most popular site.

• **User Behavior:** With different phases of price nudging methods on the LaaS (Table 5), users' behavioral changes were observed. The initial prices of different delivery slots throughout the week were set up based on sector consultation (of the standard price per delivery by cargo bikes) and a participant survey regarding their preferred day of the week for LaaS deliveries. The survey results indicate that Wednesday is the preferred day among participants, followed by Monday and Friday, while Tuesday and Thursday are the least favored. With a standard price of €6 per delivery applied by the cargo bike company, the differentiated prices of LaaS services were structured accordingly:

Table 5: LaaS Price Differentiation

Weekday	Morning	Afternoon
Monday	€ 6	€ 6
Tuesday	€ 8	€ 8
Wednesday	€ 4	€ 4
Thursday	€ 8	€ 8
Friday	€ 6	€ 6

On top of the initial prices, a rush penalty is also added for the two quickest delivery options (e.g. when ordering on Monday morning before 12pm, the quickest Option 1 is Monday afternoon and the second quickest Option 2 is Tuesday morning): from Nov 4th to Nov 21st, Option 1 +€2 and Option 2 +€1. The rush penalty amounts were increased later to further assess the impact on users' behavioral changes: from Nov 22nd onwards, Option 1 +€10, Option 2 +€5. The results are shown in Figure 39 below:

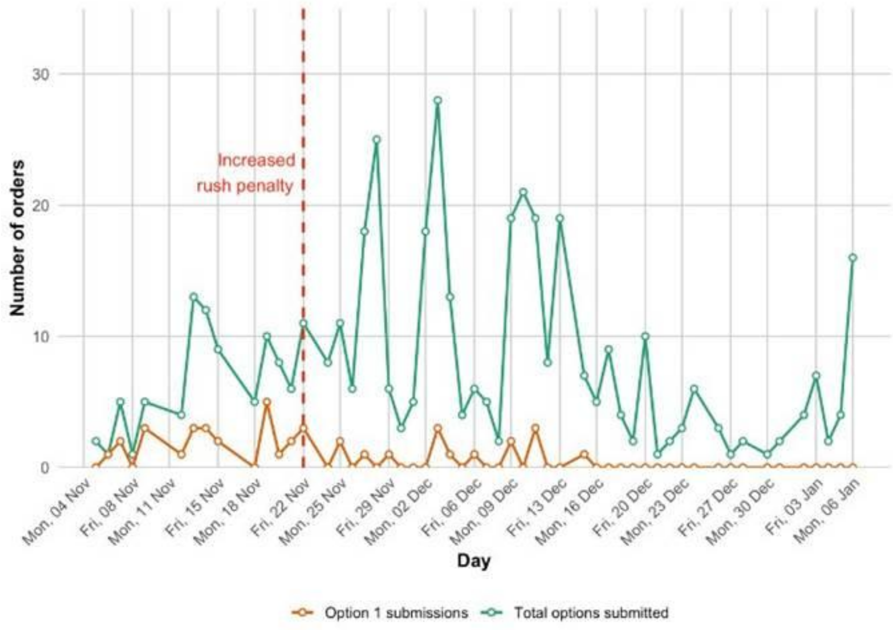


Figure 39: LaaS User Behavior Changes (1)

It can be observed that the users can certainly wait for their deliveries: after increasing the rush penalty from Nov 22nd, the total number of Option1 chosen by the users drastically decreased compared to the number of total options submitted.

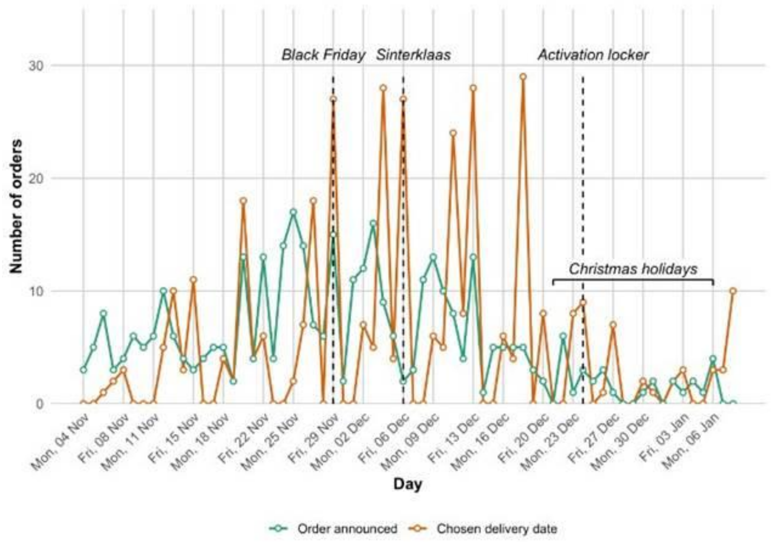


Figure 40: LaaS User Behavior Changes (2)

Looking at the orange line in Figure 40 above, which represents the actual dates that the parcels are being delivered, it can be observed that the deliveries clearly peak on most Wednesdays and some Fridays. This indicates that the users were reacting accordingly to the price differentiation by choosing the options with lower prices. During the holiday seasons, when delivery volumes are higher, consolidation can be significant, reaching up to 29 parcels on one single Wednesday (Dec 4th). This represents half of all users choosing the same delivery day. While this result may not be fully representative due to the limited scale of the neighborhood and the specific demographic profiles of the users, it still reflects a strong consolidation outcome. Additionally, user appreciation for the lockers is evident, with 22% of orders being sent there since their installation.

• **Consolidation Effect:** In total, 178 van arrivals at the city hub were consolidated into 94 cargo bike delivery tours to the pilot neighborhood, achieving a 47% reduction in delivery tours. As shown in Figure 41 below, in reality, an average of 3 to 4 vans arrived at the city hub daily, which were then consolidated into 2 to 3 cargo bike delivery tours. At the individual level, the highest consolidation rate reached 71%: the user ordered 8 parcels, which came in 7 van arrivals and were consolidated into 2 cargo bike tours. The overall average consolidation level per user is 27%.

Figure 41: LaaS Consolidation Effect

• **Continuous User Feedback:** Feedback on the reasons for choosing a delivery option was collected after each submission from the users. As shown in Figure 42 below, the continuous feedback collection indicates strong sustainability awareness among the users, with sustainability being the most frequently chosen reason. What can also be learned is that convenience is more of an important factor for the users than delivery speed, which is consistent with the users' behavior shifts in response to the price nudging and locker installation.

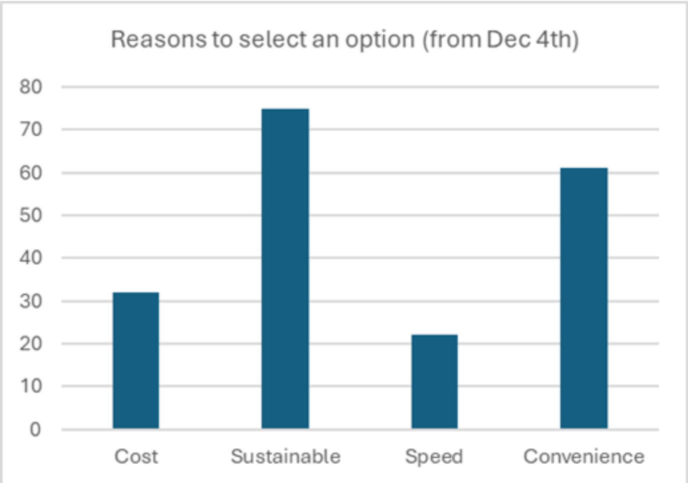


Figure 42: LaaS Continuous User Feedback

• **End Survey Results:** In the end survey that was distributed to the users after the pilot running phase, feedback regarding the LaaS's service level were collected:

➢ Overall satisfaction level: the users report an overall 3.72 (out of 5) satisfaction level of the LaaS services.

➢ Willingness to pay: Users were asked about how willing they were to pay for different price ranges to use the LaaS services. Table 6 below shows that over 66% of users are willing to pay €1, and over 44% of users are willing to pay €2 to €3 still. When it exceeds €4, the willingness to pay decreases significantly.

Table 6: LaaS End Survey - Willingness to Pay

How likely are you to pay the following extra fee for the LaaS services?	Somewhat likely	Very likely
€1	28%	38.5%
€2 – €3	30.8%	13.5 %
€4 - €5	9.6%	0%
€6 - €10	0%	0%
>€10	0%	0%

➢ Issues encountered: Users were asked how many parcels they did not pass through the LaaS and reasons for not using the LaaS for their parcel deliveries. In the results, 52% of users had less than 5 parcels which they did not pass through the LaaS, and 33% of users had 5 to 10 parcels, whereas 8% had 11 to 15 parcels. The reasons for not using the LaaS are shown in Table 7 below:

Table 7: LaaS End Survey – Reasons for Not Using the LaaS

Reasons for not using LaaS	Speed /Time	Large Parcel	Complicated process	Unreliable/ coordination issue	Forgot to change the address to the hub	Other
Percent	48%	7.7%	23%	5.8%	11.5%	11.5%

48% of users reported speed/time as the main issue since the use of the LaaS requires additional log in and registration of parcels on the LaaS platform, which is separated from the portals of the web shops and results in a time interval between ordering goods and choosing a delivery option; 23% of users claim that using the LaaS is a complicated or long process , which is also due to the LaaS being a separate platform; 11.5% of users reported act of habit when filling in their own delivery address on the web shops' portals instead of the city hub's address; 7.7% of users reported capacity limitation of the cargo bikes for their large parcels; 5.8% of users reported issues of communication or coordination with the carrier. What can be observed from the results is that nearly 90% of the identified issues could be mitigated by integrating the LaaS into the checkout pages of the web shops. The willingness to pay from the users, which was relatively modest, will also improve upon the LaaS's integration into the web shops checkout pages.

➢ Functions appreciated: Users were also asked which functions of the LaaS they would like to see in the actual checkout page of a web shop. The results are shown in Table 8 below:

Table 8: LaaS End Survey – Functions Appreciated

What functions of the LaaS would you like to see continued in the checkout?	Average
Choosing a convenient time slot	4.15
The possibility to get delivered together with the neighbors	3.46
Price differentiation	3.85
Insights into the sustainability of a delivery slot	4.21

Based on the results, users show a high level of acceptance of the LaaS services, especially with the function of 'insights in the sustainability of a delivery slot' which had the score of 4.21 (out of 5) and 'Choosing a convenient time slot' which had the score of 4.15 (out of 5). These results also align with the intermediate feedback where users consider sustainability and convenience the most important factors for their choices of delivery slots.

• **Potential Improvement:** Based on the pilot's demo 1 results, potential improvements for LaaS's application in demo 2 are proposed as follow:

➢ Integration of the LaaS into the web shop's checkout page. As mentioned in the previous section, integrating LaaS into the web shop's checkout page is expected to resolve approximately 90% of the issues users encountered, such as delays due to time intervals and the long and complicated login/registration process. This integration could also enhance users' willingness to pay for the LaaS service.

➢ Non-material nudging mechanism. Besides price nudging, it could also be insightful to evaluate how non-rewardable nudging methods impact users' behaviors. Methods such as giving sustainability titles to the users' account could be considered.

➢ Directly informing the sustainability impact of a delivery option. When selecting a sustainable delivery option, users could see a message such as, "By choosing this option, you may help reduce the number of delivery vans in your neighborhood by X." This approach could further enhance users' sustainability awareness.

➢ Multiple LSP options. With multiple LSP options of both cargo bikes and electrical vans, the limitation for large parcels' delivery could be solved and the service level could be further improved.

➢ Consolidation of constant capacity. As peak capacity has already been achieved in demo 1 through price nudging, demo 2 aims to focus on achieving the consolidation of constant capacity throughout the week.

6.1.3 Preliminary KPI Estimates

Table 9 below presents the preliminary KPIs estimates from the first round of demonstrations of the Flanders pilot overall.

Table 9: Flanders 1st Round KPIs

Category	KPIs	Flanders
SOCIETAL	1.1 Job opportunities created	n/a
	1.2 Improved quality of jobs created	n/a
	1.3 Reduced congestion	n/a
	1.4 Increased public awareness of sustainable urban delivery solutions	LaaS users report on average 69% of awareness increase
	1.5 Acceptance of sustainable urban delivery solutions	For the LaaS function of 'Choosing a convenient time slot', 89% acceptance rate; for 'possibility to get delivered together with the neighbors', 74% acceptance rate; for 'Price differentiation', 81% acceptance rate; for 'Insights in the sustainability of a delivery slot ', 92% acceptance rate.
	1.6 Improved neighborhood life quality	43% LaaS users report positive improvement on the pilot neighborhood
		74% of LaaS users are in favor of 'possibility to get delivered together with the neighbors', and 90% are in favor of 'Insights in the sustainability of a delivery slot.
	1.7 Increased safety	n/a
ENVIRONMENTAL	2.1 Saved energy consumption	29.82 L in total
	2.2 Reduced CO2 emissions	36714 g in total
	2.3 Reduction NOx emissions	19084.8 mg in total
	2.4 Reduced particulates	1669.92 mg in total
	2.5 Reduced noise pollution	170.64 dBs reduction per individual user
	2.6 Land use (sq used of the facilities)	0 (No changes)

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ECONOMIC	3.1 Increased benefits for local businesses	n/a
	3.2 Reduced cost of urban logistics services	€426 in total
	3.3 Improved service level of urban logistics	LaaS users report on average 3.72(out of 5) satisfaction rate of the LaaS services
	3.4 Improved utilization of storage space of LSPs' (fill rate of the van)	Average 2.37 delivery stops reduction per delivery address
	3.5 Increased zero-emission delivery modes of LSPs'	No. of km by cargo bikes / No. of km that would have been conducted by vans
	3.6 Reduced urban delivery time	About the same / Slightly slower
	3.7 Improved urban delivery reliability	53% of LaaS users report improved reliability

7 Evaluation Results for the Oxfordshire Pilot

This section presents the evaluation results of the Oxfordshire pilot activities during the first round of demonstrations, detailing the key activities and solutions demonstrated, an evaluation of the pilots based on participant feedback and the calculation of relevant GREEN-LOG key performance indicators (KPIs).

7.1.1 Key Activities and Solutions Demonstrated

In Oxford, 4 separate solutions were demonstrated:

1. GREEN-LOG Platform: Day-to-day demand prediction
   On 15th November 2024, the 7-day delivery prediction planning/awareness tool (T2.2) was demonstrated by representatives from University of Wolverhampton with end user (Pedal & Post depot manager) at the Pedal & Post Depot in Oxford to gather qualitative feedback which was recorded by a videographer from Halmstad University (Figure 43). The tool utilizes historical delivery data to predict future spatio-temporal demand for various uses within Pedal & Post operations. This demonstration took the form of an in-person meeting to allow the quick exchange of ideas visualizations and comparison of existing Pedal & Post systems and the GREEN-LOG solutions under development.

Figure 43: Still image from video of Matthew Hocking demonstrating day-to-day demand prediction tool to Chris Benton credit: Melania Mihalcea

2. GREEN-LOG Platform: Routing Service
   This element of the demonstration seeks to test the GREEN-LOG routing platform using real world data. For the purposes of the demonstration, next day/same day delivery data from the 4th of November was used. These data excluded 3rd party last mile fulfilment data that was used in solutions 1,3 and 4. These data were used on the basis that Pedal & Post have the most flexibility in routing their next day/same day deliveries as they are fulfilled completely by Pedal & Post.

   Routes for the 4th of November were generated from delivery data on the GREEN-LOG dataspace based on some assumptions. To simplify the demonstration, collection/delivery dependencies were removed.

   These optimized routes were then shared with a courier, who provided feedback on the route and the ideal route that they would have taken. These were then shared with project partners for further improvement of the routing service.

3. Moveable Consolidation Hub.
The Moveable Consolidation Hub (MCH) (Figure 44) demonstrates tests the potential for a temporary structure to be used as a parcel transfer site from long distance vehicles to electric cargo bike for the last mile journey in order to leverage underutilized and undeveloped land such as car parks. This demonstration was undertaken within the Pedal & Post Depot, which sits on an undeveloped floodplain on Binsey Lane in Oxford. The structure tested, a 12m x 8m industrial tent with 12 loading bays, was assembled in the first week of November 2024. Use of the structure commenced on the 9th of November, following a demonstration launch event on the 8th of November. During the launch event on the 8th of November, anonymous baseline surveys were completed by 7 Pedal & Post couriers. A follow-up survey was undertaken on the 19th of December, after one month of use of the Moveable Consolidation Hub, to measure the impact on couriers. Seven couriers completed this survey.

Figure 44 The Mobile Consolidation Hub assembled in the Pedal and Post Depot

Initially, the structure was used for 5 pre-existing 3rd party last mile fulfilment routes. In January 2025, additional last mile fulfilment routes were undertaken from a second national LSP to demonstrate the full capacity of the MCH. These routes were scaled up to a total of 6 additional routes from the 14th of January 2025, with this demonstration continuing until 31st January 2025. The use of this structure continues. However, the 6 additional routes from the 2nd LSP have been curtailed to 2 routes following an analysis of the profitability of these routes.

4. Mobile Delivery Hub
The Mobile Delivery Hub (MDH) (Figure 45) is a remote and/or self-driven converted e-cargo bike that can be used within a cargo bike fleet to increase

capacity and efficiency of operations. The MDH, based on the EAV 4-wheel cargo bikes that form the core of the Pedal & Post fleet, is currently being built and will be demonstrated in the second demonstration period. In the first demonstration, a mock-up of the MDH was used to understand how a self-driving vehicle could work within the Pedal & Post fleet. The mock-up consisted of an EAV cargo bike operated by a courier who did not interact with the load in any way and moved at a steady reduced speed. While this mock-up can effectively test how a self-driven vehicle can interact with a cargo bike fleet, there are limitations to this approach in terms of cargo capacity, vehicle weight and propulsion. These will be further investigated in the second demonstration period.

Figure 45 The Mobile Delivery Hub, and EAV 4 wheel cargo bike that will be converted into a self driving vehicle.

In the real-world demonstration undertaken, a courier driven MDH mock-up was used for 1 use case: reloading couriers in the field. Several routes currently being completed by Pedal & Post have parcel volumes that exceed the capacity of the EAV cargo bike. Currently, couriers return to the Pedal & Post depot to reload parcels before returning to the delivery area. This is an operational inefficiency. A self-driven MDH could meet a courier in the field to reload parcels, removing the need to return to the depot. In the demonstration 3 scenarios were tested:

1.Courier returns to depot to reload and returns to delivery area. This is the baseline scenario.
2.MDH meets couriers in the delivery area, courier reloads their cargo bike, MDH returns to the Pedal & Post Depot.
3.MDH meets couriers in the delivery area, courier switches bikes and completes deliveries on MDH. Original cargo bike returns to depot (this scenario requires 2 self-driven bikes).

These scenarios were completed on consecutive days on the same route, enabling a comparison of the relative benefits. The difference between scenarios 2 and 3 enabled us to evaluate the marginal benefit of having all bikes converted to MDHs or only the feeder ones.

7.1.2 Evaluation of the First Round

This section presents the results of the evaluation of GREEN-LOG solutions after the first round of demonstrations. A comparative analysis of the pre-implementation (baseline) and post-implementation (impact) survey results provides a clear picture of how the Cargo Bike Couriers and Depot Managers perceived the effect of GREEN-LOG solutions in their work. This section covers evaluation data specific to solutions demonstrated followed by survey results.

1. GREEN-LOG Platform: Day-to-day demand prediction

Evaluation of the Day-to-day demand prediction tool (T2.2) took the form of verbal feedback from the Pedal & Post Depot Manager, which was recorded by a videographer from Halmstad University. The nature of this interview was vital in both understanding the historical data that the tool has learned from as well as the potential uses to direct the development of the tool to achieve the greatest utility from a courier operations perspective. Furthermore, as the tool would most likely replace activities that are undertaken manually using courier knowledge, understanding this process and the inputs into it were vital for the solution developers to fully understand.

Potential uses outlined by the Pedal and Post Depot Manager for the prediction tool could be narrowing down hot spots for deliveries in a particular area to allow grouping to increase efficiency in the context of increasing delivery route loads, which is causing operational issues for the courier service.

Another potential use is more efficiently halving routes during seasonal peaks to optimize courier loads and delivery areas. This is currently undertaken manually, using courier knowledge.

Integration with MDH location identification for the reloading of couriers in the field use case using predictive data for more consistent and reliable positioning was also discussed.

This feedback is being used to further develop the day-to-day demand prediction tool.

2. GREEN-LOG Platform: Routing-Simulation collaborative service

The evaluation for this demonstration was the feedback from the courier on the route generated through an interview on the 5th of December 2024. The courier pointed out what actually would have happened on this route (2 couriers rather than 1, later start time, different delivery order). However, these differences stem from operational dependencies that were not included in the data set used by the routing service. As such, they cannot be used to improve the routing service, but rather the data transfer from Pedal & Post servers to the GREEN-LOG dataspace.

Beyond this, valuable feedback was gained from the courier regarding the Routing Service. This includes:

- Specific locations that are inaccessible to cargo bikes due to ongoing road construction, barrier width and path width.
- General preferences for type of path/road used by cargo bikes
- Timing and delivery order preferences: route start times, duration, preference to deliver to nearest locations first to reduce energy consumption/extend battery life, preference to deliver to main arterial roads earlier to avoid peak road traffic

Alongside this anecdotal feedback from couriers, quantitative data regarding courier speed, delivery stop duration, and routing is required to improve the routing service. Although this data collection was undertaken, it was completed in March and is therefore out of the scope of this deliverable.

Feedback will be used to improve the routing algorithm for the second demonstration period. Figure 46 can display the sequence of stops, as indicated by the collaborative operation of the optimization-simulation services.

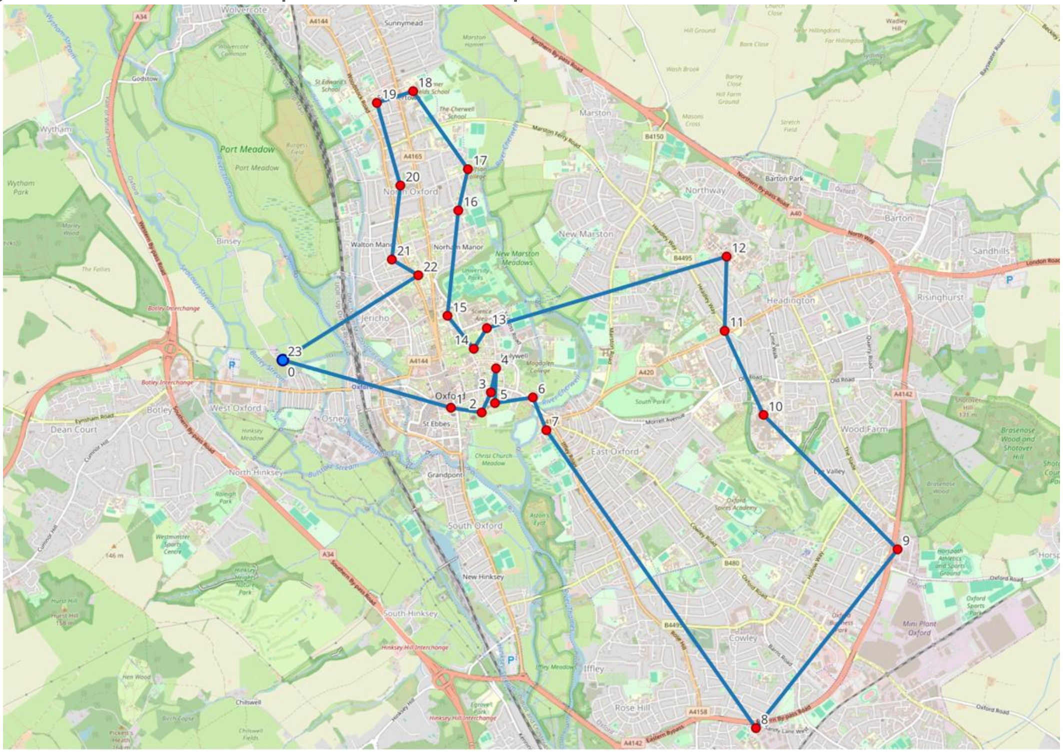

Figure 46: Oxford pilot-Sequence of Stops

3. Moveable Consolidation Hub (Figure 47)

Figure 47 Palletised parcels being prepared for last mile delivery inside the MCH

In testing the potential of the MCH structure for use in a second location, key monitoring components were:

a) Cost to set-up: The MCH was built on an unimproved site on flood plain. The Pedal & Post site had some key components, namely a fenced perimeter, vehicle loading bay, cargobikes storage and a locking secure parcel storage facility. However, further improvements were required. Understanding these costs is necessary in understanding the business case for use of other parcels of land. In total, the cost of building the MCH from the existing site was £11,051. Broken down into specific elements, these costs were:
   - Levelling and grading of site: £5,800
   - Industrial tent: £3,769
   - Tent-setup: £732
   - CCTV 3 cameras: £750

b) Prioritization of MCH requirements: To define the requirements for use of an off-site MCH location, engagement with the P&P depot manager was undertaken during the demonstration period. Requirements were separated into ‘essential’ and ‘desirable’:
   - Essential MCH requirements:
     i. Perimeter fence: needed for site security
     ii. Level and graded pad: needed for moving pallet jacks
     iii. Toilet
     iv. Lockable secure facility: needed for overnight storage of undelivered parcels
     v. Vehicle loading bay: space for larger long-distance vehicles to unload palletized loads—not necessarily within the MCH facility
     vi. CCTV: needed for site security
     vii. Covered area at least 47m2: needed for parcel transfer & organisation
   - Desirable MCH requirements:
     i. On site electricity: for lights, computer and battery charging. Ideal: 100a connection with 10x16a sockets and 2x7kWh e-Van charging
     ii. Office & staff room
     iii. On site water

c) Structure capacity: quantifying the environmental benefits associated with using a site as an MCH is crucial in engagement with stakeholders to gain buy-in. The key transferrable metric for this is two-fold: the estimated CO_2 equivalent per parcel delivered: 0.204kg[1] and the parcels delivered by cargo bike from the area of the MCH if at full capacity: (4.65 parcels/day)/m2. Calculations for parcels delivered are as follows:
   - Demonstration period: 14th to 31st Jan (16 days excluding Sundays)

i. LSP1: 5 routes: 8,632 parcels / 16 days = 539.5 parcels/day (equivalent to 110.05 kg CO_2/day)
ii. LSP2: 6 routes: 6,843 parcels /16 days = 427.7parcels/day (equivalent to 87.25 kg CO_2/day)
iii. total: 11 routes (92% capacity): 967.2 parcels/day (equivalent to 197.3 kg CO_2/day)

- Area: 19m x 12m (includes covered area and cargo bike storage) = 227m^2
- Demonstration usage: (967.2 parcels/day)/ 227m^2=4.26 parcels/m^2
- Full capacity at 12 bays: (4.26 parcels/m^2)/.92= 4.65 parcels/m^2
- Full capacity with 2 runs/bay: (4.65 parcels/m^2) x 2= 9.3 parcels/m^2

Based on estimated emissions per parcel and the number of parcels delivered from the MCH during the demonstration, at full capacity operating with 1 run/day the MCH can achieve 0.95kg CO2/m^2 per day or 289.2kg CO2/m^2 per year (excludes Sundays and bank holidays)

d) End user (courier) feedback: The primary users of the MCH are couriers. They bring in parcels by pallet, break these pallets down, organize parcels into ideal delivery order and then pack them into their cargo bikes. Anecdotally, couriers reported satisfaction at being able to carry out these activities under the cover of the structure.

Overall, the demonstration of the MCH was a success, providing much needed quantitative understanding of the requirements and benefits of an MCH site. 4 out of the 6 additional routes taken for the demonstration ended in February 2025. There are 2 reasons for this: first, the payment per parcel was not high enough from the 2nd LSP. Second, the stem journey from the Pedal & Post dept to the delivery area for routes was too long. The combination of these resulted in an overall loss in operating these routes. This underscores the need for optimization and efficiency in cargo bike logistics. Ultimately, the use of a remote MCH in another part of Oxford should reduce the average stem journey for parcels, increasing profitability.

4. Mobile Delivery Hub

The purpose of the MDH demonstration was to understand the relative benefits of using a self-driving e-cargo bike in a cargo bike fleet in one use case: reloading couriers in the field. Thus, the two alternatives were whether the MDH will provide a feeder service (where the rider will need to physically move parcels between the MDH and their bike) or whether the rider will switch over to the MDH to continue (which could be quicker, but their original bike also needs to have autonomous capability to return to the depot).

To assess the business case and viability of this use case and alternatives, the key evaluation component is the amount of time a courier spent in reloading parcels to complete their route. This is the sum of 2 components: Return stem journey time (journey from depot to delivery area—only applicable to the first scenario) and unloading/reloading or switching bikes. Total courier time for each scenario is as follows:

- Scenario 1 (returning to depot- baseline) courier time (minutes) 41:14
- Scenario 2 (reloading cargo bike from MDH in delivery area) courier time (minutes): 1:47
- Scenario 3: (courier switches bikes) courier time (minutes) 00:43

From this, it is apparent that the 1 minute 4 seconds saved by the courier does not justify the investment in a second self-driving cargo bike. However, the 39 minutes and 27 seconds saved between scenario 1 and 2 is significant, but the business case for investment in this solution is still marginal.
During the demonstration, it was observed that the reloading volume of the cargo bikes was not significant i.e. the load that needed to be delivered was approximately 1.2x the capacity of the cargo bike— usually, the courier could not fit approximately 20 parcels (out of a total parcel load range of 80-162 parcels) into the initial load on the cargo bike in the route tested. As reloading a cargo bike in the field (scenario 2) would only use approx. 20% of the MDH capacity, it is worthwhile exploring in the second demonstration period the possibility of a MDH reloading more than 1 courier in the field, thus increasing the value of the MDH.

The sample for this analysis consists of six cargo bike couriers who actively participated in the first demonstration of GREEN-LOG solution in Oxfordshire. The respondents provided insights through two survey rounds—one conducted before the implementation of GREEN-LOG solutions (baseline) and one after (post survey)—to evaluate the impact of GREEN-LOG solutions demonstrated in this pilot (as described in Section 7.1) on their daily work experiences. The baseline survey highlighted several challenges faced by cargo bike couriers.

Among the key concerns was the undervaluation of specialist last-mile services, with one respondent stating, “Bespoke and specialist last-mile services like Pedal & Post are significantly undervalued by the logistics industry—paid underwhelmingly despite the solution they provide for low-emission zone logistics.” This highlights a systemic issue within industry, where the environmental and efficiency benefits of cargo bike deliveries do not always translate into fair financial recognition.

Additionally, there was a strong call for greater council funding and backing to further develop P&P and green delivery initiatives. Operational challenges were also mentioned in the baseline survey, a courier cited, “Breakdowns, traffic, and customers’ buildings with no delivery facilities” as significant obstacles to efficient service. Another concern was parts storage and battery reliability, which directly impacted delivery availability: “Parts storage led to a shortage of bicycles available for parcel delivery, and worn-out batteries lead to occasional shutdowns.” These infrastructure and equipment-related setbacks can affect the overall service reliability.

The post-survey results suggest that GREEN-LOG solutions may have helped address some of these concerns by improving delivery speed and reducing customer complaints. However, perceived efficiency ratings did not increase significantly, indicating that while GREEN-LOG solutions have introduced positive operational shifts, some challenges—particularly regarding industry recognition and funding—still require further attention. The analysis of job satisfaction levels highlights a significant improvement in post-implementation, with most respondents now rating their satisfaction as "3-satisfied." Prior to GREEN-LOG, only a single respondent expressed this level of satisfaction, whereas in the impact survey, five respondents provided positive ratings. This increase suggests that the introduction of GREEN-LOG solutions has contributed to enhance work experience, likely through operational support. However, the work-life balance remained stable through both surveys, indicating that while job satisfaction has increased, GREEN-LOG solutions have neither improved nor worsened employees' ability to balance their professional and personal lives.

Another important area of change is safety at work, where perceptions have improved significantly. A shift from only one respondent previously feeling "somewhat safe" to five respondents indicating the same suggests that GREEN-LOG solutions have positively influenced working conditions, possibly through better route planning or enhanced operational support. However, the absence of "very safe" responses in the post-survey indicates that further measures may be needed to achieve a higher level of perceived safety.

In terms of delivery efficiency, the results show a mixed outcome. The number of respondents who rated their delivery operations as "efficient" dropped slightly from four to three, while one respondent described the system as "inefficient" in the post-implementation phase. This suggests that while GREEN-LOG solutions may have introduced new operational benefits, they could also require further adjustments to meet couriers' expectations regarding ease of deliveries. However, an encouraging sign is the reduction in customer complaints, where previously five respondents reported occasional complaints, and after GREEN-LOG this number decreased to three.

Additionally, two respondents stated that they "never" receive complaints now, reflecting an improvement in customer satisfaction. The speed of deliveries has shown clear improvement following the introduction of GREEN-LOG solutions. The number of respondents who reported complete deliveries within "30 minutes to 1 hour" increased from one in the baseline survey to four in the post survey, while longer delivery times exceeding two hours were no longer reported. This suggests that GREEN-LOG's solution has contributed to faster and more consistent service. However, the total number of deliveries per day showed more variability post-implementation, with new delivery range categories appearing in the post survey. This shift may indicate that GREEN-LOG has restructured workloads, allowing for greater flexibility in daily delivery volumes. Despite improvements in delivery time, the use of route planning tools has seen a slight decline in perceived effectiveness. While the number of respondents using route planning tools remained similar between the two surveys, the percentage of respondents who rated these tools as "effective" dropped, and more participants left this question blank in the post survey.

7.1.3 Preliminary KPI Estimates

Table 10 presents the KPIs for the Oxford pilot, from the first round of demonstrations:

Table 10: Oxford 1st Round KPIs

Category	KPIs	Oxfordshire
SOCIETAL	1.1 Job opportunities created	Mobile Consolidation Hub created 7 jobs. These ended up not being sustainable due to low margins on parcel delivery cost provided by the LSP.
	1.2 Improved quality of jobs created	The courier survey was not targeted at jobs created, but rather all couriers. The impact of any change is more likely attributable to immediate conditions around the survey completion rather than the demonstration. However, the demonstration element that would have the greatest impact would be the Mobile Consolidation Hub, which provided a structure to work under whereas previously the couriers worked exposed to the elements.
	1.3 Reduced congestion	Mobile Delivery Hub: meeting courier in field: stem journey time is effectively '0' in this scenario, savings of 39.5minutes= 8.22% savings
	1.4 Increased public awareness of sustainable urban delivery solutions	n/a
	1.5 Acceptance of sustainable urban delivery solutions	n/a
	1.6 Improved neighborhood life quality	n/a
	1.7 Increased safety	n/a
ENVIRONMENTAL	2.1 Saved energy consumption	n/a

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	2.2 Reduced CO2 emissions	87.25 kg/day
	2.3 Reduction NOx emissions	n/a
	2.4 Reduced particulates	n/a
	2.5 Reduced noise pollution	MCH replaced 6 vans with cargo bikes. Maximum noise for vans=72db. Assuming 8 hour delivery routes per van, (72db* 48hours)/day
	2.6 Land use (sq used of the facilities)	Increase in land use by 228 m2 as compared to all deliveries being made by van. This figure does not include the footprint of counterfactual van footprint or cargo bike footprint. Difficult to disaggregate space used for baseline cargo bike operations from demonstration
ECONOMIC	3.1 Increased benefits for local businesses	n/a
	3.2 Reduced cost of urban logistics services	£7.51/day
	3.3 Improved service level of urban logistics	n/a
	3.4 Improved utilization of storage space of LSPs' (fill rate of the van)	n/a
	3.5 Increased zero-emission delivery modes of LSPs'	6
	3.6 Reduced urban delivery time	MCH: equal. MDH: saving of 24 seconds per delivery
	3.7 Improved urban delivery reliability	n/a

8 Conclusions and future work

The first round of GREEN-LOG demonstrations across the five pilot areas—Athens, Barcelona, Ispra, Flanders, and Oxfordshire—provided important insights into the feasibility, efficiency, and sustainability of innovative green logistics solutions:

Athens: The simulation-based demonstration indicated significant potential efficiencies through collaborative delivery models, notably route optimization and the integration of smart locker technologies. Preliminary results showed meaningful reductions in delivery distance, time, and emissions, supporting the potential scalability of shared logistics solutions.

Barcelona: Multimodal integration involving public transport (train) and electric cargo bikes demonstrated operational viability and time efficiency, with particularly positive feedback from riders regarding usability. However, accuracy improvements are required in routing simulations to reflect realistic environmental conditions (slopes, waiting times). Trials with the autonomous delivery robot (Droid) revealed stable and reliable navigation, albeit with scope for refining sensor accuracy under variable conditions (lighting, repetitive environments).

Ispra: The implementation of combined cargo bike and autonomous vehicle delivery for canteen meal services resulted in high user acceptance, with over 90% supporting continued implementation. Although time savings were modest compared to traditional methods, the overall user satisfaction and environmental impacts were positive, validating the approach's practicality.

Flanders: Notable findings emerged from the three separate sub-demonstrations in Mechelen, Ghent, and Leuven:

- In Mechelen, consumer-focused nudging through the dynamic pricing model successfully influenced sustainable delivery choices, achieving a substantial reduction (47%) in delivery tours by vans.
- Ghent’s initial waste-collection scenario faced feasibility challenges due to regulatory complexities, low market margins, and lack of operational partner readiness. This resulted in a strategic pivot toward developing a more viable second-phase scenario involving local food logistics.
- Leuven’s data-driven insights identified substantial inefficiencies in cargo-bike logistics operations, highlighting opportunities for load consolidation and capacity optimization via the Logistics-as-a-Service (LaaS) model.

Oxfordshire: Evaluations focused on the Mobile Consolidation Hub (MCH), Mobile Delivery Hub (MDH), and demand prediction tools. The MCH showed significant promise in reducing CO_2 emissions and improving courier work conditions, although route profitability issues require further investigation. The MDH effectively demonstrated courier efficiency improvements, although its current business case requires enhancements through increased cargo load or multiple courier services. The demand-prediction tool showed potential utility for dynamic routing adjustments, particularly during peak periods.

Based on the first-round evaluation, the following recommendations are provided in anticipation of the second round of demonstrations in terms of the technical solutions demonstrated. The simulation models used should be further refined across cases to support the calculation of the required KPIs. Enhance the LaaS functionalities to improve the user experience (e.g., registration delays, complexity), and expand further the consolidation efforts testing different policies through the dynamic pricing model and nudging model.

References

Reference	Name of document
[REF-01]	GREEN-LOG D1.3 – Assessment, Transferability and Adaptability Framework, Initial Version, June 2024

Annex I : Questionnaires

Post-Survey for Customers/End-Users

This survey is part of the GREEN-LOG Horizon Europe co-funded project which develops Logistics-as-a service platforms for interconnected city logistics, automated delivery concepts using autonomous vehicles and delivery droids, cargo-bike-based innovations for sustainable micro-consolidation, and multimodal parcel deliveries integrating public transportation.

The data collected will be used solely for research purposes. Any personal data will be collected, processed, and stored in compliance with the General Data Protection Regulation (GDPR). All data will be anonymized and aggregated with that of other participants for research and analysis.

The survey will take approximately **5 to 10 minutes** to complete. Participation is voluntary, and you may exit the survey at any time.

Thank you in advance for participating in our survey. Your responses will help us measure the impact of Greenlog services. All responses are confidential.
Thank you in advance for participating in our survey.
Do you understand the survey's purpose and consent to participate?

- Yes
- No

Section 1: Demographics

1. **What is your age range?**
   - Under 18
   - 18-24
   - 25-34
   - 35-44
   - 45-54
   - 55-64
   - 65 or older
2. **What is your gender?**
   - Male
   - Female
   - Non-binary/Third gender
   - Prefer not to say
3. **What is your highest level of education completed?**
   - Less than high school
   - High school diploma or equivalent
   - Some college, no degree
   - Associate degree
   - Bachelor's degree
   - Graduate or professional degree
4. **What is your employment status?**

- Employed full-time
- Employed part-time
- Self-employed
- Unemployed looking for work
- Student
- Retired
- Homemaker
- Unable to work

5. **How long have you lived in your current neighborhood?**
   - Less than 1 year
   - 1-3 years
   - 4-6 years
   - 7-10 years
   - More than 10 years
6. **Do you have access to a personal vehicle?**
   - Yes
   - No

Section 2: Awareness of Sustainable Urban Delivery Solutions

1. Has your awareness of sustainable urban delivery solutions increased as a result of your participation in the GREEN-LOG pilot?
   a. Not at all
   b. Slightly
   c. Moderately
   d. Significantly
   e. Extremely
2. Which sustainable delivery options did you use during the GREEN-LOG pilot? (Select all that apply)
   a. Electric vehicles
   b. Cargo bikes
   c. Consolidated deliveries (Micro consolidation center)
   d. Pickup points
   e. Other (please specify): ____________
3. How did you receive information about the sustainable delivery options during the GREEN-LOG pilot? (Select all that apply)
   a. Company emails
   b. Mobile app notifications
   c. Social media
   d. Friends or family
   e. Community events
   f. Other (please specify): ____________

Section 3: Acceptance of Sustainable Urban Delivery Solutions

1. How satisfied are you with the sustainable delivery services provided during the GREEN-LOG pilot?
   a. Very dissatisfied
   b. Somewhat dissatisfied
   c. Neutral
   d. Somewhat satisfied
   e. Very satisfied

2. Would you recommend sustainable delivery services to others based on your experience?
    a. Definitely not
    b. Probably not
    c. Not sure
    d. Probably yes
    e. Definitely yes
3. How likely are you to choose sustainable delivery options in the future?
    a. Very unlikely
    b. Unlikely
    c. Neutral
    d. Likely
    e. Very likely

Section 4: Neighborhood Life Quality

1. Have you noticed any changes in your neighborhood's environment since the pilot started?
    a. Significant deterioration
    b. Slight deterioration
    c. No change
    d. Slight improvement
    e. Significant improvement
2. Please indicate the extent to which you agree with the following statements:

	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
GREEN-LOG activities has reduced noise pollution in my neighborhood					
Air quality has improved since the introduction of sustainable delivery vehicles.					
There is less traffic congestion due to GREEN-LOG					

3. Overall, how has the GREEN-LOG pilot impacted your quality of life in the neighborhood?
    a. Very negatively
    b. Somewhat negatively
    c. No impact
    d. Somewhat positively
    e. Very positively

Section 5: Service Level of Urban Logistics

1. How would you compare the delivery speed of sustainable services during the GREEN-LOG pilot to traditional methods?
    a. Much slower
    b. Slightly slower
    c. About the same
    d. Slightly faster
    e. Much faster
2. Did you experience any of the following issues with deliveries during the GREEN-LOG pilot? (Select all that apply)
    a. Delayed deliveries
    b. Lost packages
    c. Poor communication
    d. Damaged goods
    e. None of the above
3. How satisfied are you with the overall service level of the sustainable delivery options provided during the GREEN-LOG pilot?
    a. Very dissatisfied
    b. Somewhat dissatisfied
    c. Neutral
    d. Somewhat satisfied
    e. Very satisfied

Section 6: Additional Feedback

1. What aspects of the sustainable urban delivery solutions did you find most beneficial?____
2. What challenges or issues did you encounter during the pilot?____
3. What suggestions do you have for improving sustainable delivery services in the future?____
4. Any additional comments or concerns you'd like to share?____

Follow-up Survey for Cargo Bike Couriers and Depot Managers

This survey is part of the GREEN-LOG Horizon Europe co-funded project which develops Logistics-as-a service platforms for interconnected city logistics, automated delivery concepts using autonomous vehicles and delivery droids, cargo-bike-based innovations for sustainable micro-consolidation, and multimodal parcel deliveries integrating public transportation.

The data collected will be used solely for research purposes. Any personal data will be collected, processed, and stored in compliance with the General Data Protection Regulation (GDPR). All data will be anonymized and aggregated with that of other participants for research and analysis.

The survey will take approximately **5 to 10 minutes** to complete. Participation is voluntary, and you may exit the survey at any time.

Thank you in advance for participating in our survey. Please complete this survey after using the Greenlog platform and associated hubs. Your responses will help us measure the impact of Greenlog services. All responses are confidential.
Thank you in advance for participating in our survey.
Do you understand the survey's purpose and consent to participate?

- Yes
- No

Section 1: General Information

1. What is your current role?
    a. Cargo Bike Courier/e-Cargo Bike Courier
    b. Courier
    c. Droid Operator
    d. Depot Manager
    e. Micro-Hub Manager
    f. Other (please specify)___________________

2. How long have you been working in your current position (given the duration fill in the respective field)?
    a. __________week(s)
    b. __________month(s)
    c. __________year(s)

Section 2: Quality of Jobs

1. On a scale of 1 to 4, how satisfied are you with your current job?
    a. 1-Very Unsatisfied
    b. 2-Unsatisfied
    c. 3-Satisfied
    d. 4-Very Satisfied
2. How would you rate your current work-life balance?
    a. Excellent
    b. Good
    c. Fair
    d. Poor
    e. Very Poor
3. Do you feel safe performing your job?
    a. Yes, very safe
    b. Yes, somewhat safe
    c. Neutral
    d. Not very safe
    e. Not safe at all

Section 3: Service Level of Urban Logistics

1. How efficient are the current delivery processes?
    a. Very Efficient
    b. Efficient
    c. Neutral

d. Inefficient
e. Very Inefficient

2. How satisfied are you with the coordination between couriers and depots?
   a. 1-Very Unsatisfied
   b. 2-Unsatisfied
   c. 3-Satisfied
   d. 4-Very Satisfied
3. How satisfied are you with the coordination between couriers and micro-hubs?
   a. 1-Very Unsatisfied
   b. 2-Unsatisfied
   c. 3-Satisfied
   d. 4-Very Satisfied
4. How often do you encounter delays due to logistical issues?
   a. Never
   b. Rarely
   c. Sometimes
   d. Often
   e. Always
5. How frequently do customers complain about delivery services?
   a. Never
   b. Rarely
   c. Sometimes
   d. Often
   e. Always

Section 4: Urban Delivery Time

1. What is the average time it takes to deliver a package from pickup to delivery?
   a. Less than 30 minutes
   b. 30 minutes to 1 hour
   c. 1 to 2 hours
   d. More than 2 hours
2. How many deliveries do you complete on an average shift?
   a. (Please enter a number): ____________
3. Do you use any route planning tools?
   a. Yes
   b. No
4. If yes, how effective are they in reducing delivery time?
   a. Very Effective
   b. Effective
   c. Neutral
   d. Ineffective
   e. Very Ineffective
   f. Not Applicable

Section 5: Urban Delivery Reliability

1. What percentage of your deliveries are successful on the first attempt?

____________%

2. What percentage of your deliveries are delivered on time?
_____________%
3. How often do you need to reschedule deliveries due to issues (e.g., customer not available, address errors)?
    a. Never
    b. Rarely
    c. Sometimes
    d. Often
    e. Always
4. Do you feel you have adequate support for handling delivery exceptions?
    a. Yes, definitely
    b. Yes, to some extent
    c. Neutral
    d. Not really
    e. Not at all

Section 6: Open Feedback

1. What improvements have you noticed since using the Greenlog platform and associated hubs?

____
____
____

2. What further improvements would you suggest enhancing your work experience?

____
____
____
____

3. Do you have any additional comments or suggestions regarding urban logistics services?

____
____
____
____

Baseline Survey for Cargo Bike Couriers and Depot Managers

This survey is part of the GREEN-LOG Horizon Europe co-funded project which develops Logistics-as-a service platforms for interconnected city logistics, automated delivery concepts using autonomous vehicles and delivery droids, cargo-bike-based innovations for sustainable micro-consolidation, and multimodal parcel deliveries integrating public transportation.

The data collected will be used solely for research purposes. Any personal data will be collected, processed, and stored in compliance with the General Data Protection Regulation (GDPR). All data will be anonymized and aggregated with that of other participants for research and analysis.

The survey will take approximately **5 to 10 minutes** to complete. Participation is voluntary, and you may exit the survey at any time.

Thank you in advance for participating in our survey. Your insights will help us understand the current state of urban logistics services. All responses are confidential.

Thank you in advance for participating in our survey.

Do you understand the survey's purpose and consent to participate?

- Yes
- No

Section 1: General Information

1. What is your current role?
    a. Cargo Bike Courier/e-Cargo Bike Courier
    b. Courier
    c. Droid Operator
    d. Depot Manager
    e. Micro-Hub Manager
    f. Other (please specify)________________

2. How long have you been working in your current position (given the duration fill in the respective field)?
    a. __________week(s)
    b. __________month(s)
    c. __________year(s)

Section 2: Quality of Jobs

1. On a scale of 1 to 4, how satisfied are you with your current job?
    a. 1-Very Unsatisfied
    b. 2-Unsatisfied
    c. 3-Satisfied
    d. 4-Very Satisfied
2. How would you rate your current work-life balance?
    a. Excellent
    b. Good
    c. Fair
    d. Poor
    e. Very Poor
3. Do you feel safe performing your job?
    a. Yes, very safe
    b. Yes, somewhat safe
    c. Neutral
    d. Not very safe
    e. Not safe at all

Section 3: Service Level of Urban Logistics

1. How efficient are the current delivery processes?
    a. Very Efficient
    b. Efficient
    c. Neutral
    d. Inefficient

   e. Very Inefficient
2. How satisfied are you with the coordination between couriers and depots?
   a. 1-Very Unsatisfied
   b. 2-Unsatisfied
   c. 3-Satisfied
   d. 4-Very Satisfied
3. How satisfied are you with the coordination between couriers and micro-hubs?
   a. 1-Very Unsatisfied
   b. 2-Unsatisfied
   c. 3-Satisfied
   d. 4-Very Satisfied
4. How often do you encounter delays due to logistical issues?
   a. Never
   b. Rarely
   c. Sometimes
   d. Often
   e. Always
5. How frequently do customers complain about delivery services?
   a. Never
   b. Rarely
   c. Sometimes
   d. Often
   e. Always

Section 4: Urban Delivery Time

1. What is the average time it takes to deliver a package from pickup to delivery?
   a. Less than 30 minutes
   b. 30 minutes to 1 hour
   c. 1 to 2 hours
   d. More than 2 hours
2. How many deliveries do you complete on an average shift?
   a. (Please enter a number): _____________
3. Do you use any route planning tools?
   a. Yes
   b. No
4. If yes, how effective are they in reducing delivery time?
   a. Very Effective
   b. Effective
   c. Neutral
   d. Ineffective
   e. Very Ineffective
   f. Not Applicable

Section 5: Urban Delivery Reliability

1. What percentage of your deliveries are successful on the first attempt? _____________%
2. What percentage of your deliveries are delivered on-time? _____________%

3. How often do you need to reschedule deliveries due to issues (e.g., customer not available, address errors)?
    a. Never
    b. Rarely
    c. Sometimes
    d. Often
    e. Always
4. Do you feel you have adequate support for handling delivery exceptions?
    a. Yes, definitely
    b. Yes, to some extent
    c. Neutral
    d. Not really
    e. Not at all

Section 6: Open Feedback

1. What challenges do you currently face in your job that affect your performance?

____
____
____
____

2. Do you have any suggestions for improving urban logistics services?

____
____
____
____

Thank you for your valuable feedback!

Survey for E-commerce Shopkeepers

This survey is part of the GREEN-LOG Horizon Europe co-funded project which develops Logistics-as-a service platforms for interconnected city logistics, automated delivery concepts using autonomous vehicles and delivery droids, cargo-bike-based innovations for sustainable micro-consolidation, and multimodal parcel deliveries integrating public transportation.

The data collected will be used solely for research purposes. Any personal data will be collected, processed, and stored in compliance with the General Data Protection Regulation (GDPR). All data will be anonymized and aggregated with that of other participants for research and analysis.

The survey will take approximately **5 to 10 minutes** to complete. Participation is voluntary, and you may exit the survey at any time.

Thank you in advance for participating in our survey. Please complete this survey after using the Greenlog platform and associated services. Your

responses will help us measure the impact of Greenlog services. All responses are confidential.

Thank you in advance for participating in our survey.

Do you understand the survey's purpose and consent to participate?

- Yes
- No

Section 1: General Information

1. How long have you been operating your online shop?

____________months

_____________years

2. What types of products do you sell? (Select all that apply)
   a. Electronics
   b. Clothing and Accessories
   c. Home and Garden
   d. Health and Beauty
   e. Food and Beverages
   f. Other (please specify): ___________

Section 2: Business Performance

1. Since using Greenlog platform, how has your overall sales performance changed?
   a. Increased significantly
   b. Increased somewhat
   c. No change
   d. Decreased somewhat
   e. Decreased significantly
2. How has your customer base changed since using Greenlong platform?
   a. Increased significantly
   b. Increased somewhat
   c. No change
   d. Decreased somewhat
   e. Decreased significantly
3. Have you noticed any changes in customer purchase frequency since using Greenlog platform?
   a. Increased significantly
   b. Increased somewhat
   c. No change
   d. Decreased somewhat
   e. Decreased significantly
4. How has your profit margin been affected since using Greenlog platform?
   a. Improved significantly
   b. Improved somewhat
   c. No change
   d. Decreased somewhat
   e. Decreased significantly

Section 3: Operational Efficiency

1. How has the Greenlog platform affected your order processing time?
    a. Reduced significantly
    b. Reduced somewhat
    c. No change
    d. Increased somewhat
    e. Increased significantly
2. Have you experienced any changes in inventory management efficiency since using Greenlog?
    a. Improved significantly
    b. Improved somewhat
    c. No change
    d. Worsened somewhat
    e. Worsened significantly
3. How has your workload changed since using Greenlog services?
    a. Decreased significantly
    b. Decreased somewhat
    c. No change
    d. Increased somewhat
    e. Increased significantly
4. Has Greenlog provided tools or features that help streamline your business operations?
    a. Yes, significantly
    b. Yes, somewhat
    c. No change
    d. Not really
    e. Not at all

Section 4: Customer Satisfaction and Service Level

1. Since using Greenlog, how has customer satisfaction changed based on feedback or reviews?
    a. Improved significantly
    b. Improved somewhat
    c. No change
    d. Declined somewhat
    e. Declined significantly
    f. Not sure / No feedback
2. Have customer complaints about delivery times decreased since using Greenlog services?
    a. Decreased significantly
    b. Decreased somewhat
    c. No change
    d. Increased somewhat
    e. Increased significantly
    f. Not applicable / Don't know
3. How has the accuracy of order fulfillment changed since using Greenlog platform?
    a. Improved significantly
    b. Improved somewhat
    c. No change
    d. Worsened somewhat

e. Worsened significantly

4. Have you noticed any changes in return rates or order cancellations since using Greenlog services?
    a. Decreased significantly
    b. Decreased somewhat
    c. No change
    d. Increased somewhat
    e. Increased significantly

Section 5: Delivery Time and Reliability

1. How has the average delivery time to customers changed since using Greenlog services?
    a. Reduced significantly
    b. Reduced somewhat
    c. No change
    d. Increased somewhat
    e. Increased significantly
2. Has the reliability of deliveries improved since using Greenlog services?
    a. Yes, significantly
    b. Yes, somewhat
    c. No change
    d. No, it has worsened somewhat
    e. No, it has worsened significantly
3. Do you have better access to shipment tracking information since using Greenlog platform?
    a. Yes, much better
    b. Yes, somewhat better
    c. No change
    d. No, it's worse
    e. No, it's much worse

Section 6: Overall Satisfaction

1. Overall, how satisfied are you with the Greenlog platform?
    a. 1 Very Unsatisfied
    b. 2 Unsatisfied
    c. 3 Neutral
    d. 4 Satisfied
    e. 5 Very Satisfied
2. Would you recommend Greenlog to other shopkeepers?
    a. Yes, definitely
    b. Yes, probably
    c. Not sure
    d. Probably not
    e. Definitely not

Section 7: Open Feedback

1. What are the most significant benefits you've experienced since using Greenlog platform?

___

___

2. What challenges or issues have you encountered while using Greenlog platform?

3. Do you have any suggestions for improvements to the Greenlog platform?

Thank you for your feedback!

Annex II: Monitoring Tool

Field real data gathering	Athens	research	15/11/24	AUEB, FEDEX, ACS	FALSE	FALSE	18/11/24 12:00	18/11/24 12:00	Kanellopoulos Panagiotis	Kanellopoulos Panagiotis	Elemento	sites/GREEN-LOG/Lists/Living Lab test
demonstration of Greenlog platform predictive tool	Oxfordshire	event	14/11/24	Chris Benson of Pedal & Post. Feedback on benefits and potential uses discussed.	FALSE	TRUE	14/11/24 17:53	14/11/24 17:53	Stanley, Graham - Oxfordshire County Council	Stanley, Graham - Oxfordshire County Council	Elemento	sites/GREEN-LOG/Lists/Living Lab test
baseline next day/same day delivery routes completed	Oxfordshire	research	12/11/24	routes generated by the Greenlog Platform are undertaken on the 11th and 12th November. These routes are monitored to validate and compare with the GL	FALSE	TRUE	12/11/24 16:41	12/11/24 16:41	Stanley, Graham - Oxfordshire County Council	Stanley, Graham - Oxfordshire County Council	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Micro Consolidation Hub – first use	Oxfordshire	milestone	11/11/24	commences useage	FALSE	TRUE	12/11/24 16:37	12/11/24 16:37	Stanley, Graham - Oxfordshire County Council	Stanley, Graham - Oxfordshire County Council	Elemento	sites/GREEN-LOG/Lists/Living Lab test
demonstration kick-off	Oxfordshire	event;#engagement	8/11/24	Post Depot. Event was focused on increasing awareness of the demonstration with end users (couriers)	FALSE	FALSE	12/11/24 16:42	12/11/24 16:32	Stanley, Graham - Oxfordshire County Council	Stanley, Graham - Oxfordshire County Council	Elemento	sites/GREEN-LOG/Lists/Living Lab test
end user baseline survey closed	Oxfordshire	milestone	8/11/24	launch event	FALSE	TRUE	12/11/24 16:39	12/11/24 16:39	Stanley, Graham - Oxfordshire County Council	Stanley, Graham - Oxfordshire County Council	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Athens ll partners meeting	Athens	meeting	8/11/24		FALSE	FALSE	12/11/24 17:49	12/11/24 17:49	Kanellopoulos Panagiotis	Kanellopoulos Panagiotis	Elemento	sites/GREEN-LOG/Lists/Living Lab test
ACS FedEx AUEB meeting on data processing	Athens	meeting	6/11/24		FALSE	FALSE	12/11/24 17:49	12/11/24 17:49	Kanellopoulos Panagiotis	Kanellopoulos Panagiotis	Elemento	sites/GREEN-LOG/Lists/Living Lab test
ACS AIMSUN on demand prediction	Athens	planning	31/10/24		FALSE	FALSE	12/11/24 17:48	12/11/24 17:48	Kanellopoulos Panagiotis	Kanellopoulos Panagiotis	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Athens LL (WP4) meeting	Athens	meeting	23/10/24	•User recruitment •Communication •Data management •Configuration •Deployment •Evaluation (baseline, surveys,...) •Other issues	FALSE	FALSE	12/11/24 17:31	12/11/24 17:27	Kanellopoulos Panagiotis	Kanellopoulos Panagiotis	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Athens LL Pilot Starting	Athens	milestone	21/10/24	FedEX and AUEB	FALSE	TRUE	12/11/24 17:39	12/11/24 17:39	Kanellopoulos Panagiotis	Kanellopoulos Panagiotis	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Athens LL partners meeting	Athens	meeting	18/10/24		FALSE	FALSE	12/11/24 17:37	12/11/24 17:37	Kanellopoulos Panagiotis	Kanellopoulos Panagiotis	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Establishment of ACS locker at Kaluthmonos	Athens	milestone;#event	18/10/24		FALSE	TRUE	12/11/24 17:45	12/11/24 17:45	Kanellopoulos Panagiotis	Kanellopoulos Panagiotis	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Athens LL partners meeting	Athens		11/10/24		FALSE	FALSE	12/11/24 17:36	12/11/24 17:36	Kanellopoulos Panagiotis	Kanellopoulos Panagiotis	Elemento	sites/GREEN-LOG/Lists/Living Lab test
ACS FEDEX meeting	Athens	planning	2/10/24		FALSE	FALSE	12/11/24 17:35	12/11/24 17:35	Kanellopoulos Panagiotis	Kanellopoulos Panagiotis	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Athens LL (WP4) meeting	Athens	meeting	24/9/24		FALSE	FALSE	12/11/24 17:33	12/11/24 17:33	Kanellopoulos Panagiotis	Kanellopoulos Panagiotis	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Establishment of ACS locker at Serafeio	Athens	event;#milestone	24/9/24		FALSE	TRUE	12/11/24 17:43	12/11/24 17:43	Kanellopoulos Panagiotis	Kanellopoulos Panagiotis	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Athens LL partners meeting	Athens		20/9/24		FALSE	FALSE	12/11/24 17:32	12/11/24 17:32	Kanellopoulos Panagiotis	Kanellopoulos Panagiotis	Elemento	sites/GREEN-LOG/Lists/Living Lab test
ACS FEDEX meeting	Athens	planning	20/9/24		FALSE	FALSE	12/11/24 17:32	12/11/24 17:32	Kanellopoulos Panagiotis	Kanellopoulos Panagiotis	Elemento	sites/GREEN-LOG/Lists/Living Lab test
coordination meeting	Oxfordshire	planning	13/9/24	demonstration	FALSE	TRUE	11/9/24 13:09	11/9/24 13:09	Stanley, Graham - Oxfordshire County Council	Stanley, Graham - Oxfordshire County Council	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Athens LL partners meeting	Athens	planning	13/9/24		FALSE	FALSE	12/11/24 17:31	12/11/24 17:31	Kanellopoulos Panagiotis	Kanellopoulos Panagiotis	Elemento	sites/GREEN-LOG/Lists/Living Lab test
stakeholder meeting	Oxfordshire	anning;#engagemen t	12/9/24	consolidation hub (land owners) to discuss 1st iteration demonstration and plan for 2nd iteration demonstration	FALSE	FALSE	11/9/24 12:55	11/9/24 12:55	Stanley, Graham - Oxfordshire County Council	Stanley, Graham - Oxfordshire County Council	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Data sharing planning	Athens	planning	10/9/24	ACS, AUEB	FALSE	FALSE	12/11/24 17:31	12/11/24 17:29	Kanellopoulos Panagiotis	Kanellopoulos Panagiotis	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Midterm review meeting	Athens	milestone	3/9/24		FALSE	TRUE	12/11/24 17:28	12/11/24 17:28	Kanellopoulos Panagiotis	Kanellopoulos Panagiotis	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Data sharing	Oxfordshire	milestone	27/8/24	UoW provided access to P&P courier management pltfm to streamline demonstration of GL same day/scheduling	FALSE	TRUE	11/9/24 12:49	11/9/24 12:49	Stanley, Graham - Oxfordshire County Council	Stanley, Graham - Oxfordshire County Council	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Communication Plan Definition	Ispra	milestone	1/8/24	for end-user engagement. Key points: - How to convince the JRC workers to use the delivery service (benefits, green brand, ...)	FALSE	TRUE	5/3/24 10:14	5/3/24 10:14	Eleonora Di Fabio	Eleonora Di Fabio	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Athens LL partners meeting	Athens	planning	12/7/24		FALSE	FALSE	12/11/24 17:24	12/11/24 17:24	Kanellopoulos Panagiotis	Kanellopoulos Panagiotis	Elemento	sites/GREEN-LOG/Lists/Living Lab test
3rd Summer School of Digital Supply Chain and Logistics	Athens	communication	2/7/24	Green-log project Athens LL presentation at the event by ACS' Panagiotis Kanellopoulos, in person.	FALSE	FALSE	12/11/24 17:23	12/11/24 17:23	Kanellopoulos Panagiotis	Kanellopoulos Panagiotis	Elemento	sites/GREEN-LOG/Lists/Living Lab test
GA Chios	Flanders		31/5/24		FALSE	FALSE	20/6/24 16:39	20/6/24 16:38	Michiel Bertels	Michiel Bertels	Elemento	sites/GREEN-LOG/Lists/Living Lab test
6th GA Chios	Athens		31/5/24		FALSE	TRUE	12/11/24 17:15	12/11/24 17:13	Kanellopoulos Panagiotis	Kanellopoulos Panagiotis	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Athens LL core team meeting	Athens	planning	28/5/24	DAEM, FEDEX, ACS	FALSE	FALSE	12/11/24 17:15	12/11/24 17:14	Kanellopoulos Panagiotis	Kanellopoulos Panagiotis	Elemento	sites/GREEN-LOG/Lists/Living Lab test
ATHENS LL CORE PARTNERS MEETING	Athens	planning	17/5/24	DAEM, ACS, FEDEX	FALSE	FALSE	12/11/24 17:15	12/11/24 17:11	Kanellopoulos Panagiotis	Kanellopoulos Panagiotis	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Start specific discussions LL Ghent and tech partners	Flanders		24/4/24		FALSE	FALSE	20/6/24 16:38	20/6/24 16:38	Michiel Bertels	Michiel Bertels	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Meeting on optimization models	Athens	planning	9/4/24	meeting with AUEB, UAEGEAN and AIMSUN	FALSE	FALSE	12/11/24 17:15	12/11/24 17:09	Kanellopoulos Panagiotis	Kanellopoulos Panagiotis	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Collaboration Agreement with JRC	Ispra	one	31/3/24		FALSE	TRUE	5/3/24 10:07	5/3/24 10:05	Eleonora Di Fabio	Eleonora Di Fabio	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Yape engagement & Activity planning	Ispra	ng	31/3/24		FALSE	FALSE	5/3/24 10:07	5/3/24 10:07	Eleonora Di Fabio	Eleonora Di Fabio	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Use Case Finalisation	Ispra	milestone	31/3/24	- How to place the order (Excel, other...) - verify the payment - send a confirmation to the end user - How to use BYOD component	FALSE	TRUE	5/3/24 10:10	5/3/24 10:10	Eleonora Di Fabio	Eleonora Di Fabio	Elemento	sites/GREEN-LOG/Lists/Living Lab test
GA online	Flanders		27/3/24		FALSE	FALSE	20/6/24 16:39	20/6/24 16:36	Michiel Bertels	Michiel Bertels	Elemento	sites/GREEN-LOG/Lists/Living Lab test
5th GA online	Athens	nning	27/3/24		FALSE	FALSE	12/11/24 17:04	12/11/24 17:04	Kanellopoulos Panagiotis	Kanellopoulos Panagiotis	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Start Mechelen specific use case meetings with Tech partners	Flanders		26/3/24		FALSE	FALSE	20/6/24 16:39	20/6/24 16:36	Michiel Bertels	Michiel Bertels	Elemento	sites/GREEN-LOG/Lists/Living Lab test
ACS - FedEx collaboration	Athens	meeting;#planning	20/3/24		FALSE	FALSE	12/11/24 17:12	12/11/24 17:03	Kanellopoulos Panagiotis	Kanellopoulos Panagiotis	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Use case discussions with LSP's	Flanders		13/3/24	the 11th of March	FALSE	FALSE	18/11/24 16:16	20/6/24 16:35	Michiel Bertels	Michiel Bertels	Elemento	sites/GREEN-LOG/Lists/Living Lab test

Technical meeting Frontier/Factual/Moby	Flanders		6/3/24		FALSE	FALSE	20/6/24 16:34	20/6/24 16:34	Michiel Bertels	Michiel Bertels	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Integration We.Deliver and GREENLOG software with Statik	Flanders		5/3/24		FALSE	FALSE	20/6/24 16:34	20/6/24 16:32	Michiel Bertels	Michiel Bertels	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Athens LL - Miro Exercise	Athens	engagement	29/2/24	identify main actors of the action, etc	FALSE	FALSE	12/11/24 17:01	12/11/24 17:01	Kanellopoulos Panagiotis	Kanellopoulos Panagiotis	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Athens LL ACS - FedEx collaboration planning	Athens	engagement;#meeting	23/2/24	meeting between the LSPs to discusss collaboration issues	FALSE	FALSE	12/11/24 16:58	12/11/24 16:58	Kanellopoulos Panagiotis	Kanellopoulos Panagiotis	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Discussion LL Flanders - Factual Rideal tool	Flanders		20/2/24		FALSE	FALSE	20/6/24 16:34	20/6/24 16:32	Michiel Bertels	Michiel Bertels	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Athens LL co-creation Workshop	Athens	milestone	16/2/24		FALSE	TRUE	12/11/24 16:55	12/11/24 16:55	Kanellopoulos Panagiotis	Kanellopoulos Panagiotis	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Kick-off new LL journey - Halmstad	Flanders		13/2/24		FALSE	FALSE	20/6/24 16:30	20/6/24 16:30	Michiel Bertels	Michiel Bertels	Elemento	sites/GREEN-LOG/Lists/Living Lab test
GREENLOG stakeholder workshop with LSP's	Flanders		8/2/24		FALSE	FALSE	20/6/24 16:30	20/6/24 16:26	Michiel Bertels	Michiel Bertels	Elemento	sites/GREEN-LOG/Lists/Living Lab test
A new event	Barcelona	cation;#event	6/2/24	Describe the event in a bit more details...	FALSE	FALSE	6/2/24 12:41	6/2/24 12:40	Giulia Zarpellon	Giulia Zarpellon	Elemento	sites/GREEN-LOG/Lists/Living Lab test
GREENLOG stakeholder workshop shop owners and citizens	Flanders		6/2/24		FALSE	FALSE	20/6/24 16:23	20/6/24 16:21	Michiel Bertels	Michiel Bertels	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Demo entry	Athens	event	2/2/24	added.	TRUE		12/11/24 16:49	31/1/24 15:03	Giulia Zarpellon	Kanellopoulos Panagiotis	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Testing of LL logbook	Barcelona	g	31/1/24	LLs!	FALSE		31/1/24 15:22	29/1/24 17:54	Giulia Zarpellon	Giulia Zarpellon	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Older event	Barcelona	munication	23/1/24	columns (still working on this...)	TRUE	TRUE	31/1/24 16:02	31/1/24 15:26	Giulia Zarpellon	Giulia Zarpellon	Elemento	sites/GREEN-LOG/Lists/Living Lab test
4th GA Wolverhampton	Athens	meeting;#planning	18/1/24		FALSE	TRUE	12/11/24 16:52	12/11/24 16:52	Kanellopoulos Panagiotis	Kanellopoulos Panagiotis	Elemento	sites/GREEN-LOG/Lists/Living Lab test
General assembly Wolverhampton	Flanders		17/1/24		FALSE	FALSE	20/6/24 16:23	20/6/24 16:20	Michiel Bertels	Michiel Bertels	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Demo entry	Ispra	event;#meeting	12/1/24	added.	FALSE	FALSE	31/1/24 16:01	31/1/24 16:01	Giulia Zarpellon	Giulia Zarpellon	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Oxford Living Lab Experiment 1	Oxfordshire	anning	9/1/24	Pedal & Post Living Lab.	FALSE	TRUE	26/6/24 14:50	31/1/24 15:59	Giulia Zarpellon	Hocking, Matthew	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Official entry of ACS and FedEx to the project	Athens	engagement	1/1/24	Change of Athens LL core team	FALSE	TRUE	12/11/24 17:12	12/11/24 16:49	Kanellopoulos Panagiotis	Kanellopoulos Panagiotis	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Potential partner meeting for use cases	Flanders		23/10/23	looking for potential synergies	FALSE	FALSE	20/6/24 16:17	20/6/24 16:16	Michiel Bertels	Michiel Bertels	Elemento	sites/GREEN-LOG/Lists/Living Lab test
General assembly M10	Flanders		18/10/23		FALSE	TRUE	20/6/24 16:14	20/6/24 16:14	Michiel Bertels	Michiel Bertels	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Discussion user stories	Flanders		27/9/23		FALSE	FALSE	20/6/24 16:14	20/6/24 16:14	Michiel Bertels	Michiel Bertels	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Start weekly meetings LL Flanders	Flanders		11/9/23		FALSE	TRUE	20/6/24 16:12	20/6/24 16:12	Michiel Bertels	Michiel Bertels	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Meeting potential transporters in use cases	Flanders		24/8/23	Meeting with potential transporters that want to be involved in the living lab	FALSE	FALSE	20/6/24 16:11	20/6/24 16:11	Michiel Bertels	Michiel Bertels	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Technical meeting Frontier - LL Flanders	Flanders		31/7/23		FALSE	FALSE	20/6/24 14:51	20/6/24 14:51	Michiel Bertels	Michiel Bertels	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Physical pleanairy meeting GREENLOG	Flanders		4/7/23		FALSE	FALSE	20/6/24 14:27	20/6/24 14:27	Michiel Bertels	Michiel Bertels	Elemento	sites/GREEN-LOG/Lists/Living Lab test
First mailing with ECF	Flanders		28/6/23	GREENLOG. They will be included in the stakeholder consultation later on.	FALSE	FALSE	20/6/24 14:26	20/6/24 14:25	Michiel Bertels	Michiel Bertels	Elemento	sites/GREEN-LOG/Lists/Living Lab test
GREENLOG meeting lead by Halmstad	Flanders		16/6/23	Halmstad	FALSE	FALSE	20/6/24 12:56	20/6/24 12:56	Michiel Bertels	Michiel Bertels	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Technical meetings Frontier - LL Flanders	Flanders		14/6/23	Technical meetings with frontier on 12/06/2023 and 14/06/2023	FALSE	FALSE	20/6/24 12:53	20/6/24 12:53	Michiel Bertels	Michiel Bertels	Elemento	sites/GREEN-LOG/Lists/Living Lab test
GREENLOG meet-up 2 - Halmstad	Flanders		25/5/23	brainstorm sessions lead by Halmstad - second of series	FALSE	FALSE	20/6/24 12:41	20/6/24 12:34	Michiel Bertels	Michiel Bertels	Elemento	sites/GREEN-LOG/Lists/Living Lab test
GREENLOG meet-up brainstorm interview halmstad	Flanders		8/5/23	Meeting lead by Halmstad. user stories and use cases	FALSE	FALSE	20/6/24 12:37	20/6/24 12:36	Michiel Bertels	Michiel Bertels	Elemento	sites/GREEN-LOG/Lists/Living Lab test
GREEN-LOG GA M3	Flanders		23/3/23	online GA in month 3	FALSE	FALSE	20/6/24 12:39	20/6/24 12:21	Michiel Bertels	Michiel Bertels	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Brainstorm LL Flanders	Flanders		9/3/23	Brainstorm about the Living Lab Use Cases	FALSE	FALSE	20/6/24 12:39	20/6/24 12:16	Michiel Bertels	Michiel Bertels	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Kick-off meeting GREENLOG	Flanders		1/2/23	Kick-off meeting GREENLOG	FALSE	FALSE	20/6/24 12:12	20/6/24 12:12	Michiel Bertels	Michiel Bertels	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Pre-kick off LL Flanders	Flanders		17/1/23	Preperation of the kick-off meeting	FALSE	FALSE	20/6/24 12:12	20/6/24 12:10	Michiel Bertels	Michiel Bertels	Elemento	sites/GREEN-LOG/Lists/Living Lab test
Start-up meeting LL Flanders	Flanders		21/11/22	First meeting with Flemish Living Lab partners to read the General agreement en discuss first line of the use cases	FALSE	FALSE	20/6/24 12:08	20/6/24 12:05	Michiel Bertels	Michiel Bertels	Elemento	sites/GREEN-LOG/Lists/Living Lab test

Annex III: Ghent

gent:

GreenLog Learnings Use Case

City of Ghent – Waste Logistics

14 januari 2025

Entiteit City of Ghent
Contactpersoon Eveline van Hooijdonk – eveline.vanhooijdonk@stad.gent

1. The context of Ghent

1.1. Flanders Living Lab - GreenLog

GreenLog is a Horizon Europe project. The City of Ghent is a partner in the Living Lab Flanders, along with the City of Mechelen and the City of Leuven. VIL is responsible for project coordination, with the University of Antwerp providing support. The project commenced on 1/1/2023 and will conclude on 30/6/2026. The project's objective is to consolidate the sustainable last mile through the application of technology in the planning, execution and pricing of logistics. There are 5 Living Labs. Each Living Lab uses various technological applications. Flanders Living lab is testing a Logistics as a Service (LaaS) which will have a trail in the three cities. The objective of the LaaS is to ascertain the extent to which a receiver of goods can influence the sustainability of the supply chain through means of dynamic price setting and nudging.

On 26/8/2024, the project officer of the City of Ghent met with the Living Lab leader and the project coordinator GreenLog to inform them that the City of Ghent will not be participating in the first demonstration phase of the project. The goal of this document is to show why the original use case in city of Ghent couldn't start in the first demophase of GreenLog and to spread our learnings.

1.2. City logistics in the City of Ghent

Ghent is a city with a population of 260,000, situated in a medieval setting. On 3 April 2017, a new circulation plan was implemented, dividing the R40 area into sectors and avoiding through traffic. Furthermore, the car-free zone has been expanded to 51 hectares. A permit is required to enter the car-free zone and loading and unloading in this zone is only permitted before 11am and after 6pm. As of 1 January 2020, the area within the R40 has been designated as a Low Emission Zone. The goal of the policy changes were to promote a modal shift, enhance accessibility of the city centre and improve quality of life. In 2023, the city council approved an urban logistics plan. For further information, please visit website page about city logistics. The vision in our Plan of city logistics is :

"By 2030, we will organise city logistics safely, efficiently, sustainably, with as little disruption as possible and even emission-free within the R40."

The Urban Logistics Plan is a starting point for the city to implement SULP measures in our SUMP, several actions in the plan contribute to this integration. In GreenLog the city of Ghent wanted to enhance the learnings in policy making to support the logistics sector in the transfer to zero emission deliveries in our city. The plan has been written and is being executed by three different Departments: Department of Milieu and Climate – Department of Mobility – Department of Economics. GreenLog is executed from the Department of Economics, with the support of the two other departments.

Co-funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor the granting authority can be held responsible for them.

GreenLog has the ambition to not only enhance sustainable last mile operations in European cities, but also to consolidate them in a realistic business model. In the city of Ghent we see that sustainable last mile logistics, especially bike couriers, have troubles to consolidate their business model. The project fits perfectly with our vision on entrepreneurship in our city:

"We strive for a vibrant and liveable city that offers prosperity, job creation and a sustainable, attractive and future-proof business climate with room to grow. We do this for (future) entrepreneurs, companies and investors in Ghent, together with civil society, knowledge and education institutions and municipal services. We focus on customer orientation, cooperation and efficiency."

With this context in mind, we started to build a use case which was a support to our entrepreneurs, our sustainable logistics players and the urban logistic plan in our city.

2. The original use case of city of Ghent

2.1. The problem definition in Ghent

On 11/12/2023, there was an information session on industrial waste, organised by the Culinary Council. The local traders voiced following challenges:

- New Vlarema legislation on waste disposal[1]: kitchen waste must be separated from organic waste. Not all retailers have the space to store this waste in a correct way.
- The amount of kitchen waste or organic waste depends very much on the day's consumption. As a result, the catering traders are sometimes suddenly and unexpectedly faced with a lot of waste. The collection of industrial waste is organised on a subscription basis, and while flexibility would certainly be an added value, it is costly.
- Waste can only be put out for collection on the pick-up day and the empty containers have to be brought back inside after the collection. Many entrepreneurs do not live close to their business and therefore sometimes have to make an extra journey to take the waste out or bring the containers in.
- In practice, many entrepreneurs look for other solutions. For example: in the evening they take their waste home, they rent a garage box together to store their waste there temporarily, ...

We also found a challenge at the waste collectors' side:

- Waste collection in our city is mostly done with large vehicles. The waste collectors want to experiment with smaller zero-emission vehicles to collect waste from traders in a more agile way and to lower their emissions.

From the city point of view we found a big challenge:

- Retailers are free to choose which waste collector they contract with. This choice is made on the basis of cost price, service level.... This means that in the already dense city centre, several large waste collectors have to be on the same street to collect waste from their respective customers, using big vehicles.
- The collection of the waste of household is organised with one partner in the city. The collection of industrial waste is done by several companies, with their own business models.

[1] https://ovam.vlaanderen.be/selectieve-inzameling-uw-verplichtingen-als-bedrijf

It is unclear how these business models work and if they have room to evolve towards zero emission collections.

Other cities in Flanders are also facing this challenges and are noticing problems with the collection of industrial waste in their city centres. The city of Ghent has the idea of testing LaaS for the collection of waste from traders, giving priority to kitchen waste/organic waste from catering traders. There is a demand for this within the Culinary Council and it might offer a solution, given the change in legislation (Vlarema Legislation).

2.2. The goal of the use case

A LaaS platform connects logistics supply and demand in a data-driven way. The LaaS includes different logistics service providers. A requester of logistics services, receives various options to meet its demand. By providing different Logistics service providers, the LaaS can incentivize the use of sustainable last mile by dynamic pricing and nudging.

By calculating and visualising the real (and social) costs of logistics, we give the requester of logistic services more insight into the options. Through dynamic pricing or nudging according to the city's business rules, we steer shippers/receivers towards low-impact logistics with less emissions, less nuisance, more safety and more efficiency. In our use case the process would be the following:

- A retailer has waste to be collected
- He goes to the Greenlog LaaS user interface and enters the data related to his logistics request.
    - collection address
    - volume – weight /properties of the container
    - waste fraction
- The Laas contains a large amount of data (fixed delivery routes, fleet characteristics, price...) from the pre-selected last-mile logistics operators in the waste collection.
- An initial check is made on the basis of transport characteristics and the city's hard measures. This ensures that service providers who are unable to perform the logistics task or logistics requests that are not possible according to the city's legislation are not included in the selection process.
- The retailer chooses the best option for his demand.

Can the LaaS be a solution for the complex nature of waste collection in the city of Ghent, with a focus on organic waste or kitchen waste? With this objective, we wanted to reduce the number of kilometres driven for waste fractions that is highly dependable on daily consumption. Next we wanted to see if zero-emission waste collection was possible and scalable.

2.3. The method to form the use case

We had to build our use case in our city and we did this mainly through bilateral meetings with partners. This was a collaboration between different departments within the city of Ghent. First we defined our partners and then we engaged with them.

2.3.1. Partners in the use case

<u>Local merchants:</u>

Interested traders from the town centre. This could include hospitality, retail or catering. The initial focus will be on waste but delivery or collection of other goods flows will also be considered. In order to involve entrepreneurs, cooperation will be established with Puur Gent, the medium-sized organisation for retail and catering.

At the moment, we already have a number of interested shopkeepers who have spontaneously contacted us in response to their waste problems and there is also a working group within the Culinary Council with catering that is also looking into this waste problem.

Logistic service providers:

The Laas includes several pre-selected logistics service providers. Discussion were done with the following service providers to discuss interest in participating in the project.

- Waste sector
- Bicycle couriers
- Last mile operators

By engaging with them we found two interesting projects. Firstly, is a start-up of a non- profit organisation that aims to transform organic waste streams from the catering industry into circular value streams through socially responsible collection. By means of carrier bicycles and where possible through social employment, these flows are delivered to partners for further processing. Second, a waste collector wanted to start with a project in which small fractions of waste are collected on request from traders in the city centre by small e-vans or lorries and taken to the hub on the Stropkaai. When the containers at the hub are full, they are picked up there by a large waste collection truck and taken to the waste processing plant.

The city is crossed by a number of waterways and the shift to waterborne transport is one of the actions of the Urban Logistics Plan. We also investigated the possibility of involving waterway logistics service providers in this project.

2.3.2. Timeline of engaging partners

The city of Ghent's test case has undergone a preliminary investigation, based on signals from the Culinary Council. Below is a timeline.

At the end of 2023 we had the meeting with the Culinary Council, from there on we talked to several waste collectors and found the information about the two projects. The project of the waste collector, who wanted to test smaller vehicles, was not allowed to be tested in Ghent because of a gentleman's agreement with the preferred partner for collection of household waste in Ghent. The cooperation between the two companies, in the collection of industrial waste, prevented the start of the project because of market advantage.

In June 2024 we met with the collector of household waste in Ghent. They were very interested in GreenLog, because of the possibility to test a more agile collection of industrial waste by using bike couriers or smaller vehicles. Afterwards it became clear that they were in a difficult position to participate and it was a sensitive matter. The collector has the intermunicipal structure, but because the project focuses on industrial waste and not on household waste, it seemed feasible to try. Therefor we needed to have a meeting with the Alderman. These meeting concluded in two comments. First of all, within the city administration nobody monitors the collection of industrial waste. So the knowledge about the market is minimal. Secondly, the Alderman was informed that the sector of waste collection is struggling with logistics. After consultation between different Aldermen, we got a go to set-up a use case with the collector of waste.

Also in June 2024 we had a meeting with the Facility Departement of Ghent to see if we could test the LaaS in the collection of the waste of the city administration buildings. This was too difficult because we have our own logistic flow of waste and it wasn't feasible to adapt these flows.

In July 2024 the news followed that the intercommunal collector of household waste, which was a mixed enterprise with private and public resources, didn't find a new private investor in a new tender. The enterprise will become a full public intercommunal organization who will collect the household waste and will have a separate part to collect industrial waste. The market of the collection of industrial waste will open in july 2025, there wouldn't be anymore gentleman agreements or cooperations. The market will be open to new cooperations.

The company was still interested in the project for their collection of industrial waste. They started conversations with the non-profit organization who collects organic waste by using a bike to see if they could work out a business model among themselves. In September 2024 we had a meeting and they told us that the conversations with the non-profit organization ended because of these reasons:

- The non-profit organisation are not yet in order with their permits. They have a permit to transport waste (registration), but not to process waste.
- They don't respect agreements, communication is difficult. The idea was to start a pilot project in October 2024, but in the meantime they are recruiting customers from the waste collector (including some prestige customers).
- The waste collector has no place to set up collection points in the city to empty the cargo bikes. They could empty them into rolling containers, but we have no idea where to put them.
- It is unclear where the non-profit organization is working with now, because their collected waste needs to be processed.
- One option would be for the non-profit organization to work as a subcontractor of the waste collector, but this would take time:
  - This takes time because of government procedures and EU regulations about subcontracting. The non-profit organisation has little understanding of these.
  - This means that they only have to be registered as a transporter, but they are now doing more than just transporting (or at least it seems that way).
  - Their prices turn out to be unprofitable. They are more expensive. There is little margin for industrial waste. Customers don't necessarily want to pay more.
  - They only work with volunteers, but this is not ethical for the work they do, certainly not towards the employees of the waste collector. This is absolutely not scalable.
  - The collection of industrial waste needs to be fully cost-effective, especially within the new status that the waste collector will have in 2025.

After this meeting the City of Ghent had a meeting with OVAM to talk about the new legislation and their experience with sustainable waste collection. First of all, they said that industrial waste collection is a very competitive market. The margins on certain waste fractions is small, especially on kitchen waste. The legislation on waste collection demands that these main guidelines will be respected:

- Separate fractions need to be stored and collected in a separate way. This means that one vehicle cannot pick-up different waste fractions.
- The legislation asks that a transporter of waste has certain permits to do the logistics. This means that a normal logistics service provider can't deliver goods (full in the city) and collect waste (full out the city) in one vehicle. For certain waste fractions, for example 'batteries', they need extra permits and training.

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That's the reason that waste collection companies focus on large vehicles to lower costs and be in line with legislation.

The various meetings ended in a difficult environment to continue with the use case. While these meetings were taking place, the project colleague was already looking for a new use case definition.

2.4. Main conclusion

Waste collection of industrial waste is a highly sensitive matter. In our city we are involved in the organisation of the collection of household waste and partly in industrial waste. From 2025 this will change and the market of collection of industrial waste will transform. As a city it is important to not add extra disruption to the market by opening a tender. The market needs to settle.

Of course, we could support new cooperation in waste logistics. But because of the highly competitive market, we experienced difficulties to do so. The one partner, the non-profit organization, has been collecting waste but has little chance to be consolidated because of their prices in combination with them working with volunteers only. The business case at hand is not scalable. We also had meetings with them, but they didn't want to cooperate in GreenLog.

The local traders in the Culinary Council still have difficulties in storing their waste. In the meantime, the City of Ghent adjusted their rules about waste collection for entrepreneurs. Their containers don't have to be brought in right after the collection of the waste, but can be brought in the morning after. This is a solution to some of them. Next to that, although costly, flexible pick-up is possible.

The legislation puts up some boundaries to experiment with 'full in and full out' of the city and also in adding waste collection to the regular services of a logistics company. Although this legislation, we keep on hearing that waste collectors and logistics service companies, are trying to use smaller vehicles to collect waste. The interest to collect waste in a more agile and sustainable way, is still there.

3. Learnings in the use case

3.1. Discussion of the foreseeable challenges

In our use case definition, we identified several foreseeable challenges, which we will use as a starting point to formulate learnings.

- Challenge 1: Willingness to cooperate and, above all, mutual cooperation between logistics operators.

The only partner in the sector who had already started collecting organic waste wasn't willing to participate in the project. They knew they had a market advantage and they wanted to keep it. They tried to set up a cooperation (or subcontracting) with a waste collector. After several meetings it didn't seem feasible, not economically but also not ethically. And also not practically because of the lack of different small collection points in our city, on private property and on public property.

The focus on waste logistics brings a number of additional challenges as waste cannot simply be combined with other goods in the chain and permits are required. As a logistics service provider you can not simply also collect waste. Therefor, they need to adapt their systems and sometimes even their vehicles.

To participate in the LaaS, the waste collectors and logistics service providers needed to invest in new vehicles, training and work out a way of cooperation with economically feasible prices. We didn't have a waste collector who already uses smaller vehicles, apart from the non-profit organization, so we would have to start from scratch where time and money had to be invested, just to do a demo phase of some months.

If a city wants to experiment with sustainable waste collection, then there needs to be a partner who's willing to invest money and time to make it possible. A new cooperation asks new technical connections, adaption of working processes, but they also need new/adaption of vehicles and training and permits for the drivers. If there is no working business model in the city, funding isn't enough to make a base.

- Challenge 2: What about dynamic pricing? Stakeholders don't really buy into the system, and what role do we as a city have to play in it anyway?

The collection of industrial waste is a highly competitive market. The consumer is not easily persuaded to pay more. The conversations between the waste collector and the non-profit organization made it clear that a strong business case was difficult. In particular, the non-profit organization already charge more for their collection and only work with volunteers, which means they only pay a little contribution to their couriers.

Industrial waste has an economic value. The market is highly competitive and margins on some fractions are low. Dynamic pricing entails that bundling of pick-ups would result in cheaper prices for the requester of logistics. This bundling is already done on the market by the waste collectors to reduce costs, the price cannot lower.

- Challenge 3: What non-financial nudging techniques do we use and how might, for example, a safety or sustainability label for local traders or logistics services work?

The working group within the Culinary Council didn't continue the search in the case of their waste problem. After the meetings with the waste collectors and other partners, we didn't ask this question because the use case ended up to not being realistic.

- Challenge 4: How do you formalise cooperation with logistics operators? Through an open call, a tender, an agreement?

The waste collection market is very competitive and heavily regulated. To test a LaaS, where we would work with one or two companies, would be disruptive because of the upcoming changes in the market in 2025. We would change prices and give some companies an advantage in this new constellation. The open call, according to EU regulation, would not be on a right time where waste collectors will be trying to find new business models and cooperations. As a city, we do not want to be disruptive and we want to support the sector in their search towards more agile and sustainable way of collecting waste by, specifically not interfering. We keep on talking and started monitoring the industrial waste collection, to see what the sector needs to perform this task efficient in our city and how they want to innovate.

- Challenge 5: What role can the existing urban distribution platform GentLevert play in this?

GentLevert will no longer be a platform after 2025. The city of Ghent has decided to prioritise other forms of cooperation with the logistics service operators instead of the GentLevert platform.

3.2. Conclusion

The expectations within the project were a use case to test a LaaS. We wanted to test how the consumer can play a role in making waste collection more sustainable in our city, by adding waste collectors to the LaaS platform who would be able to do it with smaller vehicles and/or zero-emission vehicles. We concluded that the challenges were too great to set up this use case for LaaS. We formulate here the three biggest reasons and obstacles:

- If we go ahead, we should be able to motivate the traders. We expect this to be difficult because of pricing issues. The dynamic pricing wasn't feasible.
- A collaboration with a waste processor and last mile provider does not currently exist. This cooperation had to start from the beginning, with the necessary investments.
- We would be disrupting the industrial waste collection market, which is highly competitive and politically sensitive.

4. Recommendations

We have some recommendations for governments who want to test sustainable ways of collecting waste in their city centres.

1. Urbanisation leads to more waste: both from households and businesses. This requires good sorting, which has been implemented through new legislation on industrial waste. Because of these additional waste flows, we have more logistical movements in our city centres. Waste management companies are trying to make their collection more efficient, but this is a new business model and requires investments.
2. Waste systems are based on a linear model and need to be changed to a circular model, according to new EU directives. Our cities also want to remain liveable and demand lower emissions. These new directives target not only the transport of waste, but also the processing of waste and collection of waste. The current state of the recycling infrastructure needs to change quickly, which will require significant investment from companies.

We want more liveable cities. If we look at waste, we want a different way of collecting it (transport in our cities) and a different way of processing it (energy from waste, composting, recycling). These objectives require a major commitment from companies, but also from citizens. It's not just a question of legislation, it's also a question of attitude. In order to involve citizens and companies, investment is required. Not only in infrastructure, other vehicles and machines, but also in behaviour. This investment, without any starting point, is big. For a cooperation in a project, it is too soon because we needed to build in almost entirely from scratch. A good, working, example in your city is the best way to build further on it.

If we're going to make a good use case, we need commitment. In this case, from waste collectors and traders. This commitment was difficult to get because of the government's involvement in waste collection. To have a good use case, you also need room to experiment. In the case of waste collection, there's already a lot of competition and low margins, so the playing field is small. The investment in new ways of collecting industrial waste, ask effort from the waste companies, their costumers and the policymakers. And because we are choosing a commercial business to experiment in, as a city we have to be careful not to disrupt the market. The timing to support innovation in a sector needs to be right.