D4.2 Starring LL measures implementation

ITL

15/05/2025

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Abstract

The current deliverable (D4.2) presents a comprehensive narrative of the implementation of urban freight-efficient servicing and delivery measures in four European Starring Living Labs (Copenhagen, Ghent, Helsinki, Thessaloniki).

These cities were the first to test 23 different modular, data-enabled solutions—classified among DISCOCURB, DISCOPROXI, DISCOBAY, DISCOLLECTION, and DISCOESTATE—designed to address urban logistics challenges through an integrated approach that combines spatial planning, technological innovation, and multistakeholder governance.

At the core of these interventions lies a commitment to the **Physical Internet (PI)** paradigm: a vision of logistics where resources such as data, infrastructure, and transport capacity are shared and interoperable. Each Living Lab deployed tailor-made measures based on local context analyses, in line with the **Agile Model Implementation Roadmap** (delivered in D4.1), and contributed, based on their goals, to the development of Sustainable Urban Logistics Plans (SULPs), Urban Freight Dataspaces, and other strategic planning tools.

The measures demonstrated include: the transformation of underused infrastructure into logistics hubs, dynamic curbside management based on real-time sensor data, establishment of multifunctional microhubs for low-emission last-mile deliveries, and integration of urban vehicle access regulations into planning tools. Across all cities, high-quality logistics and geospatial data formed the backbone of decision-making, enabling the development of different planning tools and technologies (e.g. Digital Twins) and advanced freight modelling scenarios.

Stakeholder engagement was central, with cities acting as neutral facilitators to enable cooperative planning and the implementation of public-private agreements on data sharing, infrastructure use, and service provision.

The deliverable highlights how DISCO interventions contribute to the broader goals of the **EU Urban Mobility Framework**, the **European Green Deal**, and climate-neutral city strategies. It showcases early outcomes, lessons learned, and insights for scaling and transferring the solutions piloted in the Starring Living Labs to other European urban contexts through Twinning Living Labs and Open Data tools. The result is a growing ecosystem of interoperable, evidence-based, and citizen-centred urban freight systems capable of supporting the transition to low-emission, resilient, and inclusive urban logistics.

Summary sheet

Deliverable No.	D4.2
Project Acronym	DISCO
Full Title	DATA-DRIVEN, INTEGRATED, SYNCHROMODAL, COLLABORATIVE AND OPTIMISED URBAN FREIGHT META MODEL FOR A NEW GENERATION OF URBAN LOGISTICS AND PLANNING WITH DATA SHARING AT EUROPEAN LIVING LABS
Grant Agreement No.	101103954
Responsible Author(s)	Andrei Lucian Turlea, Lorenzo Cello, Alice Benini
Peer Review	INLE, VIL
Quality Assurance Committee Review	FIT
Date	14/05/2025
Status	Final
Dissemination level	Public
Work Package No.	4
Work Package Title	The Starring Living Labs
Programme	HORIZON Innovation Actions
Coordinator	FIT CONSULTING SRL
Website	https://discoprojecteu.com/
Starting date	01/05/2023
Number of months	42 months

Project partners

Organisation	Country	Abbreviation
FIT CONSULTING SRL IT Coordinator	IT	FIT
RUPPRECHT CONSULT-FORSCHUNG & BERATUNG GMBH	DE	RC
INLECOM INNOVATION ASTIKI MI KERDOSKOPIKI ETAIREIA	EL	INLE
PNO INNOVATION SL	ES	PNO
INTERNATIONAL DATA SPACES EV	DE	IDSA
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INSTITUT DE RECHERCHE TECHNOLOGIQUE SYSTEM X	FR	IRTX
STICHTING BREDA UNIVERSITY OF APPLIED SCIENCES	NL	BUAS
POLIS - PROMOTION OF OPERATIONAL LINKS WITH INTEGRATED SERVICES, ASSOCIATION INTERNATIONALE	BE	POLIS
EUROPEAN PARKING ASSOCIATION EPA EV	DE	EPA
ALLIANCE FOR LOGISTICS INNOVATION THROUGH COLLABORATION IN EUROPE	BE	ALICE
ERASMUS CENTRE FOR URBAN, PORT AND TRANSPORT ECONOMICS BV	NL	ERASMUS

INTERUNIVERSITAIR MICRO-ELECTRONICA CENTRUM	BE	IMEC
VLAAMS INSTITUUT VOOR DE LOGISTIEK VZW	BE	VIL
FUNDACION ZARAGOZA LOGISTICS CENTER	ES	ZLC
BE-MOBILE	BE	BE-MOBILE
STAD GENT	BE	GENT
OPLEIDINGSCENTRUM VOOR HOUT EN BOUW VZW	BE	OHB
CITYLOGIN IBERICA SL	ES	CITYLOGIN
UNIVERSITAT POLITECNICA DE CATALUNYA	ES	UPC
AJUNTAMENT DE BARCELONA	ES	BCN
VENICE INTERNATIONAL UNIVERSITY	IT	VIU
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FUNDACION ZARAGOZA CIUDAD DE CONOCIMIENTO	ES	FZCC
FORUM VIRIUM HELSINKI OY	FI	FVH
KOBENHAVNS KOMMUNE	DK	COPENHAGEN
REGION HOVEDSTADEN DK Partner	DK	REGIONH
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AARHUS KOMMUNE		DK	AAKS
DIMOS THESSALONIKIS		EL	THESSALONIKI
DIETHNIS EKTHESI THESSALONIKI AE		EL	TIF HELEXPO
ACS TACHIDROMIKES IPIRESIES MONOPROSOPI ANONYM		EL	ACS
ROLAN OY		FI	ROLAN
ASOCIACIÓN LOGÍSTICA INNOVADORA DE ARAGÓN		ES	ALIA
A to B Finland Oy		FI	A2B
GETPLUS srl IT Partner		IT	NEXT
COMUNE DI PADOVA IT		IT	ComPADUA

Document history

Version	Date	Organisation	Main area of changes
0.1	28/10/2024	ITL	Definition of ToC
0.2	26/03/2025	VIL, FVH, CERTH, COPENHAGEN	Inputs from all Starring LLs
0.3	11/04/2025	ITL	First draft
0.4	14/04/2025	FIT	Comments on first draft
0.5	15/04/2025	ITL	Final draft for internal peer-review
0.6	24/04/2025	INLE	Comments from Reviewer
0.7	05/05/2025	VIL	Comments from Reviewer
0.8	09/05/2025	VIL, FVH, CERTH, COPENHAGEN	Final integrations from all Starring LLs
1.0	14/05/2025	ITL	Ready for submission

List of acronyms

API	Application Programming Interface
B2B	Business to Business
B2C	Business to Consumer
CO2	carbon dioxide
D	Deliverable
DMP	Data Management Plan
DoA	Description of Actions
DOI	Digital Object Identifier
ETL	Extract, Transform, Load
EU	European Union
EV	Electric Vehicle
FAIR	Findability, Accessibility, Interoperability, and Reusability
FLC	Floating Car Data
GB	Giga Byte
GIS	Geographic Information System
GLM	Green Last Mile
HEU	Horizon Europe
HGV	Heavy Goods Vehicles
HMI	Human-Machine Interface (HMI),
HORECA	Hotel, Restaurant and Catering

HRI	Helsinki Region Infoshare platform
IA	Innovation Action
ICBT	Impact Creation Board for Transformation
ITS	Intelligent Transportation Systems
KPI	Key Performance Indicator
LCV	Light Commercial Vehicle
LEZ	Low-emission zone
LL	Living Lab
LSP	Logistics Service Provider
MMS	Meta Model Suite
PI	Physical Internet
R&D	Research&Development
RFID	Radio Frequency Identification
SDGs	Sustainable Development Goals
SDP	Smart Data Platform
SLL	Starring Living Lab
SUMP	Sustainable Urban Mobility Plan
SULP	Sustainable Urban Logistics Plan
TEN-T	Trans-European Transport Network
TMS	Transport Management System
TRL	Technology Readiness Level
UAC	Urban Access Control

UF	Urban Freight
UFDS	Urban Freight Data Space
UFT	Urban Freight Transport
UI	User Interface
UVARs	Urban Vehicle Access Regulations
WMS	Warehouse Management System
WP	Work Package
ZEZ	Zero-Emission Zones

1. Introduction

The purpose of this document is to provide a detailed overview of the **urban freight-efficient servicing and delivery plans[1]** implemented in the four **Starring Living Labs (SLLs)** of the DISCO project, within the scope of Work Package 4. This report presents a comprehensive account of the **context, rationale, design, and implementation** of the measures tested across these Living Labs, as well as the challenges faced, the solutions adopted, and the early outcomes observed.

Each SLL—**Copenhagen (DK), Ghent (BE), Helsinki (FI), and Thessaloniki (EL)**—plays a leading role in demonstrating innovative and **data-driven urban logistics solutions**, developed within the DISCO framework. These cities represent diverse European urban environments and are at the forefront of implementing new approaches to freight planning and logistics in line with the EU's climate neutrality and smart city goals.

This report aims to support not only the internal learning and cross-fertilisation across Living Labs but also the replicability and scalability of DISCO's innovations. It provides valuable input for the development of the **Meta Model Suite** and the **Urban Freight Data Space** produced in WP2 and WP3, and will feed the work of the **Twinning Living Labs**, which will test and adapt these solutions in different urban contexts.

DISCO operates in a context of urgent transformation, responding to the **climate crisis**, growing **urban congestion**, and worsening **air quality** in European cities. In line with the **European Green Deal[2]** and the **EU Urban Mobility Framework[3]**, the project seeks to drastically reduce greenhouse gas emissions from transport and improve the efficiency and resilience of urban logistics. These ambitions cannot be met by vehicle decarbonisation alone. DISCO therefore proposes a paradigm shift, moving from fragmented and inefficient systems to a **hyperconnected, Physical Internet (PI)-led network-of-networks** approach.

To achieve this, DISCO brings together a wide range of stakeholders, amongst others: cities, logistics service providers, retailers, infrastructure owners, real estate actors, researchers, and citizens, in a collaborative process of co-design, deployment, evaluation, and replication. Through this inclusive approach, the project aims to unlock hidden assets, reallocate urban space, and foster freight-efficient, low-emission, and nearby delivery-based models. The implementation of DISCO-X innovations in the Living Labs is a key step toward this transformation.

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[1] https://www.mdpi.com/2071-1050/13/6/3059.

[2] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en.

[3] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021DC0811&qid=1644666550402.

The **DISCO-X innovation domains—DISCOCURB, DISCOPROXI, DISCOBAY, DISCOESTATE, and DISCOLLECTION**—constitute a set of modular tools designed to integrate physical and digital urban logistics systems. The report also examines how each SLL's implementation aligns with the development of the Meta Model Suite and Urban Freight Data Space.

Chapter 2 sets the conceptual framework behind the measures implemented in the Starring Living Labs. In Chapter 3, the activities carried out by each SLL are described in detail, including the local background and context, the logistics challenges addressed, the rationale for the chosen interventions, and the stakeholder engagement processes. Each chapter also presents the implementation process of the selected DISCO-X measures, the operational and governance arrangements, and the expected impacts, particularly in terms of land use, emissions, efficiency, and equity. Lessons learned and early indicators of success are also highlighted.

Chapters 4 and 5 examine how the SLLs' activities align with the Meta Model Suite and contribute to the Urban Freight Data Space, providing insights into the interoperability, data integration, and digital maturity of the implemented measures.

Chapter 6 explores the transferability of these measures to other cities and contexts, identifying key success factors, barriers, and recommendations for scaling. The analysis builds on the diversity of the SLLs and provides input for the Twinning Living Labs and Early Adopter cities, supporting the creation of a pan-European ecosystem of sustainable urban logistics.

Finally, Chapter 7 presents overarching reflections on the implementation of freight-efficient land use planning and logistics innovations in the SLLs, highlighting how these experiences contribute to DISCO's wider ambition: enabling a trusted, interoperable, and citizen-centred transformation of urban logistics toward climate-neutral, smart cities by 2030.

2. Urban freight efficient servicing and delivery plans

Urban freight transportation and logistics play a crucial role in supply chains, ensuring the efficient flow of goods in cities. While these activities are an absolute necessity for businesses and consumers, they also generate negative externalities, impacting shared urban resources such as land use, air quality, and noise levels. These unintended consequences contribute to higher social costs, adding to congestion and environmental degradation. As urbanisation and e-commerce continue to grow, the pressure on city infrastructure and the environment is expected to intensify. This highlights the need for **efficient urban freight servicing and delivery plans** that optimize logistics while minimizing disruptions, reducing emissions, and improving overall urban liveability.

A **freight-efficient land use plan** is a key tool for improving urban logistics while reducing its negative externalities. This approach is **win-win**, as it enhances logistics efficiency, making operations less

costly for businesses while also reducing resource consumption, emissions, energy use, and noise pollution.

Such planning involves two key aspects. First, it requires **targeted measures** to address specific challenges of the urban context, such as congestion on main roads, curbside management, unsafe freight routes, and reliance on fossil fuel-powered vehicles. These measures can include the strategic placement of urban consolidation centres, dedicated freight corridors, multimodal hubs, and low-emission zones, all of which help optimize freight flows and minimize disruptions.

Second, effective land use planning depends on **governance and coordination among stakeholders**. Logistics efficiency is not only a matter of infrastructure but also of cooperative decision-making between public authorities, private companies, and local communities. Collaborative planning ensures that freight solutions are integrated into broader urban strategies, maximizing system-wide benefits.

Both aspects of such freight-efficient land use plans are inspired by the concept of the Physical Internet. The **Physical Internet (PI)** is an outlook, a logistics framework that applies internet-inspired principles to the movement of goods, aiming for a fully interconnected, standardized, and shared freight system. It enables seamless, efficient, and sustainable transportation by using modular containers, open logistics networks, and real-time optimization across different modes of transport.

This is precisely the approach taken by the Starring Living Labs, which tested a range of measures in their respective urban contexts. In the DISCO project, particular emphasis is placed on cooperation in data utilization and sharing, recognizing **data as a central element** in both the definition of measures and the collaboration among stakeholders. Data-driven insights play a crucial role in informing planning activities, ensuring that decisions are based on real-world conditions and measurable impacts. By gathering results, analysing impacts, and integrating findings into strategic planning tools such as local Sustainable Urban Logistics Plans (SULPs), these Living Labs have demonstrated how structured, evidence-based freight planning—grounded in data and stakeholder cooperation—can contribute to more efficient, sustainable, and liveable cities.

Following the **Agile Model Implementation Roadmap** (D4.1), each Living Lab began by analysing the urban logistics context and identifying key challenges. Once the specific issues were defined, they explored potential technological, physical, business, data-driven, and governance-based solutions. A key step in this process was the engagement of relevant stakeholders from the urban logistics sector to ensure that proposed measures were both viable and collaborative. They then implemented a series of actions to test, simulate, and gather data on potential solutions aimed at achieving a freight-efficient land use. Through this iterative approach, the Living Labs generated valuable insights on feasibility, scalability, and replicability, while also assessing the broader impact of these solutions on urban logistics and sustainability.

In the following chapter, we present the above implementation process for each SLL: Copenhagen, Ghent, Helsinki, and Thessaloniki.

3. Measure implementation in the Starring Living Labs

3.1. Copenhagen

3.1.1. Background and rationale of the intervention

General and logistics characteristics

Copenhagen, the capital of Denmark, is a city renowned for its commitment to sustainability and innovative urban planning. Home to approximately 800.000 residents, it serves as a central hub in the Øresund Region, connecting Denmark and Sweden. The city's strategic location along the **Scandinavian/Mediterranean TEN-T Corridor** positions it as a fundamental node for both national and international freight transport.

Copenhagen has established itself as one of Europe's leading cities in sustainable urban logistics, implementing ambitious policies aimed at reducing congestion, emissions, and optimizing urban space for multimodal transport. The city has been at the forefront of introducing SUMPs and SULPs, prioritizing zero-emission zones, shared logistics hubs, and digital innovations to enhance freight management. Its logistics system integrates a well-connected road, rail, and waterway network, further supported by advanced digital infrastructure for data-driven urban mobility planning.

Relevant actions linked to logistics development in the city of Copenhagen

In pursuit of becoming **carbon-neutral by 2025[4]**, Copenhagen has introduced several logistics strategies designed to reduce emissions and improve urban liveability. The city has implemented low-emission zones, developed intelligent traffic management systems to optimize delivery routes, and promoted bicycle logistics as part of its extensive cycling infrastructure. With over 450 km of segregated bike lanes, Copenhagen is increasingly integrating cargo bikes and microhubs to support sustainable last-mile delivery solutions. The logistics system in Copenhagen operates through a collaborative approach involving public authorities, private logistics providers, and other stakeholders. This cooperation has led to the development of consolidation hubs and shared transport facilities to streamline urban freight operations while minimizing environmental impacts. The city has also embraced digitalization in logistics, leveraging real-time data collection and decision-making tools to optimize freight flows and improve efficiency. Copenhagen's urban landscape is designed to support multimodal transport, with a strong emphasis on cycling and public

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[4] https://international.kk.dk/about-copenhagen/liveable-green-city/2025-climate-plan.

transportation. The city's infrastructure includes extensive pedestrian-friendly zones, reflecting its commitment to reducing reliance on private vehicles and promoting active and sustainable transport modes. These efforts ensure that Copenhagen remains at the forefront of innovative urban logistics, working towards a cleaner, smarter, and more efficient urban freight system.

Challenges addressed by the LL

Despite Copenhagen's progressive initiatives, several challenges persist in urban logistics that the proposed interventions aim to address. The city experiences a significant volume of freight traffic, with more than **100,000 heavy goods vehicles, delivery trucks, and logistics vehicles** crossing the municipal border daily.[5] Of these, approximately 20,000 enter the city centre, exacerbating congestion, increasing emissions, and placing strain on infrastructure. Another challenge is the limited visibility of logistics operations within the city. Currently, there is insufficient data on the routes, stops, and loads of logistics vehicles, hindering the ability to implement targeted measures for a transition to **zero-emission and cycling logistics**. Freight transport remains a substantial contributor to CO_2 and particulate emissions, undermining Copenhagen's broader climate objectives. While cycling has been integrated into passenger mobility, cargo bikes have not yet been widely adopted for freight deliveries in the city centre, despite their potential.

Urban planning must balance ambitious sustainability goals with the operational needs of logistics providers. The city's push for **Zero-Emission Zones (ZEZs)** and car-free neighbourhoods requires careful consideration to avoid disrupting goods delivery and economic activity. Achieving a sustainable urban logistics system also requires strong collaboration among diverse stakeholders, including industry sectors, citizens, and public authorities. Facilitating effective partnerships is essential to implement long-term solutions that support environmental goals and logistical needs.

Copenhagen aims to be **CO2-neutral by 2025**, and DISCO supports this by introducing an innovative, data-driven approach to city planning and traffic management. While traffic is a significant contributor to CO2 and particulate emissions, cargo bikes are still rarely used for freight deliveries. The city has strong political will for ZEZs and car-free neighbourhoods, but logistics needs must be carefully considered when designing traffic reduction measures. Copenhagen is taking an integrated approach to ensure the entire urban area benefits from this transition and is engaging local stakeholders to ensure mutually beneficial outcomes.

The Copenhagen Living Lab aims to test and validate innovative urban logistics measures that support the transition to a **zero-emission freight system**, enhancing efficiency and reducing congestion. The demonstration measures will provide **data-driven insights** to guide future urban

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[5] Mobility facts and figures – City of Copenhagen 2023.

mobility planning and infrastructure investments, with measurable impacts on key performance indicators (KPIs).

The **objectives** include testing shared logistics hubs, improving data-driven planning, optimizing curbside management, and promoting zero-emission deliveries in Copenhagen Municipality and the capital region.

Actors involved in the LL implementation

- **COPENHAGEN**: Leads the Living Lab; responsible for policy alignment, regulatory compliance, and stakeholder engagement. In charge of coordinating DISCOPROXI, DISCOLLECTION, and DISCOCURB.
- **REGIONH**: Supports integration of logistics solutions across municipalities and promotes digital data sharing initiatives. In charge of coordinating DISCOBAY.
- **IRTX**: Develops the Digital Twin by implementing data processing pipelines, a dashboard-based Human-Machine Interface (HMI), and data-driven urban parcel delivery scenarios.
- **Freight Quality Partnership**: Collaborates on data collection and contributes to the development of the SULP.
- **Copenhagen Freight Network and the Green Mile**: A forum of 15 companies working with the Danish Chamber of Commerce to promote the transition of heavy goods vehicles (HGVs) to CO2-neutral transport.
- **Bicycle Logistics Network**: Provides expertise and input on cycling-based logistics solutions.
- **Electric Vehicle Network**: Facilitates discussions on e-mobility and the development of charging infrastructure.

3.1.2. Implementation outline

3.1.2.1. DISCO-CURB

DISCOCURB: This measure focuses on developing a dynamic space management and urban planning tool to optimize curbside use. By integrating real-time data from logistics service providers, DISCOCURB will enable efficient and flexible curbside management that accommodates delivery vehicles while minimizing disruptions to urban traffic. The goal is to increase curbside efficiency by at least 30%, reducing double parking and improving loading/unloading operations in key commercial zones. This will contribute to reducing delivery time and distance travelled per route while optimizing urban space usage.

Measure definition

To identify and select the most suitable solution, the Municipality Traffic Unit engaged the **Copenhagen Solution Lab** to optimize flexible delivery and parking at curbsides for goods and freight vehicles. This need emerged due to recurring challenges associated with **curbside deliveries**

in dense urban areas, including reduced traffic safety, discomfort for other and vulnerable road users, increased environmental impact, prolonged delivery times, parking at considerable distances from the delivery location, and increased search traffic that negatively affected traffic flow.

While the solution could have involved the use of **sensors**, this was not a requirement. Through market research and identification of potential products, the goal was to find a **mature solution** capable of meeting the identified needs, enabling physical testing at a selected location in Copenhagen in the autumn of 2024, where demand for such a solution was evident.

The following 14 companies and sources were identified and analysed:

- Vade.ai
- SFpark Pilot Project Evaluation
- TPP Curb Management
- Smart Cities and Curb Management
- Curbiq (Arcadis & IBI Group's CurbiQ Solution)
- Torino City Lab - Complete Curb Management
- Urban Mobility Courses - Flexible Curbside Management
- AI-Safari (formerly CurbFlow)
- Coord
- CurbLR
- Parkopedia
- SpotHero
- ParkMobile
- **Coding the Curbs**

After meetings and discussions comparing insights with other cities (Tampere, Aarhus, Gent, Helsinki, Torshavn, and Stockholm), and based on desk research and experiences shared by these cities, **"Coding the Curbs"** was selected as the supplier for testing the parking solution. It was the only provider capable of offering a user-friendly booking platform, smart signage at the location, sensors, and an integrated platform, all at a competitive price for testing the technology at two delivery sites relevant to **Tivoli**.

Tivoli Gardens, a central attraction in Copenhagen with millions of annual visitors and nearly 100 restaurant facilities, has long faced challenges in managing deliveries. The absence of a system to organize delivery schedules led to conflicts over limited truck parking spaces. As construction at Tietgensgade shifted the main delivery entrance to a side street, H.C. Andersen Boulevard, starting in September 2024, this provided a unique opportunity to pilot a smarter solution. With this change, Coding the Curbs stepped in with the aim of improving delivery logistics at the site.

Measure implementation

Two **Smart Zones** were implemented, covering a total curbside length of 41.6 meters. This length was deemed sufficient for the installation of the two Smart Zones, based on average vehicle

dimensions. Each Smart Zone was designed to accommodate either two standard-sized delivery vehicles or one large truck for unloading. The following hardware components were installed on-site:

- Six sensors were placed—three per Smart Zone—at equal intervals to ensure accurate coverage.
- Three **traffic signs** were mounted on existing poles: one at the midpoint of Smart Zone 1, one positioned between the two zones, and the third at the end of Smart Zone 2. These signs provide user instructions and include a link to the booking application.

Tivoli Management was notified of the pilot in advance and was fully aware of its launch. Two onboarding campaigns were conducted—one at the end of September 2024 and another in early December 2024. During these campaigns, instructional materials and a call to action encouraging app usage were distributed to a list of key stakeholders compiled by Tivoli Management. A clear correlation was observed between these onboarding efforts and an increase in user sign-ups.

During the implementation stage, booking and sensor data were collected and analysed to produce an evaluation report of the curbside management system, and insights were derived from the identified patterns described in the following session.

Lessons learned

The lessons learned were derived from three main sources: **booking data**, **sensor data**, and **project reflections**. These provided information on delivery patterns, booking behaviour, occupancy rates, and instances of violations or no-shows.

In parallel, ongoing communication with Tivoli Management helped gather user feedback and assess overall satisfaction. This input contributed to the second objective of the pilot—**evaluating the user experience** and understanding how logistics providers interacted with the Smart Zone booking system and its practicality in daily operations. All feedback received via Tivoli Management and COPENHAGEN was reported as positive.

Since the pilot's launch in late September 2024, a steady increase in bookings was observed, with 89 bookings recorded over a 71-day period. Booking activity declined towards the end of the year, probably due to the seasonal closure of Tivoli, during which no deliveries were made. A renewed increase is expected after Tivoli's reopening in April 2025 (outside the scope of the DISCO project). The majority of bookings occurred towards the end of the week, with Saturday showing the highest activity. In contrast, booking activity was low from Sunday through Wednesday. Most bookings were made around 14:30, indicating a preference for afternoon delivery slots, while little to no activity was recorded after 17:00. Booking activity between 06:00 and 08:00 was also minimal. The system currently allows reservations only between 04:00 and 17:00.

Analysis of usage patterns showed that 60% of users completed deliveries within 15 minutes, while nearly 18% reserved the space for over an hour. This suggests the system supports a variety of unloading needs, with a clear preference for shorter time slots.

3.1.2.2.　　DISCO-PROXI

DISCOPROXI: This initiative aims to develop a sustainable business model for an open consolidation hub, encouraging more couriers to utilize shared logistics facilities, such as Køleskabet. The objective is to achieve a 25% increase in courier participation in shared microhubs, leading to improved last-mile delivery efficiency and reduced vehicle trips into the city centre. This intervention is expected to lower CO₂ emissions per km by optimizing route efficiency, reducing the number of delivery vehicles required, and shifting freight movements to more sustainable modes.

Measure definition

The DISCOPROXI initiative in Copenhagen aimed to lay the groundwork for an updated **Sustainable Urban Logistics Plan (SULP)** by developing a viable business model for an open consolidation hub and investigating the **financial and legal conditions necessary for establishing shared logistics infrastructure**. A key focus was encouraging more couriers to use shared microhubs, such as the existing urban facility Køleskabet, to improve last-mile delivery efficiency and reduce the number of vehicle trips into the city centre.

On the financial side, the project explored how to involve the logistics industry in shaping a more sustainable urban logistics framework through investment and cooperative governance models. On the legal side, a dedicated assessment clarified the **City of Copenhagen's limited mandate** to directly interact with private operators. The findings defined the municipality's legal room for action, which includes:

- **Offering general support** to the logistics sector on market-based terms, such as leasing municipal space for a microhub at fair market value, provided it does not subsidize individual companies.
- **Avoiding direct financial support** tailored to specific private companies based on individual needs or conditions.
- **Launching public calls** for dialogue to engage interested operators in delivering sustainable logistics hub services.

Ultimately, DISCOPROXI aims to increase courier participation in shared hubs, leading to more efficient deliveries, lower CO₂ emissions per kilometre, and a modal shift toward more sustainable freight transport solutions.

Given this legal context, the approach carried out by the LL was focused on the development of a **network of engaged stakeholders**.

First, in connection with another Horizon project, NOVELOG[6] (Grant Agreement ID: 636626), a Quality Freight Network was established with participants from universities such as DTU, AAU, RUC, CBS, industry organizations like Dansk Industri, Danish Chamber of Commerce, Dansk Transport og Logistik, and a wide range of private companies and transporters. The main purpose of the Quality Freight Network was to establish dialogue/collaboration between the "users" of the City of Copenhagen and the City planners in the Technical and Environmental Administration. The Quality Freight Network has been in place since 2015, and this network was an important partner in realizing the objectives of DISCOPROXI.

Moreover, an Advisory Board was formed in 2023 with participants from Gehl Architects, JaJa Architects, Technical University (DTU), CONCITO, Susanne Krawack, Beta Mobilitet, tGrace, Aalborg University, and COWI. The members of the Advisory Board agreed to contribute with professional insights, assessments, and recommendations in the development of the plan for sustainable city logistics in Copenhagen.

Measure implementation

Context

The process for updating the **Sustainable Urban Logistics Plan (SULP)** followed a structured series of meetings and events:

- **Kick Off meeting**: 5 September 2023
- **Advisory board meeting**: 7 September 2023
- **Partner group meeting**: 14 December 2023
- **Advisory-board meeting**: 16 January 2024
- **Open Days**: 3 April 2024
- **Final conference**: 19 August 2025 (*planned*)

At the initial meetings, all partners were invited to join a **partnership agreement** with COPENHAGEN. These agreements included provisions for the **exchange of data**.

The delivery of freight to the end-user is the final step in a complex logistics chain, which begins at production facilities across various countries. This process includes transportation to container harbours, sea shipment, reloading at dry port facilities, transfer to land transport modalities, and finally reaching the shop where the consumer purchases the item. Urban logistics systems are a small but critical link in this chain, influencing only the last miles of transportation.

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[6] https://cordis.europa.eu/project/id/636626.

To understand the dynamics of the urban and interurban logistics system, several meetings and workshops were organized. Participants included the partner groups, the Freight Network, and the Advisory Board. More than 60 participants attended the first workshop on 5 September 2023 at Copenhagen City Hall. The workshop aimed to map the different logistics modalities in urban areas and to inform the project about industry trends and the need for a transition toward a more sustainable urban logistics system. The logistics industry is composed of independent, competing companies, making the creation of a common partnership a new initiative. This partnership provided a platform for companies to share insights on the transition and identify areas of common interest outside the competitive framework.

As a public authority, COPENHAGEN cannot dictate or invest in the transition to a sustainable logistics system, as this would violate legal mandates. However, the city can actively support the market through the facilitation of partnerships. These partnerships involve sharing data related to parcel management and transportation, from receipt to delivery. This data is anonymized and used to create a digital twin for freight transport, which in turn informs the updated guidelines for the SULP.

During **partner workshops**, specific needs and suggestions for improving logistics delivery chains sustainably were developed and assessed. These topics included:

- **Freight delivery outside of rush hours** – Establishing transport corridors for heavy freight vehicles
- **Flexible and dynamic loading zones** – Intelligent curbside management for loading areas
- **Hubs and microhubs** – Reloading parcels from heavy vehicles to cargo bikes through logistics hubs in peri-urban locations or microhubs within urban areas
- **Charging infrastructure** – The transition to electric vehicles, including charging stations for logistics fleets, with distinct needs compared to private vehicles
- **Zero-emission zones (ZEZ)** – Discussions on the implications for freight deliveries in EU cities
- **Optimization of access roads** – ITS management for transport corridors for heavy vehicles.

These initiatives were refined in partner group meetings and further discussed in the Advisory Board on November 7, 2023, November 14, 2023, and January 16, 2024. The final meeting before the completion of the updated guidelines for the SULP was the Open Days on 3 April 2024, held at Copenhagen City Hall. The guidelines are expected to be finalized in June 2025.

Due to legal assessment of the role of COPENHAGEN in establishing logistics hubs, COPENHAGEN has no possibilities to invest and support logistic infrastructure.

Partnership Agreements

Data delivery and formatting were established through **bilateral partnership agreements** between the COPENHAGEN, the Technical and Environmental Administration (TMF), and data providers. These agreements specified the content and format of the data to be submitted to TMF, with a focus on minimizing the resources required from data providers, typically using email and CSV or Excel files.

The primary data collected was **route data**, including sender, recipient, transshipment location (if applicable), product category, size/weight, and vehicle categorization. The data was used to develop and implement a model simulating freight transport in the capital region and Copenhagen, known as the **Digital Twin** under the DISCOLLECTION measure. This simulation helped evaluate potential delivery scenarios, such as electric bike deliveries and nighttime deliveries.

A **legal paper** on data use, focusing on GDPR compliance, was prepared as an appendix to the partnership agreement, ensuring proper handling, anonymization, and storage of company-related data.

All project partners signed a **Partnership Agreement**, agreeing to share data with the COPENHAGEN. The specific data to be shared, including content, format, and file types, was separately agreed upon. By signing the agreement, partners authorized the City to transmit their data to IRTX for modelling logistics scenarios in the city of Copenhagen and capital region.

The partners and their legal advisers agreed on the following text:

2.1. The partner is committed to sharing data with the City of Copenhagen

2.2. The specific data that the partner commits to share, including content, format, file types, and any other relevant information regarding the sharing and subsequent use of data, will be separately agreed upon following the partnership agreement.

2.3. The partner accepts that data will be transmitted by the City of Copenhagen to IRT-SystemX, which uses the data to model a baseline of goods and urban logistics in the City of Copenhagen and Capital region, as well as modelling new scenarios.

2.4. By agreeing to this partnership agreement, the partner gives the City of Copenhagen the right to use the data, which the partner voluntarily is offering through the entire lifetime of the project.

2.5. The contact person of the partner has the responsibility to provide the City of Copenhagen with data.

2.6. The data will be sent to a chosen contact person inside the City of Copenhagen, who is connected to the DISCO-project.

2.7. The City of Copenhagen's contact person will be informed in continuation of agreeing the partnership agreement

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A total of 13 partnership agreements were signed, involving 11 companies 2 associations (**Danish Chamber of Commerce** and **Danish Industri).** In particular, the 11 companies below agreed to share their logistics data:

- Danske Fragtmænd, parcels

- DHL, parcels
- Bring, parcels
- SFT Logistics, parcels
- DAO, parcels
- Läntmannen Schulstad, bread B2B
- Årstiderne, food B2C
- Hørkram, food, B2B
- Dagrofa, food, B2B
- Carlsberg, Brewery, B2B
- Dansk Retursystem, Return Materiels B2B.

This data became a crucial input for the DISCOLLECTION system, where it underwent a thorough process of cleaning, sorting, and storing to ensure it could be effectively utilized within the Digital Twin model. The model was designed to simulate prospective logistics scenarios, which also incorporated the potential implementation of a **consolidation hub**. The outcomes from these simulations provided a set of Key Performance Indicators (KPIs), including economic indicators, which were used to assess the feasibility and impact of the consolidation hub.

The data management activities focused on three main areas: (1) the establishment and management of a **data platform** to collect and transform data from logistics partners, (2) the ongoing collection and management of this data, and (3) the conversion of this data into a usable format for integration into the Digital Twin model. To facilitate the integration of collected data into the work on the Digital Twin within the **DISCOLLECTION** innovation, a specialized data platform was developed. This platform employed various tools, methods, and processes to accept, code, and send data to IRTX. The platform was built on a Unix server, equipped with advanced software and libraries designed for geocoding the data provided by logistics partners.

Ensuring the security and confidentiality of the data was a critical concern throughout this process. The platform was designed with stringent data security protocols to guarantee that supplier data would remain confidential at all times. One of the major challenges was geocoding the extensive route data from logistics partners, which required a significant amount of historical data, specifically, three weeks of route information, for the development of the Digital Twin. To efficiently handle this large volume of data, a suitable **geocode library** was identified and implemented, along with an optimized **key system** for merging geospatial data with the logistical data from partners. Given the sheer scale of the routing data, a mechanism incorporating **lookup keys** was developed to ensure seamless data integration and processing.

Lessons learned

Developing a precise methodology to support the economic feasibility of sustainable logistics measures required significant effort to ensure the collection of representative and accurate data. A

key lesson learned from the implementation of the measures is that **high-quality data is essential to build a reliable foundation for decision-making and economic modelling.**

Furthermore, while engaging with the logistics industry for exploring the potential of peri-urban logistics hubs and urban microhubs and updating Copenhagen's Sustainable Urban Logistics Plan (SULP), the municipality gathered some key insights. The industry demonstrated a **clear awareness** of the need to transition urban logistics systems in response to global CO_2 reduction targets and local pressures to reduce traffic and free up urban space. Stakeholders expressed a willingness to transform, acknowledging their role in enabling more sustainable last-mile delivery models. However, a critical lesson learned from these discussions was the industry's demand for **regulatory stability and clarity.** Given the scale and long-term nature of the investments required, operators emphasized the need for clear and lasting policies to ensure security and reduce risk.

Eventually, the last lesson learned during the measure implementation process involved the legal assessment of the City's mandate in supporting the development of logistics hubs. The assessment confirmed that while the city can support the logistics industry under general market conditions, such as leasing municipal land for hubs at market rates, it cannot offer targeted support to individual companies based on specific needs. However, the city may issue public notifications to invite dialogue with potential operators, ensuring an open and transparent process for developing sustainable logistics services.

3.1.2.3.　　DISCO-BAY

DISCOBAY: This measure involves retrofitting the Høje Taastrup terminal to function as a peri-urban and neighbourhood multimodal hub that supports zero-emission freight deliveries. The aim is to facilitate the adoption of electric and cargo bikes for last-mile logistics while ensuring seamless integration with regional freight networks. The target is a 40% reduction in CO_2 emissions from freight movements, achieved by increasing the share of goods delivered via zero-emission vehicles and optimizing freight distribution to reduce unnecessary travel distance.

Measure definition

REGIONH is working to reduce CO2 emissions as part of its regional development strategy by assisting municipalities in implementing climate plans and promoting green transportation solutions. While progress has been made with electric vehicles, additional attention is needed on heavy and public transport to meet CO2 reduction targets. The region will also support the transition in the energy and heating sectors, focusing on cross-sector solutions. Key goals include reducing CO2 emissions by 85% by 2030 compared to 1990 levels, with the aim of achieving CO2 neutrality by 2045.

The flowchart below (Figure 1) was created in June 2024 as a management tool inspired by the SULP tool. It has undergone two iterative revisions: in the first version, the physical retrofit was not yet

clearly defined. After the first local workshop at the end of August, the flowchart was updated to align with the DISCO project. The updated flowchart depicts the **physical retrofit** as the starting point, branching into two tracks: (1) the implementation of the retrofit, and (2) the simulation of the retrofit in the digital twin.
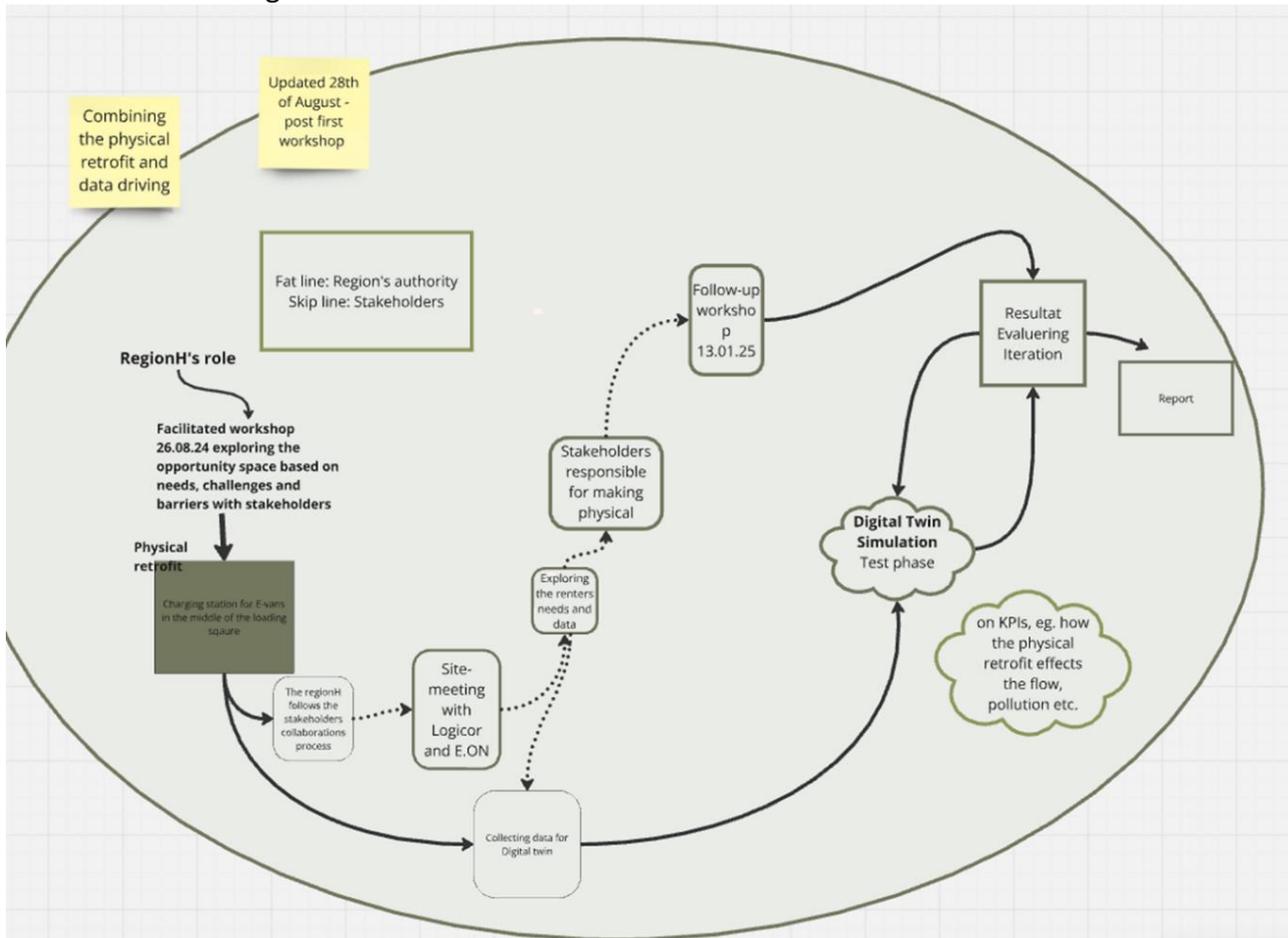

Figure 1: Retrofit flowchart.

During the first workshop, an implementation plan was created as a project guideline. One key suggestion from a local stakeholder involved developing infrastructure for the outbound flow of the grocery wholesaler area. Within this area, only vans and cars (under 3.5t) are allowed, as the surface cannot support trucks. A major challenge discussed was that owners cannot afford the investment or the risk of installing charging infrastructure, which was recognized as essential to support the green transition, given the area's variety of independent businesses. A charging infrastructure provider offered a free test setup following a site visit.

In parallel with work involving local stakeholders, activities focused on calculating the potential impact of a physical retrofit. A traffic count was conducted, and the data was used to create a model for electric vehicle (EV) fleet scenarios, considering factors such as energy demand, charging time, and the number of recharging points required.

Measure implementation

The Copenhagen DISCOBAY implementation was officially launched at the end of May 2024 with a bilateral meeting involving Høje Taastrup Municipality, which became the first confirmed local partner. During this meeting, the municipality approved initiating contact with a key grocery wholesaler.

In June 2024, a bilateral meeting was held with a charging infrastructure company, which subsequently joined the initiative as an active partner. Their participation brought essential expertise and technological capabilities to the project. Later that month, a meeting with the grocery wholesaler was also held, and the company promptly joined the initiative, citing increasing demand from its tenants for support in the green transition.

The integration of DISCOBAY within the Digital Twin began in June 2024 with an initial planning meeting, which has since developed into an ongoing collaborative process.

In July 2024, RegionH conducted a field visit to Copenhagen Markets during the early morning hours (05:00–07:00) to gather observational data and gain a deeper understanding of the site. The insights from this visit contributed as valuable input to the Stepwise Approach defined in WP2 and in the development of the Living Lab.

The first local workshop, held in August 2024, aimed to establish a collaborative framework and explore options for physically retrofitting the site. The workshop identified key needs, challenges, and barriers, resulting in a shared plan for continued collaboration. Invitations for a follow-up workshop were subsequently sent to participating actors.

In September 2024, a site meeting with all local partners was held to further develop retrofit plans. By the end of the month, a draft design was completed. Around the same time, the charging infrastructure company proposed a test setup that included the delivery, installation, and operation of a charging station and crash fences. Coordination meetings followed between the infrastructure provider and the wholesaler.

In November 2024, traffic flow data was collected by a subcontractor and submitted to IRTX for further analysis.

The second local workshop took place in January 2025. Although the wholesaler withdrew at the last minute and was unable to participate in the discussions, the workshop still resulted in **ongoing collaboration** and dialogue between the municipality, the charging infrastructure provider, and the wholesaler.

The results of the traffic analysis by IRTX, based on the November 2024 data, are expected to be delivered in June 2025.

Lessons learned

During the implementation of DISCO, several challenges emerged. In November 2024, one of the key stakeholders began to withdraw from the process and ultimately declined to participate in the second workshop. As a result, progress on the physical retrofit has temporarily stalled. However, according to the charging infrastructure company, dialogue with the involved parties remains active, and collaboration continues—albeit without any physical implementation at this stage.

The project has also been significantly affected by the **dynamic nature of political priorities** within the participating public organization. Frequent shifts in focus have disrupted the project's continuity, leading to changes in its direction, objectives, and scope. These evolving priorities have required constant reassessment of the project's goals, making it challenging to maintain alignment with the original vision.

Another key insight is that the area designated for the retrofit is not yet sufficiently mature for the deployment of green logistics infrastructure. Stakeholders in the area—including companies operating within the logistics hub—have expressed that they are not yet prepared to transition to sustainable logistics solutions or invest in infrastructure like charging stations. A recurring message throughout the engagement process has been that the shift to greener practices will only occur once regulatory or market-driven incentives, such as the implementation of zero-emission zones, create a clear motivation for change.

3.1.2.4. DISCOLLECTION

DISCOLLECTION: This measure seeks to establish a real-time transport data collection model by engaging private logistics and e-commerce companies. By leveraging urban freight data, the city will be able to refine its SULP with evidence-based policies. The goal is to collect and analyse transport data covering at least 80% of logistics operators in the city, enabling informed decision-making and predictive analytics for traffic management. The effectiveness of this measure will be assessed through the number of new/enhanced services utilizing logistics data, ensuring that logistics planning is continuously improved with up-to-date information and supporting the long-term optimization of urban freight flows.

Measure definition

The objective of DISCOLLECTION is to develop a dynamic transport data collection model involving private logistics and e-commerce companies, and to engage the local industrial community in shaping the new **Sustainable Urban Logistics Plan (SULP)**. The project adopts a **Digital Twin** approach for urban logistics, allowing for the simulation and analysis of logistics movements and patterns across different scales within the city. This digital representation supports the creation of forward-looking strategies that contribute to the decarbonization of the logistics sector—such as

new traffic regulations, unbundling infrastructure, incentives for clean vehicles, and the adjustment of distribution periods.

The territorial Digital Twin solution was selected for its ability to address the specific challenges and needs of the Living Lab. The model is based on the LIAISON platform[7] developed by IRTX, and consists of a systemic representation of the logistics system. It integrates several features that add value and align with the goals of the Living Lab:

- A **modular platform** composed of individual components, allowing tailored handling of use cases and flexible analytical configurations;
- A **disaggregated operator-based approach**, enabling individual data to be processed for model calibration and later consolidated to preserve data anonymity and protect business models;
- A **generalizable methodology** that allows models built on sample data to be extrapolated;
- **Dynamic operation**, which supports iterative data integration and continuous model improvement;
- A **scalable model** capable of running scenarios and analyses at varying scales—from neighbourhood level to the **capital region**;
- A **documented and replicable methodology** designed to improve the understanding and analysis of urban logistics systems across the **European Union**.

The Digital Twin was implemented over two years from the start of the DISCO project. Following an initial introduction to the initiative, a first workshop was held in Copenhagen to share the vision and expectations with local logistics stakeholders. This was followed by a phase of data collection, cleaning, and matching, carried out alongside the development of initial model components. By mid-2024, once a sufficiently representative dataset had been assembled, an iterative process began to refine the use cases that would inform the SULP.

Measure implementation

The data previously collected under DISCOPROXI—specifically the eleven datasets described earlier—contributed to the development of generic models that represent the behaviour of logistics operators within a given area, based on demand patterns and operational constraints. Once gathered, the source data was cleaned, sorted, and stored to ensure it could be effectively utilized. This dataset became one of the key reference inputs used to construct the reference model within the Digital Twin. The model is capable of generating a range of operational indicators, including fleet composition, vehicle capacity, number of shifts, activity periods, distance travelled, energy consumption, and CO_2 emissions.

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[7] https://liaison.irt-systemx.fr/.

Version: 2

Using this foundation, prospective scenarios were developed within the Digital Twin, factoring in the potential implementation of a consolidation hub. The scenario results were then used to generate a set of key performance indicators (KPIs)—including economic metrics—to assess and qualify the role of the consolidation hub.

These modelling frameworks supported the exploration of use cases that inform the City of Copenhagen's logistics decarbonization strategy, including:

- **Zero-Emission Zones**, which restrict access for non-electric vehicles;
- **Microhubs**, which consolidate flows from multiple operators and enable zero-emission last-mile deliveries;
- **Off-hour deliveries**, which shift logistics operations to earlier, less congested hours.

Zero-Emission Zones restricting accesses for non-electric vehicles
- All vehicles stopping at least once in the ZEZ are converted from thermic to electric vehicles
- Vehicles not stopping in the ZEZ remain thermic but need to detour around the zone
- Operations concerned by the measure: all logistics operations
- Operating area: Medieval City

The exploration of this scenario generated an analysis base for all territorial scales:
- At the Medieval City level, there has been a sharp reduction in the number of vehicles using the zone for logistics operations (-44%) related to the fact that transit traffic is prohibited. At the same time, the number of electric vehicles in this zone is doubled and the fleet of combustion vehicles is reduced to zero. The overall volume of traffic is stable while emissions are reduced by 83% and vehicle energy consumption reduced by 60%.
- In Inner City, the total number of vehicles is stable (+1%), while emissions (-16%) and energy consumption (-8%) are reduced.
- The Environmental Zone saw a slight increase in the fleet of motorized vehicles (+2%), however this was composed by a reduction in combustion vehicles (-6%) and an increase in electric vehicles (+72%). The distances travelled at the territorial scale of the environmental zone have increased slightly (+1%), but the emissions (-5%) and energy consumption (-3%) balances have been reduced.

Zero Emission Zone: overall results Medieval city

Vehicles Interacting with the area

Medieval City Average day	Baseline situation	ZEZ enforced	Evolution (%)
Thermic operating	28	0	-100%
Thermic transit	<1	0	--
Ev operating	6	19	+216%
Ev transit	0	0	--
Total vehicles	34	19	-44%

Environmental indicators

Medieval City Annual values	Baseline situation	ZEZ enforced	Evolution (%)
Distance [1000 km]	7.7	7.6	-1%
Emissions [tCO2eq]	1.5	0.25	-83%
Energy [MWh]	5.2	2.1	-60%
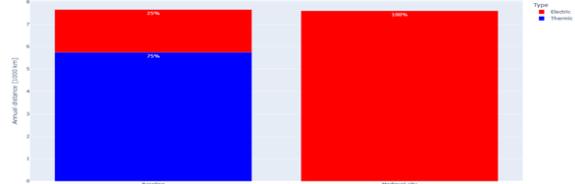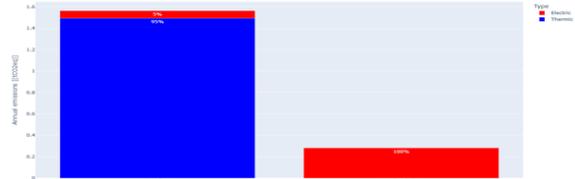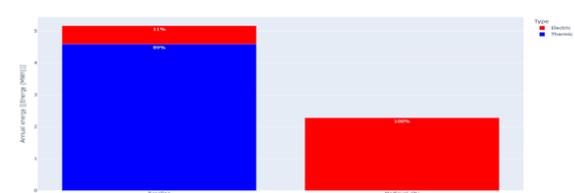
Figure 2: Evolution of logistics fleet and environmental indicators once the ZEZ is enforced in the Medieval City.

Average daily distance travelled by all vehicles, by operator, by zone

🟦 Thermic vehicles

🟥 Electric vehicles
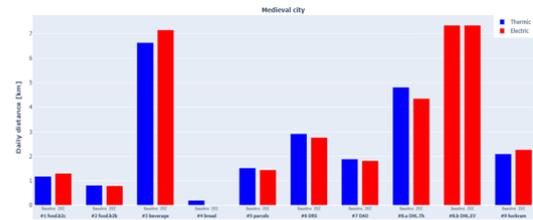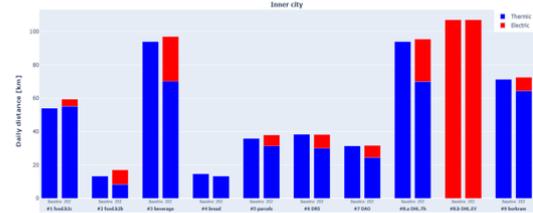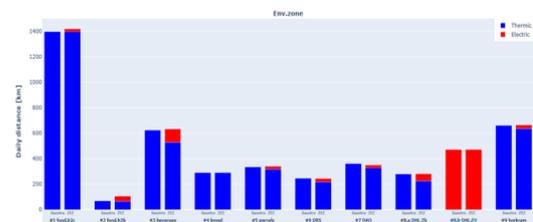
Figure 3: ZEZ – Evolution of travel distance per zone and per engine type.
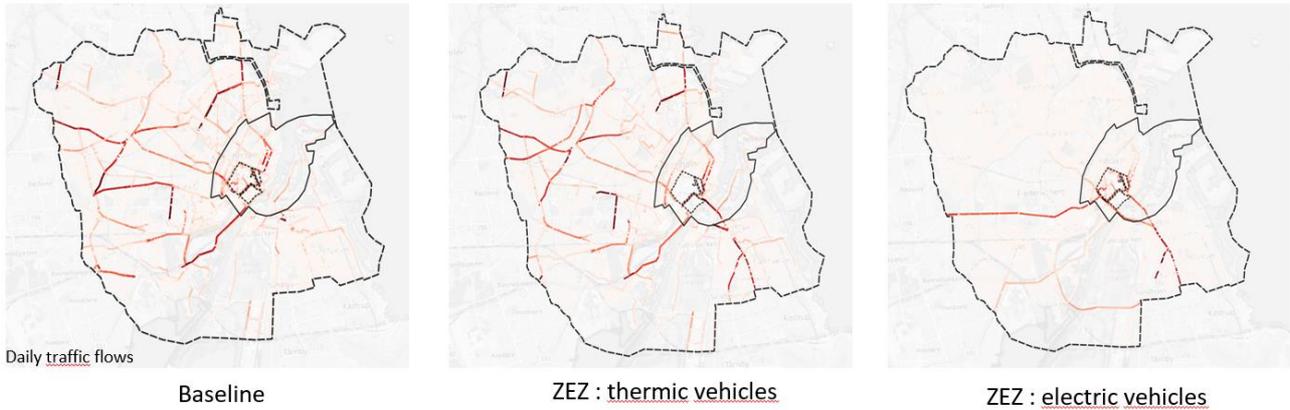
Figure 4: ZEZ – evolution of travelled distances per scenario and per engine type.

Baseline *Average day*	Medieval City	Inner City	Env.zone
Shipments	201	594	2 591
Distance thermic	22 km	447 km	4 269 km
Distance electric	7.3 km	107 km	471 km

ZEZ enforced *Average day*	Medieval City	Inner City	Env.zone
Shipments	201	594	2 591
Distance thermic	0	367 km	4 005 km
Distance electric	29 km	202 km	789 km

Logistics hubs
- All deliveries in the Medieval city are made with cargobikes
- Parcels are delivered by motor vehicles at the hub before 10:00 am
- Cargobikes start at 10:30; capacity 20 parcels per bike
- Motor vehicles keep circulating in the Medieval city
- Other areas are delivered normally
- Operations concerned by the measure: parcels B2C
- Operating area: Medieval City

The exploration of this scenario generated an analysis base for all territorial scales:
- At the Medieval city level, the fleet of motorised vehicles has been reduced from 16 to 3 vehicles. 5 cargo bikes are needed to carry out operations. There has been an increase in the distances travelled in the hub area (+150%), due to the load capacity of the cargo bikes. As logistics operations are covered by the cargo bikes, the energy balance and CO2 emissions are reduced by 90%.
- In the Environmental Zone, the fleet of motorised vehicles needed for operations has increased (+14%) due to operational constraints, suggesting the hub should be delivered before 10am. The distances travelled, emissions and energy consumption indicators remain stable.

　　　　　　Version: 2

Multi-functional logistics hub: Medieval City results

Fleets composition

Medieval City *Average day*	Baseline situation	Hub operational	evolution
Thermic vehicles fleet	10	2	-80%
Electric vehicles fleet	6	1	-83%
Cargobikes fleet	0	5	+5v

Environmental indicators

Medieval City *Annual values*	Baseline situation	(*) Hub operationaL	Evolution (%)
Distance [1000 km]	4	10	+150%
Emissions [tCO2eq]	0.6	0.04	-94%
Energy [MWh]	2.2	0.26	-89%

(*) **Cargobikes + Electric vehicles fleet**
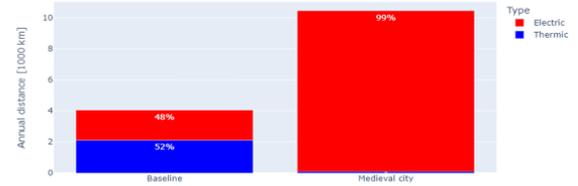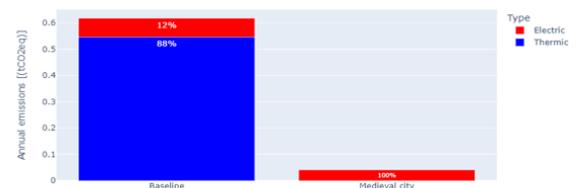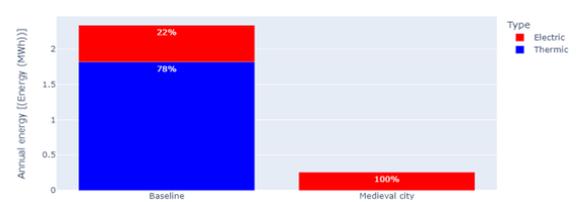
Figure 5: Evolution of logistics fleet and environmental indicators once the logistics hub is implemented in the Medieval City.

Baseline — Hub: vehicles — Hub: Cargobikes
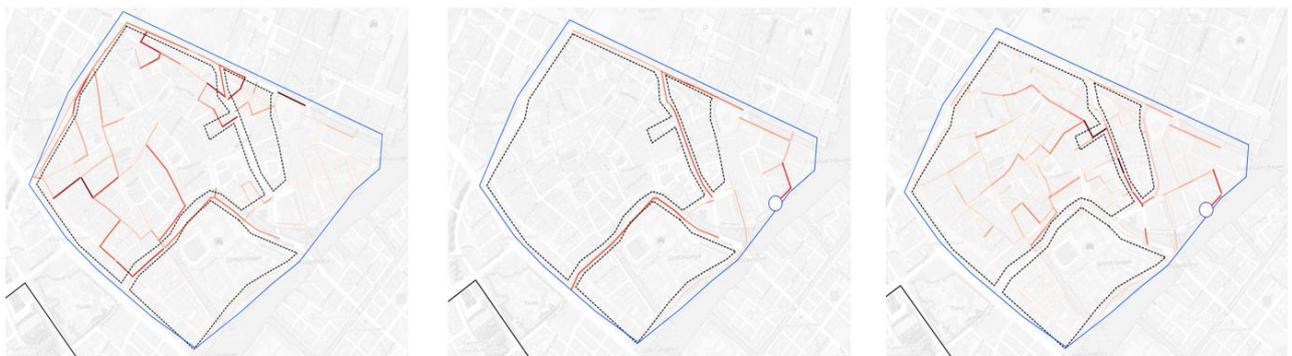
Daily traffic density

Baseline *Average day*	Medieval City	Inner City	Env.zone
Shipments	113	327	1578
Distance motor veh.	15.55	264.54	1418.10
Distance cargobikes	0	0	0

Hub operational *Average day*	Medieval City	Inner City	Env.zone
Shipments	113	327	1578
Distance motor veh.	0.52	249.71	1400.55
Distance cargobikes	17.80	39.75	39.75

Figure 6: Logistics hub – evolution of travelled distances per scenario and per vehicle type.

Off-hour deliveries

- All deliveries within the Medieval city must be finished by 7:00 am
- Motor vehicles keep circulating in the Medieval city
- Other areas are delivered normally

- Operations concerned by the measure: all logistics operations B2B
- Operating area: Medieval City

The exploration of this scenario generated an analysis base for all territorial scales:
- On the Medieval city level, there is a strong peak in logistics traffic in the morning before 7:00 am, involving an 81% increase in km travelled during this morning time. The fleet of vehicles needed to carry out these operations increases by 5%, and the distances travelled by 8% over the course of a day.
- At the Environmental Zone level on a daily basis, the fleet of motorised vehicles required for operations is increased (+3%). The distances travelled, emissions, and energy consumption also increased by 3%.

Off-hour deliveries: results
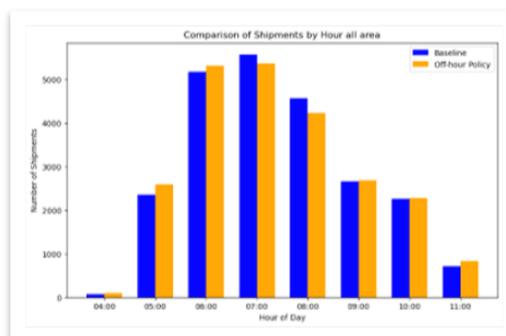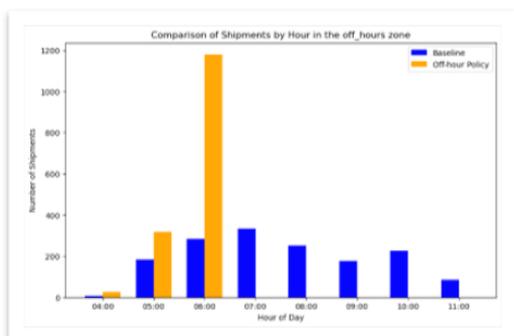
Medieval city *Average day*	Baseline situation	Off-hour enforced	Evolution (%)
Nb of vehicles	41	43	+5%
Travelled distance	17.81	17.98	+8%

Medieval city *5:00-700*	Baseline situation	Off-hour enforced	Evolution (%)
Travelled distance	9.52	17.21	+81%

Env.zone *Average day*	Baseline situation	Off-hour enforced	Evolution (%)
Nb of vehicles	61	63	+3%
Travelled distance	1394.00	1440.30	+3%

Env.zone *5:00-7:00*	Baseline situation	Off-hour enforced	Evolution (%)
Travelled distance	884.13	861.98	-3%

Figure 7: Compared evolution of traffic and travelled distance on an average day and during the morning shift once the off-hour policy is implemented.

Off-hour deliveries: Env. Zone results

Fleets composition

Env.zone *Average day*	Baseline situation	Off-hour enforced	Evolution (%)
Thermic vehicles fleet	43	44	**+2%**
Electric vehicles fleet	18	19	**+5%**

Environmental indicators

Env.zone *Annual values*	Baseline situation	Off-hour enforced	Evolution (%)
Distance [1000 km]	362	374	**+3%**
Emissions [tCO2eq]	66	68	**+3%**
Energy [MWh]	229	233	**+3%**
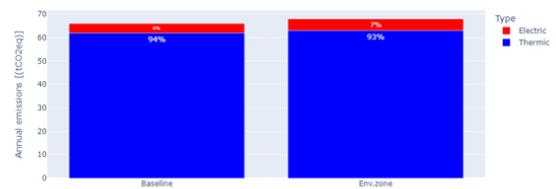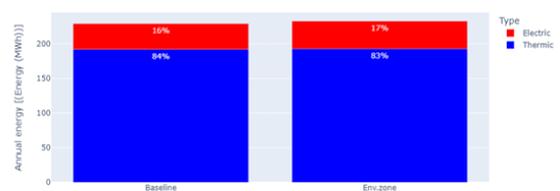
Figure 8: Evolution of logistics fleet and environmental indicators in the Environmental Zone once the off-hour deliveries policy is implemented in the Medieval City.

In parallel, the development of synthetic operators to generate global logistical flows corresponding to local demand was leveraged to build a generic model, currently under development. It is based on the processing of operating data and the exploration of scenarios presented above. It aims to combine these approaches with a model of the topological specificities of the environment under consideration, in order to establish a model that can take advantage of sample data to establish a representation of logistics phenomena on a territorial scale. This approach makes it possible to reconstruct the entire logistics activity of an area, based on a set of representative source data. This approach is iterative, with the integration of additional data over time reinforcing the representativeness and robustness of the model.
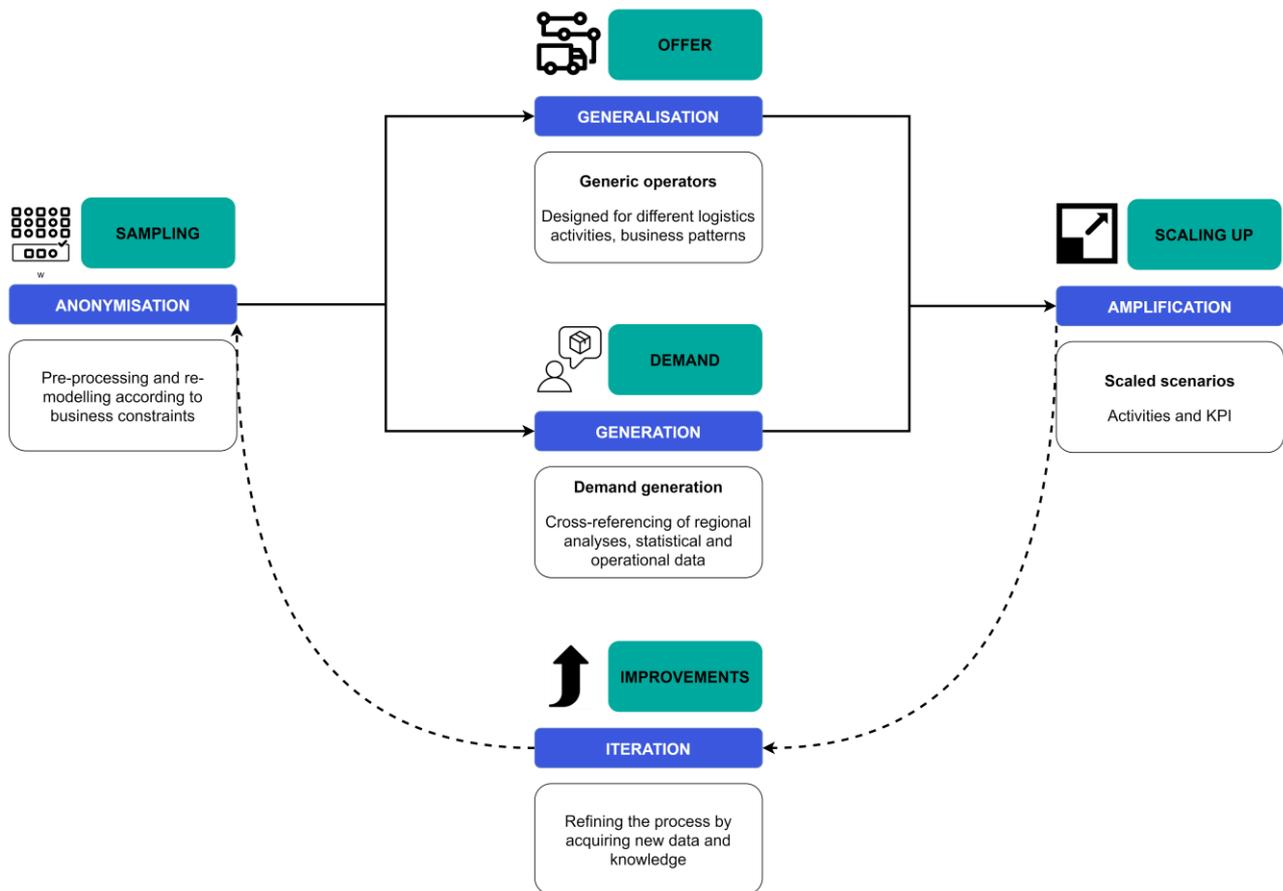
Figure 9: Generic model Copenhagen DISCOLLECTION.

Lessons learned

One key lesson from the implementation process is that building a **realistic and reliable model** requires extensive **parameterization** and **calibration**, both of which demand a significant investment of time and resources. These steps are essential to ensure that the model produces **consistent** and **generalizable results**. The availability of high-quality **source data**, provided through the project, has been crucial in enabling us to achieve this objective.

3.1.3.   Results

DISCOPROXI

The DISCOPROXI measure successfully fostered public-private collaboration in Copenhagen's urban logistics system. Through 13 partnership agreements, including with major logistics providers such as DHL, Bring, and Carlsberg, a new foundation was laid for data sharing and sustainable freight planning. Eleven datasets were collected, cleaned, and integrated into the city's Digital Twin platform, helping simulate different freight scenarios.
Key results include:

- Establishment of Økoskabet, a **shared microhub**, promoting last-mile deliveries via sustainable means.

- Initiation of off-hour delivery planning and microhub design through collaborative workshops.

- Legal analysis clarified municipal boundaries in supporting logistics

- Updated **SULP guidelines**.

DISCOLLECTION

DISCOLLECTION delivered a functioning data-driven transport model (Digital Twin) based on the LIAISON platform, enabling evidence-based policy making. The platform was populated using data from 11 logistics providers and scenarios were tested on zero-emission zones, off-hour deliveries, and cargo bike microhubs.

Key insights:

- Zero-Emission Zone scenario in the Medieval City showed **83% reduction in emissions**, **60% drop in energy use**, and complete electrification of stopping freight vehicles.

- Logistics hub scenario demonstrated a **90% reduction in CO$_2$ emissions** using cargo bikes, despite increased distances travelled.

- Off-hour delivery simulations led to more intensive morning activity but modest increases in emissions (+3%) citywide.

- KPI: Coverage of 80% of logistics operators with transport data; foundation for long-term optimization of urban freight.

DISCO CURB

DISCO CURB piloted Smart Zones at Tivoli Gardens to manage curbside deliveries using "Coding the Curbs" technology. This involved smart signage, sensors, and an app-based booking platform.

Implementation results:

- Two Smart Zones (41.6 meters total) were installed with six sensors and three signs.

- 89 bookings occurred during the 71-day pilot, with **60% of users completing deliveries within 15 minutes**.

- Peak booking was on Saturdays around 14:30, with minimal activity post-17:00.

- User feedback collected via Tivoli Management was entirely positive, validating the booking system's usability.

The pilot was extended beyond the DISCO project period (April–August 2025), reflecting city interest in scaling the solution.

3.1.4.   Beyond DISCO

Beyond DISCO, the project's scientific and technical methodologies will have a lasting impact, contributing to the broader scientific community through publications in peer-reviewed journals and conferences. The outcomes of DISCO will extend beyond the immediate project scope, offering a **framework for public-private cooperation in collecting data and developing strategic decarbonisation plans**.

A process for **anonymising logistics data** has been implemented in the Urban Freight Data Space, ensuring that critical business information is protected while allowing for its safe reuse by engineering companies and researchers for strategic planning and analysis. Another key development is the creation of a digital twin model for urban logistics systems, which facilitates the exploration of prospective scenarios and the evaluation of policies aimed at reducing carbon emissions. This model, if calibrated with the right data, could be replicated across the EU to assess logistics activities and emissions at a broader scale.

In Copenhagen, the **SULP will be politically approved by the end of 2026** and serve as a cornerstone for the city's future sustainable mobility planning. Private companies and the logistics industry have been effectively engaged in the planning process, with the Quality Freight Network playing a key role in transforming the city's logistics network. The City of Copenhagen will continue working with logistics operators to explore potential cooperation opportunities and **identify private land for establishing logistics hubs**.

Furthermore, the City of Copenhagen has **extended the testing phase for DISCOCURB**, which will now run from April to August 2025. During the initial phase, it became clear that well-timed and clear communication is vital. As a result, user communication and informational materials will be revised to improve clarity, engagement, and effectiveness throughout the extended testing period.

The potential for scaling DISCOBAY lies in its model for **collaboration between grocery wholesalers, transshipment centres, independent companies, and infrastructure providers in Greater Copenhagen**. Discussions with infrastructure suppliers continue, with plans to further develop and transfer the knowledge gained to Høje Taastrup Municipality. This collaboration is set to continue through the LifeAct project[8], where Høje Taastrup is an active participant, and the SULP will provide continued support for sustainable logistics solutions.

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[8] https://life-act.eu/english/about-life-act/.

3.2. Ghent

3.2.1.   Background and rationale of the intervention

General and logistics characteristics

Ghent is a medium-sized European city located in the Flemish region of Belgium. It is renowned for its rich historical heritage, featuring a well-preserved medieval city centre that attracts residents, businesses, and tourists alike. With a population of approximately 271,000 inhabitants, Ghent has a diverse urban landscape with varying levels of population density. While the historic centre is highly concentrated, with 7,200 inhabitants per km², the overall city has a density of around 1,600 inhabitants per km².

The city is strategically positioned at the crossroads of two major motorways, **E40 and E17**, both of which are key corridors in the **Trans-European Transport Network (TEN-T)**, making the city an important node in regional and international connectivity. Ghent also benefits from an efficient road network, including two ring roads, R4 and R40, which help regulate traffic flow and provide access to different parts of the city and beyond.

Economically, Ghent is a dynamic and growing city, home to around 30,000 enterprises and providing 135,000 jobs, particularly in the medium and high-tech sectors, as well as the knowledge economy. The city has a net growth rate of enterprises of 6.5%, indicating strong business development. In addition, Ghent boasts 5,400 commercial premises with a total shop floor area of 517,000 m², making it a key commercial hub in the region.

Relevant actions linked to logistics development in the City of Ghent

Ghent has been an active participant in sustainable urban mobility planning since the early 1990s, pioneering bicycle and mobility initiatives long before they became mainstream in European cities. In 2014, the city finalized its **Sustainable Urban Mobility Plan (SUMP)**, which laid the foundation for a range of policies that followed. This was complemented by the **Parking Plan (2015)** and the **Circulation Plan (2017)**, which reshaped mobility patterns, improved accessibility, and encouraged sustainable transport options. More recently, in 2023, Ghent developed a **roadmap for Sustainable Urban Logistics Planning (SULP)**, reinforcing its commitment to making urban freight more efficient and environmentally friendly.

Ghent is also a member of POLIS and Eurocities, two leading European networks dedicated to sustainable urban mobility and city governance. Through these memberships, Ghent actively engages in knowledge-sharing and collaboration with other European cities to advance innovative urban mobility solutions.

Urban logistics play a crucial role in Ghent's overall mobility strategy. Recognizing the increasing challenges posed by freight transport, the city has developed a **comprehensive urban freight plan** known as "Plan Stedelijke Logistiek" (Urban Freight Plan), which was officially validated in 2023. This plan addresses urban freight through six strategic pillars: knowledge sharing, having the right vehicle

at the right place at the right time, reduced and cleaner transport, space for logistics, best practices by the city of Ghent and innovation/entrepreneurship in the last mile.

Challenges addressed by the LL

Ghent has long been a leader in sustainable urban mobility, balancing economic activity with environmental and social well-being. As a dense, historic city, it faces the challenge of managing freight efficiently while **reducing emissions, congestion, and preserving liveability**.

Within DISCO, Ghent aims to reduce freight kilometres and emissions by improving logistics efficiency. Poor route planning leads to unnecessary trips and pollution. By integrating vehicle access regulations into transport planning, the city seeks to enhance compliance and optimize delivery routes.

Ghent also prioritizes innovation through data-driven logistics. A key challenge in urban freight is fragmented digital systems that require constant updates. Using a **data-space approach**, Ghent aims to create an interconnected logistics ecosystem, enabling seamless communication between public and privately owned databases and systems without costly integrations.

The Living Lab aimed to develop a tool that **integrates urban vehicle access regulations (UVARs) into logistics planning**. The tool aims to optimize deliveries by ensuring compliance and suggesting collaborations with Green Last Mile operators when cost-effective.

Beyond optimizing freight, the Living Lab supports a Physical Internet-inspired logistics network, where data-sharing and interoperability improve urban deliveries. By integrating these innovations into its mobility strategy, Ghent sets a model for freight-efficient urban land use and low-impact logistics.

Actors involved in LL implementation

- **VIL**: the logistics innovation cluster in Flanders, Belgium, with over 650 members, primarily SMEs. VIL coordinates the living lab.
- **Imec**: A renowned research institute, leads research tasks in the living lab.
- **Be-Mobile**: Develops software for urban mobility solutions (parking/traffic management) and is responsible for the UAC software.
- **City of Ghent**: Provides the living lab setting, using the inner city. Involves local business, economy, mobility, and data departments.
- **OHB**: A consortium of retailers and logistics companies around Ghent, focusing on waterway logistics. OHB sets up testing possibilities.

During the demonstration implementation, the following companies joined the living lab:

- **Dropon**: Transport management system provider, who was the main testing partner for integrating traffic regulations into planning solutions.
- **Geosparc**: traffic management system provider who integrated with the UFT dataspace
- **Bicobel**, logistic operator, who tested the solutions physically

- **Foodbag**, logistic operator, who tested the solution physically

3.2.2. Implementation outline

3.2.2.1. DISCO-PROXI

DISCOPROXI: This measure aims to develop an Urban Access Control (UAC) system to enhance logistics efficiency, safety, and sustainability. By integrating digitized Urban Vehicle Access Regulations (UVARs) into logistics planning tools, the system will enable transport companies to automatically incorporate access rules—such as emission zones and time windows—into their route optimization. The UAC will also provide real-time information on (un)loading zones, school areas, and congestion hotspots, improving navigation and operational decision-making for logistics operators.

Measure definition

The concept builds on insights from the H2020 TOKEN project[9] (Grant Agreement: 870603), where a rudimentary version was tested by VIL and Imec. It addresses key challenges in urban freight: dangerous traffic conditions, inefficient compliance with regulations, costly inefficiencies in city transport, and the untapped potential of sustainable alternatives.

The measure was structured in three phases:
- **Scoping phase** (Months 1–6): Identifying use cases, defining functional requirements, mapping stakeholders, and creating the IT architecture.
- **Development phase** (Months 6–18): Building the UAC, integrating it with external test partners like **Dropon**, and engaging stakeholders through a bootcamp and an open day (June 2024).
- **Testing phase** (Months 18–24): Live testing with Bicobel and Foodbag and further refinement.

A key challenge was digitizing Ghent's access data, which was integrated into the **Ghent Open Data Portal**. One of the opportunities faced was **digitizing the (un)loading zones in the city.** After discussion with the city of Ghent, one specific feature of interest is the visualization of designated un/loading zones close to the drop-off destination. When a driver nears their destination, the navigation app shows nearby loading zones on the map, as well as in a list (sorted by distance). From the city's experience, it was found that drivers often are not aware of such zones, even if they are just around the corner. This feature should help increase the use of these designated zones, thus reducing the nuisance caused by e.g., parking on the street.

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[9] https://token-project.eu/.

The UAC also promotes four sustainable last-mile alternatives: bike couriers Urbike and CargoVelo, zero-emission provider BD Logistics, and a waterway logistics solution via Urban Waterway Logistics (DISCOBAY). By enabling real-time emissions and cost calculations, the UAC helps compare conventional and green delivery options, supporting Ghent's broader goals for sustainable urban logistics.
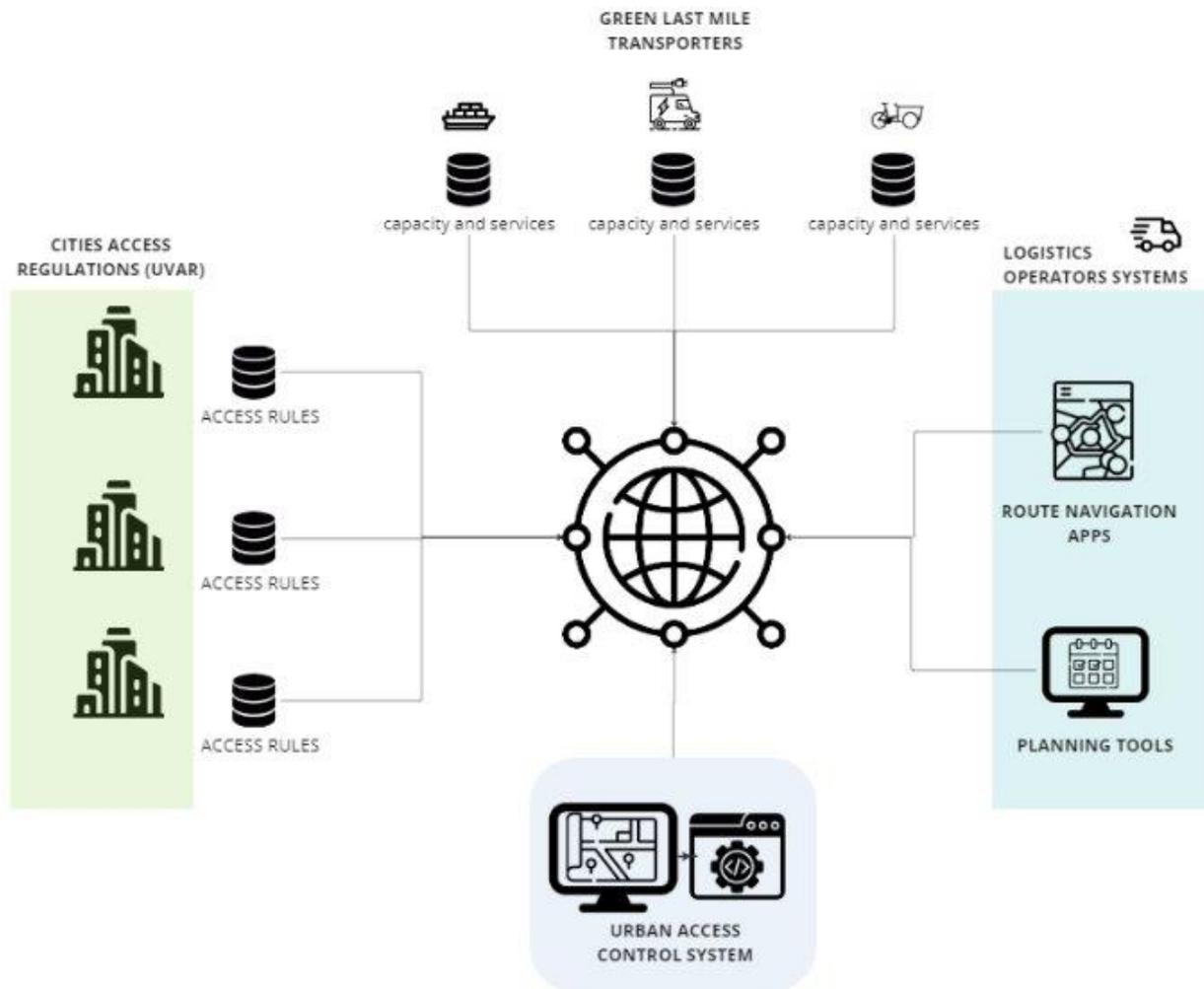

Figure 10: Data Space Architecture of Ghent DISCOPROXI and DISCOLLECTION measures.

Measure implementation

The implementation of the **Urban Access Control (UAC) system** in Ghent was carried out in three structured phases:

1. **Development of the Features and API**

After defining user stories and conducting stakeholder interviews, the required functionalities were mapped into a functional design. Based on this, Be-Mobile developed the technical architecture and began implementing the features. The access regulations of Ghent were integrated into Be-Mobile's **Location Manager tool** using data from the Ghent Open Data Portal.

A key component of the development was the creation of an API that allows seamless integration with third-party applications, such as **Transport Management Systems (TMS)**, provided they can process machine-readable data. To ensure usability, a **"report mail"** feature was also developed, enabling users to receive human-readable summaries of test cases via email.

The core functionalities of the UAC API include:

1. **Retrieving all access rules** for a specific area.
2. **Checking a planned delivery route** against access rules and flagging conflicts or warnings.
3. **Generating an optimized delivery route** based on a list of delivery points and departure time, ensuring compliance with access regulations.
4. **Suggesting Green Last Mile (GLM) partnerships**, if the user uploads a Bill of Lading (list of transported goods), by recommending bike couriers or zero-emission services where possible.

Be-Mobile developed a logistics navigation app with special features useful for the test phase of the Ghent Living Lab. After discussion with the city of Ghent, one specific feature of interest is the visualization of designated (un-)loading zones close to the drop off destination. When a driver nears their destination, the app will show nearby loading zones on the map, as well as in a list (sorted by distance). From experience, it was found that drivers often are not aware of such zones, even if they are just around the corner. This feature should help increase the use of these designated zones, thus reducing the nuisance caused by e.g. parking on the street.
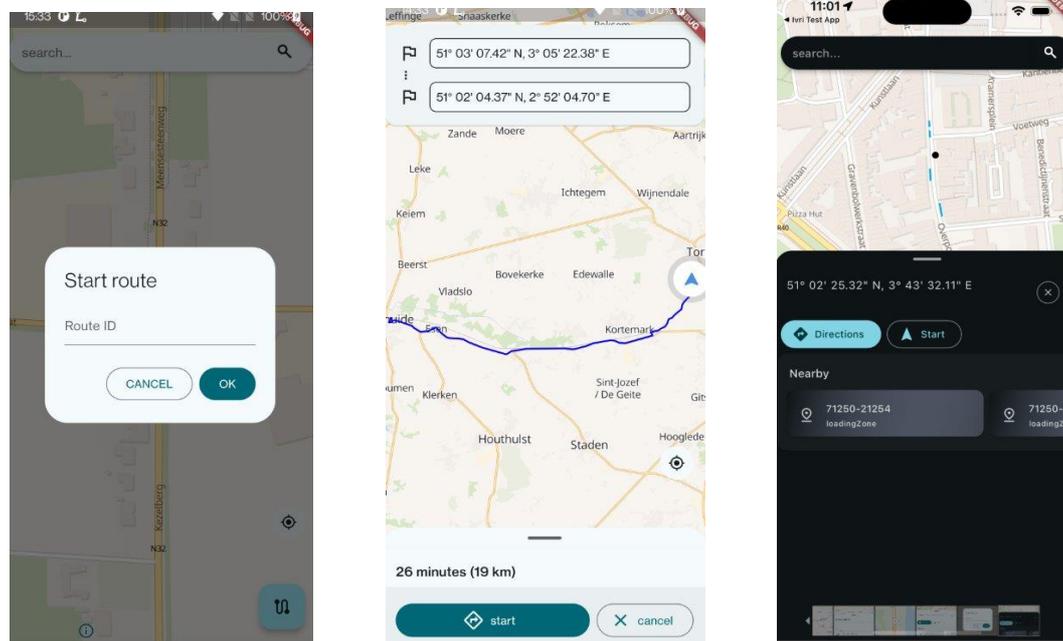
Figure 11: Be-Mobile logistics navigation app. Left: option to select a rout from the Ghent LL tests. Center: Pre-trip overview of the delivery route. Right: Nearby drop zones shown to the driver.

2. Integration with Test Partner Dropon

To validate the system, the UAC API was integrated into Dropon's Transport Management System (TMS). This required alignment of input and output formats to ensure smooth data exchange. Once integrated, the system could display relevant access regulations directly in Dropon's interface for logistics service providers (LSPs).

For live testing, Dropon recruited the logistics provider Bicobel, which was onboarded through a survey designed to establish baseline data for future KPI evaluations.

3. Live Testing Phase

Starting in December 2024, Bicobel conducted real-world test deliveries using the UAC API's route-checking functionality. All delivery data was logged for later KPI analysis, measuring the efficiency, compliance, and potential CO_2 reductions achieved through the system.

By providing logistics operators with automated access compliance checks, optimized routing, and sustainable last-mile delivery options, the UAC improves efficiency, reduces emissions, and enhances road safety in Ghent's urban logistics ecosystem.

Lessons learned

A full analysis of the quantitative results and impact will be presented in a separate deliverable (D4.3). However, initial findings already demonstrate that the Urban Access Control (UAC) system has a **significant effect on safety and stress-free planning**.

During tests in Ghent's inner city, the UAC flagged an average of 2 potential risks per kilometre and 17 per route (with an average route length of 10 km). These risks required specific adaptations:

- 10 school zones, where drivers need to exercise extra caution.
- 4 car-free zones, which may be inaccessible depending on the time of day.
- 3 low-emission zones, requiring vehicle compliance.
- 10% of planned routes included a school street that was closed at the scheduled transport time.

These results highlight the complexity of urban deliveries and the stress placed on drivers. By helping to optimize route planning, the UAC enhances safety, compliance, and efficiency in inner-city logistics.

During the testing phase the City of Ghent continued on **the digitisation of the school zones.** For the UAC, Be-Mobile did the definition of a school zone manually. This is not feasible for other tech developers and we wanted to make sure that this feature stayed in case of more safety around schools. The City of Ghent had tried in the past to make school zones safer and thought about restrictions for freight during school zones. This was not implemented because their own freight flows (eg. waste collection, road works, …) were not able to implement it in their daily operations. Also was enforcement of the restrictions not feasible. After discussion with Be-Mobile and internal Mobility department and Department of schools, the City of Ghent decided to collect the entries of the pupils of all the primary schools on their territory, so not only the inner city. Defining school zones in the City of Ghent, would mean to add practically all of the territory of Ghent to the map. There are 129 primary schools in the city. This isn't usable for logistics companies in their routing or navigation apps. From the view of the logistic planners, voiced by Be-Mobile, and the view of more safety in the city, it was logical to map the daily used entries of the pupils. The City of Ghent subcontracted Traject NV to make a new dataset of the school entries. By questionnaire to all the primary schools, Traject NV collected all the entries that the pupils daily us. The dataset has a 100% accuracy. This dataset is finished and is being prepared to be uploaded on the Open Data Portal of the City of Ghent. The Mobility Department of the City of Ghent will maintain this dataset and has ambitions to add also high schools and leisure places for children.

Route Navigation Functionality

Interest in the route navigation feature was limited. This was primarily due to its workflow incompatibility with Dropon's Transport Management System (TMS), meaning the data could not be seamlessly integrated. As a result, the living lab tested the beta version of Be-Mobile's route navigation app in a simulated environment instead of real-world conditions.

Green Last-Mile Logistics Integration

The feature comparing routes with Green Last-Mile (GLM) logistics providers also saw little adoption. Most logistics service providers (LSPs) were not inclined to outsource their last-mile deliveries, as this does not align with their core operations. Instead, the living lab conducted a retrospective comparison of routes, demonstrating how GLM services could improve efficiency. Interestingly, consolidated results from these comparisons helped increase the likelihood of companies considering future collaborations with GLM providers.

Integration with a Second LSP (Foodbag)

A second test partner, Foodbag, was onboarded due to its high volume of daily inner-city deliveries. However, latency issues in data transfer between systems made real-time demonstrations unfeasible. While this challenge is technically solvable, it could not be addressed within the budget, timeframe, and scope of the living lab. Future projects should allocate resources to ensure seamless data integration.

Key Takeaways

The most critical lesson learned is the need to create value for all actively involved stakeholders. However, value perception varies among stakeholders:

- **Cities** aim for safer, more sustainable, and less congested urban environments, reducing logistics traffic to a bare minimum.
- **LSPs** seek efficient, stress-free, and cost-effective operations while complying with regulations.
- **TMS providers**—rather than LSPs—are the primary direct stakeholders for system integration. Therefore, convincing TMS providers of the UAC's value to their LSP clients is essential.

This underscores the importance of testing results, as they serve as critical evidence for demonstrating the UAC's real-world benefits to both public and private stakeholders.

3.2.2.2. DISCO-BAY

DISCOBAY: This measure aims to integrate multimodal green last-mile logistics by combining waterway transport (barging) with cargo bike deliveries in the city of Ghent. By linking existing logistics services, the initiative seeks to demonstrate a Physical Internet (PI)-oriented model for sustainable urban freight. Cargo bike deliveries are operated by Cargo Velo, while the barging component explores alternative transport routes for goods entering the city. The measure supports the development of a more connected and environmentally friendly logistics network, reducing urban congestion and emissions while enhancing the efficiency of last-mile deliveries.

Measure definition

Ghent LL's measures were inspired by the city's vision note "Water in de Stad" (2018) and the pre-SULP "Plan Stedelijke Logistiek" (2023), both of which emphasized the potential of **urban waterways for freight transport**. These strategic documents highlighted the need for sustainable, efficient delivery models to reduce congestion and emissions in the city's core.

The living lab set out to test the feasibility of collaborative barge-to-bike logistics for small-scale deliveries. The experiment followed the methodology proposed by ERASMUS in WP2, focusing on operational viability, stakeholder collaboration, and long-term integration within Ghent's logistics ecosystem.

Although the network itself was not pre-existing, the combination of different services represented a significant step toward integrated urban logistics. The key takeaway was that barge-based last-mile solutions require strong coordination between logistics providers, city planners, and service operators. While technical and operational challenges emerged, the Ghent LL demonstrated that multimodal last-mile solutions could play a crucial role in reducing urban freight congestion and emissions.
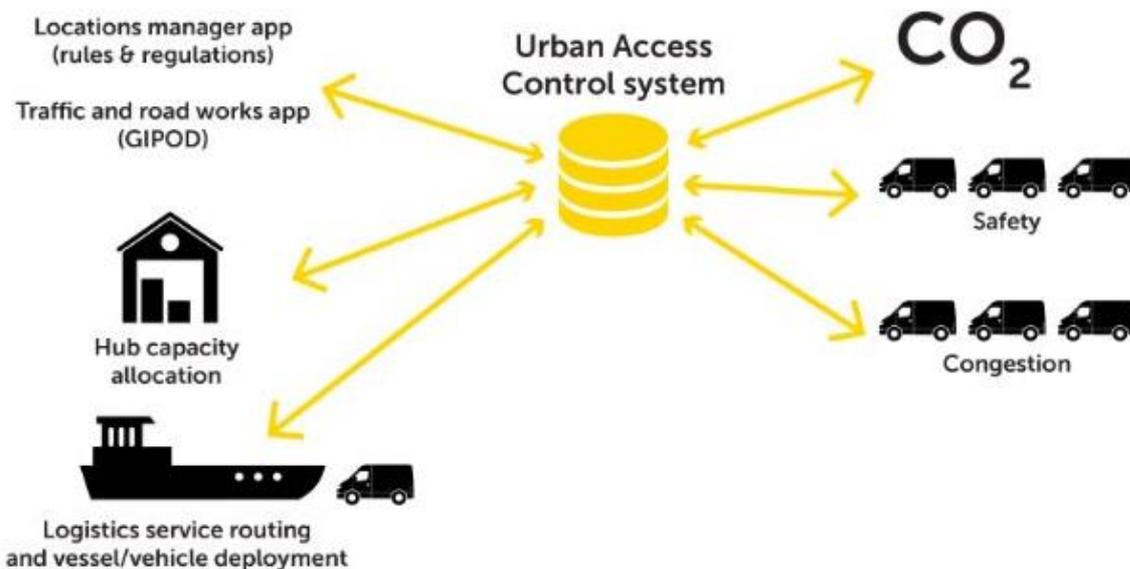
Figure 12: Schema of how DISCOBAY measure is integrated in the UAC tool.

Measure implementation

The DISCOBAY methodology was introduced to the Ghent Living Lab in month 6 of the project, but its practical implementation only began in month 12. The implementation process was led by partner OHB, in close collaboration with the City of Ghent and key stakeholders from the logistics service provider (LSP) ecosystem. The first step involved identifying suitable loading and unloading locations, ensuring seamless integration between waterway transport and cargo bike deliveries.
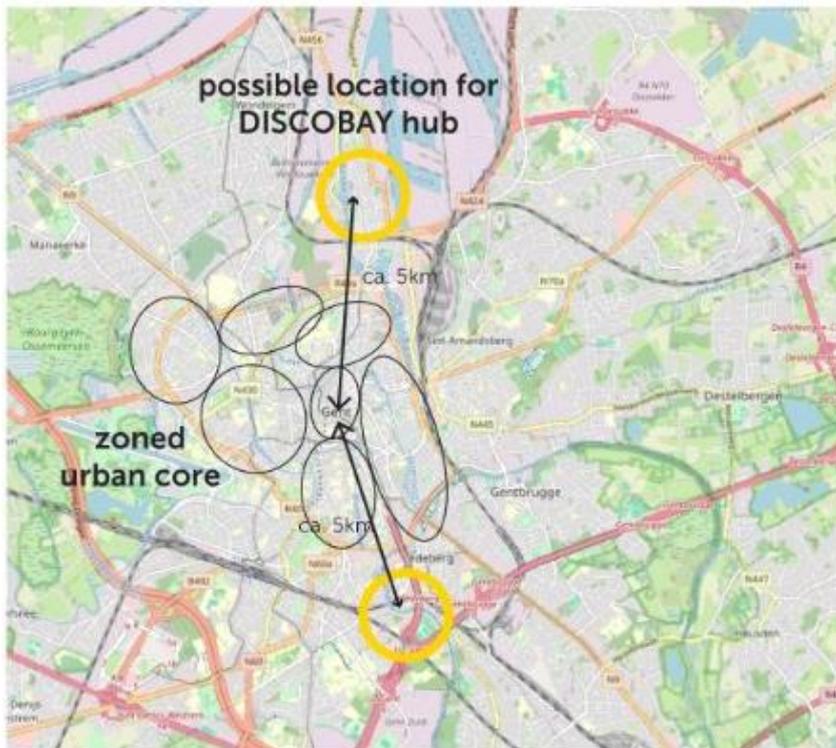
Figure 13: Possible location for DISCOBAY hub.

A crucial aspect of the implementation was building partnerships with local logistics providers willing to participate in the demonstration phase. OHB and the City of Ghent worked to map out the operational needs, assess potential challenges, and engage relevant service providers who could support the **barge-to-bike delivery model**. This required addressing practical considerations such as route optimization, timing, and cargo handling procedures to ensure the model's viability.

The culmination of the DISCOBAY implementation took place during the Open Day 2 demonstration on April 25, 2025. This event showcased the full multimodal delivery process in action. The demonstration featured a fresh food delivery that began with a cargo bike picking up goods directly from the producer. The cargobike was then transported via a barge into the inner city, and after arrival, completed the final-mile delivery to the end customer.

This demonstration served as a **real-world test** of the DISCOBAY concept, highlighting its potential to reduce urban congestion and emissions while enhancing efficiency in last-mile logistics.

Figure 14: Demonstration of DISCOBAY, 25th of April 2025.

3.2.2.3.   DISCOLLECTION

DISCOLLECTION: This measure aims to integrate the Ghent DISCOPROXI use case into the broader data space, enabling coordinated and efficient data sharing for urban logistics. By orchestrating the most critical data exchange operations, the initiative seeks to demonstrate how urban access and logistics information can be shared securely and effectively across stakeholders. The measure supports the development of a connected data ecosystem that enhances decision-making, optimizes logistics planning, and promotes a more collaborative and digitally enabled urban freight system.

Measure definition

After thoroughly analysing the Ghent DISCOPROXI use case, the following key activities were identified as essential for the successful transfer of the use case to the data space:

- **Connecting Key Stakeholders to the Data Space**: The first step involved ensuring that all relevant stakeholders, namely the City of Ghent and BE-MOBILE, were effectively connected to the data space. This required collaboration with these partners to define roles, responsibilities, and the data exchange processes.
- **Standardizing the Main Data Set Shared**: A crucial element of the transition was to standardize the Ghent urban access rules data. By ensuring that the data was uniform and

consistent, it could be shared more efficiently across platforms and applications, which is vital for the functionality of the system.

- **Orchestrating Critical Data Sharing**: One of the most critical data-sharing activities was to integrate the Ghent urban access rules into the BE-MOBILE application. This process required careful coordination to ensure that the access rules were accurately reflected in the system, enabling users to access real-time information about urban restrictions and routes.

The following visualization outlines the necessary setup changes to adapt the DISCOPROXI use case into the DISCOLLECTION framework. Initially, in the DISCOPROXI setup, BE-MOBILE made a direct API connection with the Ghent open data portal to retrieve and integrate the urban access rules. In the new DISCOLLECTION setup, however, the City of Ghent would now offer its standardized data directly to the data space. From there, BE-MOBILE could seamlessly access and consume the data within their application. This change marked a significant step toward centralizing data access, improving data management, and fostering more collaborative and efficient data sharing within the city's logistics ecosystem.
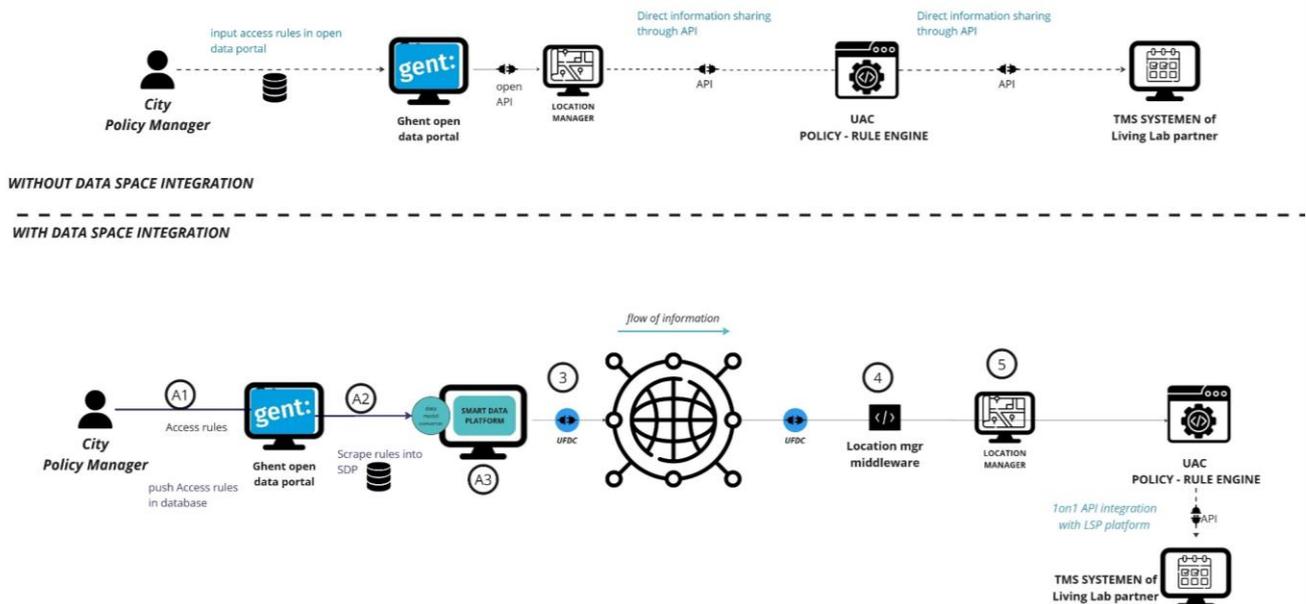
Figure 15: DISCOLLECTION use case in Ghent Living Lab.

Measure implementation

Setup of the Smart Data Platform (SDP)

To facilitate the integration and sharing of urban freight data, Imec deployed a Smart Data Platform (SDP), a tool developed within DISCOLLECTION, on a Kubernetes cluster and hosted it on their servers. The SDP was specifically designed to manage and integrate urban freight data. It included a built-in **Urban Freight Data Space (UFDS) connector**, enabling the platform to publish all data

within it to the broader UFDS, facilitating seamless data exchange between the stakeholders in the ecosystem.

Retrieving Data from Ghent Open Data Portal to the Smart Data Platform

Next, Imec connected their SDP to the Ghent Open Data Portal via its open API. The objective was to transfer the urban access rules from the Open Data Portal to the data space for integration. To automate this process, Imec developed and deployed a Python ingestion script within the SDP. This script automatically retrieved all the relevant datasets from the portal, ensuring that the data was regularly updated and made available for processing and sharing.

The datasets retrieved included essential urban access rule data for Ghent, such as:

- School streets in Ghent
- Locations of elementary and secondary schools in Ghent
- Low emission zones in Ghent
- Car-free zones in Ghent
- Loading and unloading locations in Ghent

Transformation and Standardization of Urban Access Rule Data

Once the data was retrieved from the Ghent Open Data Portal, the access rules were distributed across multiple datasets. To create a unified dataset, Imec utilized the ETL (Extract, Transform, Load) pipeline capabilities of the Smart Data Platform to consolidate all the relevant data into a single "Urban Access Rules" dataset.

A key part of this process involved identifying a **draft version of the Datex2 standard[10]** (draft 3.6) for use as the universal data standard for urban access rules. Although the Datex2 draft 3.6 was not yet an official version and was incomplete, it was the only viable alternative at the time for standardizing the urban access rules data.

Imec mapped the "Urban Access Rules" dataset to the Datex2 semantic model, ensuring consistency with the emerging standard. A transformation script was then written and deployed within the Smart Data Platform to convert the dataset into the new standard. This work is currently being documented in a Data Transformation Guide for Urban Access Rules, which will serve as a reference for others looking to adopt similar approaches.

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[10] https://datex2.eu/.

After transformation, the Data Space Connector UI within the platform was used to publish the standardized Urban Access Rules dataset to the data space, making it available for consumption by other stakeholders.

Connecting Be-Mobile to the Data Space
As part of the work in DISCOLLECTION, Imec also developed a Cookbook to guide cities and applications in installing and using the UFDS connector. This cookbook formed the basis for BE-MOBILE to deploy the UFDS connector within their Location Manager tool, which is integral to their logistics operations. Imec provided continuous support to BE-MOBILE throughout the deployment process, with regular feedback sessions to ensure smooth implementation.

BE-MOBILE used the UFDS connector UI to locate and consume the Ghent Urban Access Rules dataset. However, since the BE-MOBILE Location Manager was not yet designed to fully support the Datex2 standard, BE-MOBILE needed to develop an additional middleware solution. This middleware translated the standardized Urban Access Rules dataset into the format compatible with their existing system.

Eventually, BE-MOBILE successfully retrieved and consumed the Ghent Urban Access Rules data over the data space and integrated it into their DISCOPROXI use case. This integration enabled BE-MOBILE's Location Manager to leverage the most up-to-date urban access rules, improving the efficiency of their logistics operations in Ghent and contributing to the overall success of the DISCOLLECTION measure.

Lessons learned

Limitations of Data Maturity in Cities
One of the key challenges faced during the DISCOLLECTION measure implementation was the varying levels of data maturity across cities. Many cities do not have open data portals or even a data warehouse, and in many cases, the available data is not machine-readable. As a result, a significant portion of the project effort was spent on manual labour to structure and digitize existing datasets before any implementation could take place. This effort highlighted the gap in data readiness among cities, with only a few cities possessing a sufficiently mature data culture to support more advanced processes like data collection and analytics. This challenge underscores the need for cities to further develop their data infrastructures to fully leverage the potential of digital tools and data-driven decision-making.

Increased Awareness Needed of the Added Value for Cities
While some cities have made progress by offering open data portals, there is still a lack of awareness regarding the full potential of data spaces. Cities with open data portals often feel that they no longer need access to a broader data space because they already provide a gateway to share data. Moreover, many cities lack policies that require logistics companies to collect or share data, limiting the added value of a connection to the data space. As a result, cities are not yet capitalizing on the

opportunities offered by data spaces to manage data-sharing policies. Data spaces have the potential to facilitate the sharing of more sensitive data that would not typically be published as open data, but cities are not yet fully aware of how these systems can support this level of data governance and transparency.

Further Maturation Needed of DATEX2 Standards for Access Rules

The DATEX2 data model, used in the DISCOLLECTION measure, is still in the early stages of development, and the draft version 3.6 that was used included only partial standards for access rules. As it stands, this data model is not official and remains far from complete. The use of this draft version served more as a proof of concept rather than a fully standardized solution. This limitation emphasizes the need for further development of the DATEX2 standards to support access rules in a comprehensive and universal manner. To address this, collaboration with international organizations, such as NAPCORE[11], is being explored to help develop a more universal and scalable standard for urban access rules that can be applied across cities and regions.

3.2.3. Results

A full analysis of the quantitative results and impact will be presented in a separate deliverable (D4.3). However, this chapter will discuss some first insights and directly visible results of the demonstration of the different Disco-X products developed in the Ghent living lab.

DISCOPROXI

Initial findings already demonstrate that the **Urban Access Control (UAC) system** has a **significant effect on safety and stress-free planning**.

During tests in Ghent's inner city, the UAC flagged an average of 11 potential risks per route (with an average route length of 12.8 km after implementation of UAC, which was 15km before implementation). These risks required specific adaptations:

- 3.7 school zones, where drivers need to exercise extra caution.
- 4.5 car-free zones, which may be inaccessible depending on the time of day.
- 2.8 low-emission zones, requiring vehicle compliance.
- 10% of planned routes included a school street that was closed at the scheduled transport time.

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[11] https://napcore.eu/.

These results highlight the complexity of urban deliveries and the stress placed on drivers. By helping to optimize route planning, the UAC enhances safety, compliance, and efficiency in inner-city logistics.

The post-delivery optimisation is still in progress, but first results show that a significant part of Bicobel's routes could have been externalized to GLM providers, with a 100% savings in inner city CO_2-emissions without much additional operational cost. This could have an impact on the service level agreements, as an extra handling point (cross-docking of the goods at the city hub of the GLM) will create extra time in the delivery process. This could be taken in account in the future planning, if Bicobel decides to make use these GLM delivery alternatives.

DISCOBAY

The demonstration of DISCOBAY was performed successfully during the Open Day, held on the 25th of April 2025 in the inner city of Ghent. Although the setup was limited to the delivery of the catering of the event and the transport of several cargobikes (in cooperation with Urbike), it shows the potential of including the periphery of the city as a loading bay for multimodal purposes. However, a suitable business model is not yet proven by this demonstration: the most impact is still believed to be gained in the field of construction logistics. In the upcoming year, several big reconstruction projects will have delivery of materials and disposal of debris by using barging.

DISCOLLECTION

The DISCOLLECTION Living Lab consisted of two setups.
- **Proof of Concept:** The above-described setup where the data sharing use case between the city of Ghent and BEmobile was integrated in the Data space to demonstrate the technical setup required for sharing data across the data space and integrate it in a Living lab operations
- **Proof of Value:** An expansion of the Ghent Living Proof-of-Concept use case towards additional Flemish cities and software providers, which served to prove the value of data spaces in establishing a LaaS ecosystem. This setup will be described in the below chapter "What after DISCO".

Within these two setups, DISCOLLECTION was able to provide in the following results

Results	PoC	PoV expansion
Integration of stakeholders	- City of Ghent (via imec Smart Data Platform) - Software provider BEmobile	- City of Leuven (via BEmobile) - City of Hasselt (via BEmobile - Software provider GeoSparc
Connected data sets	- Ghent parking locations - Ghent circulation plan - Ghent low emissions zone - Ghent school zones	- Leuven Low emissions zone - Hasselt Low Emissions zone

1-on-1 connections saved by sharing information through the Data Space*	0	4

* The most significant impact of the DISCOLLECTION Living Lab was the demonstration that 1 Data space connection can significantly reduce the amount of 1-on-1 connections needed.
In the case of the Ghent PoC, there were only 2 stakeholders connected to the data space, with each stakeholders installing a data space connector. In the case of a bilateral connection, each stakeholder should also install 1 (API) connection.
However, once you scale up the ecosystems (as happened in the PoV) you notice a drastic reduction in the amount of connections needed. If both software providers would want to connect to each city, they would need to make 2x3 connections. Through the data space, only 2 connections were needed to achieve this.

3.2.4. Beyond DISCO

As the project reached its final stages, attention shifted toward ensuring the continuity and expansion of its most promising measures.

Efforts were made to scale up the **data-sharing infrastructure** initially developed within the project, with a focus on engaging additional Flemish cities and **logistics stakeholders**. The aim was to transform a pilot initiative into a broader, replicable model for urban logistics data collaboration.
This resulted in a new setup that enabled the integration of access rules from three more cities—**Mechelen**, **Leuven**, and **Hasselt**—into the existing data space. This expansion demonstrated the scalability of the model and its potential for wider application across the region.

A key enabler of this process was the role of intermediary data providers, such as BE-MOBILE, which facilitated the connection between cities and the shared data space. Cities could transmit their access rules either via API connections from local databases or through manual input using user-friendly tools. This flexibility allowed for streamlined integration regardless of each city's digital maturity.

The value of the expanded data space was further enhanced through collaboration with private actors like Geosparc[12], which connected its logistics booking tool to the system. This integration allowed for the exchange of real-time logistics activity data, offering cities deeper insights for planning and analysis.

Overall, the post-project developments were designed not only to include more cities but also to demonstrate the added value for logistics companies. By connecting through a single interface, logistics operators gained access to harmonized urban access rules and cross-city logistics insights, helping them optimize routes, reduce administrative burdens, and make more informed decisions.
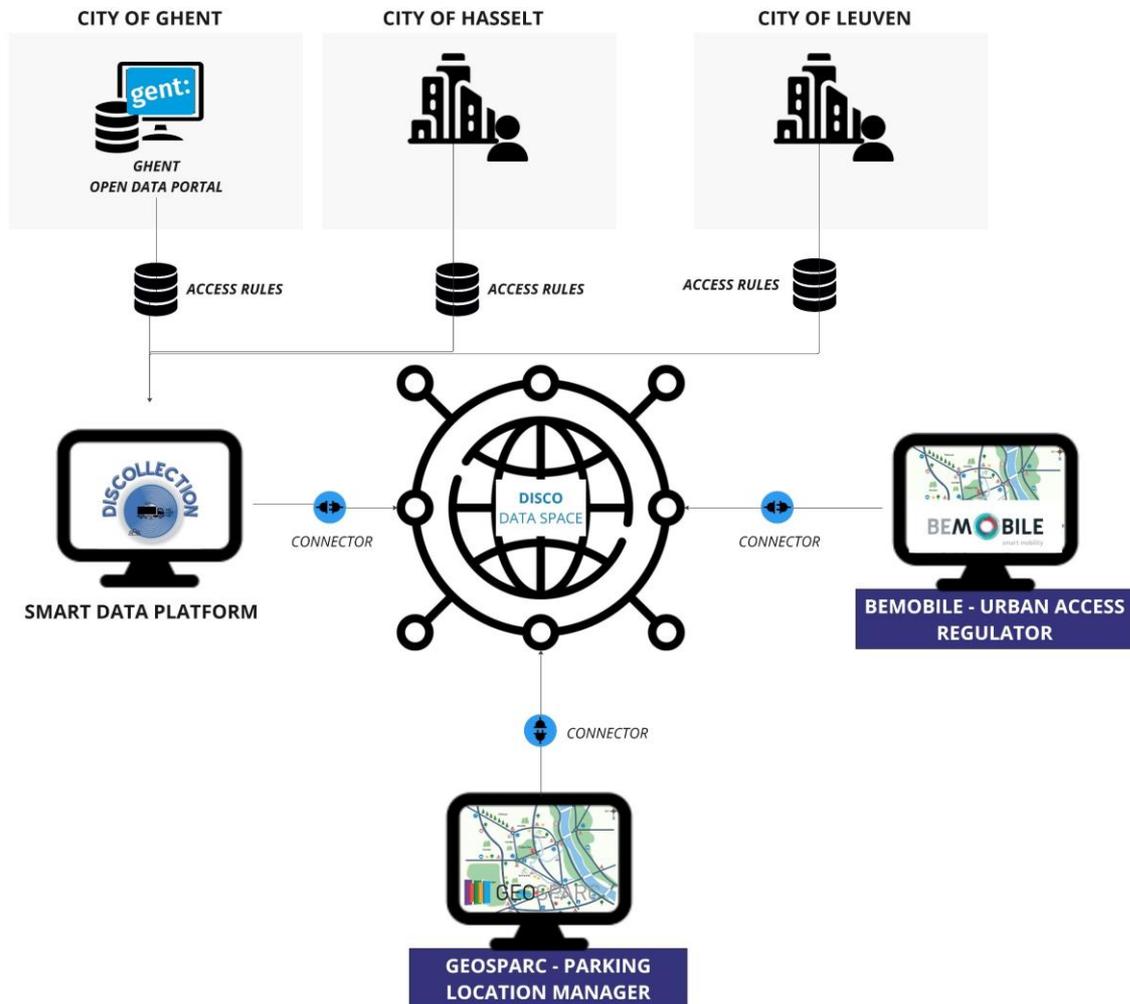
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[12] https://www.geosparc.com/en/about-geosparc.

Figure 16: Disco Data Space Ghent – development beyond DISCO project.

3.3. Helsinki

3.3.1.   Background and rationale of the intervention

General and logistics characteristics

Helsinki, located on Finland's southern coast, is one of the largest cities in Northern Europe, with a population of over 660,000 residents. The greater metropolitan area, including Vantaa and Espoo, has a total population of 1.55 million. The city is growing at a rate of 1% annually and is projected to reach 700,000 residents by 2028. Its population density stands at 3,042 people per square kilometre.

Helsinki's logistics landscape is shaped by heavy freight **traffic from its ports** and its peninsular geography, which limits land access. Most storage and terminal facilities are concentrated in the northern part of the city, where major logistics operators have warehouses and terminals.

The overview of Helsinki's logistics and transportation is illustrated in the image below, highlighting key logistics companies in the area.
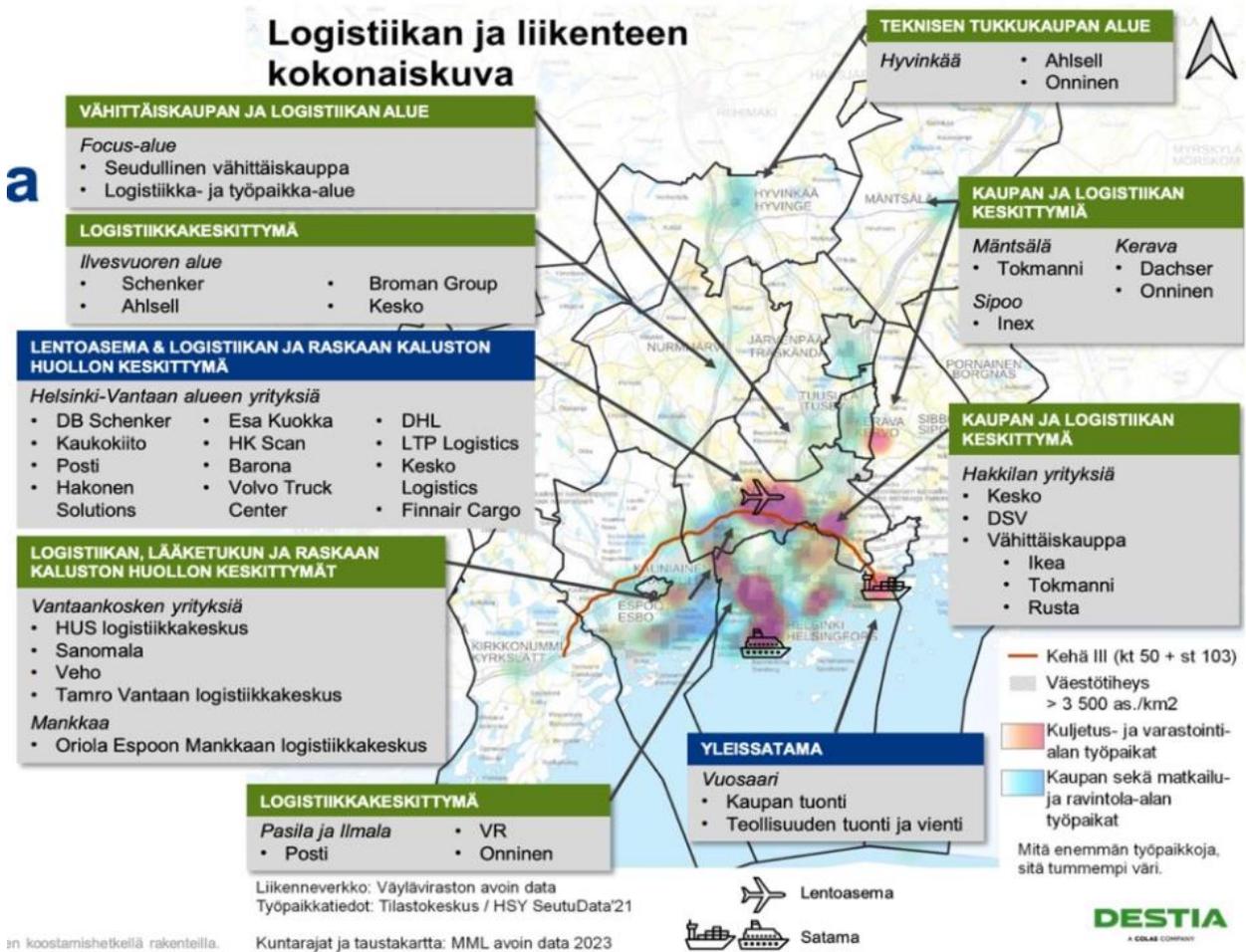
Figure 17: Main logistics and transportation nodes in Helsinki.

Moving to traffic flow and fleet changes, the two images below show heavy logistics traffic patterns and vehicle numbers:

- The left image estimates the daily number of heavy logistics vehicles and their primary routes across Helsinki.
- The right image focuses on the city centre, detailing key roads and vehicle flow.
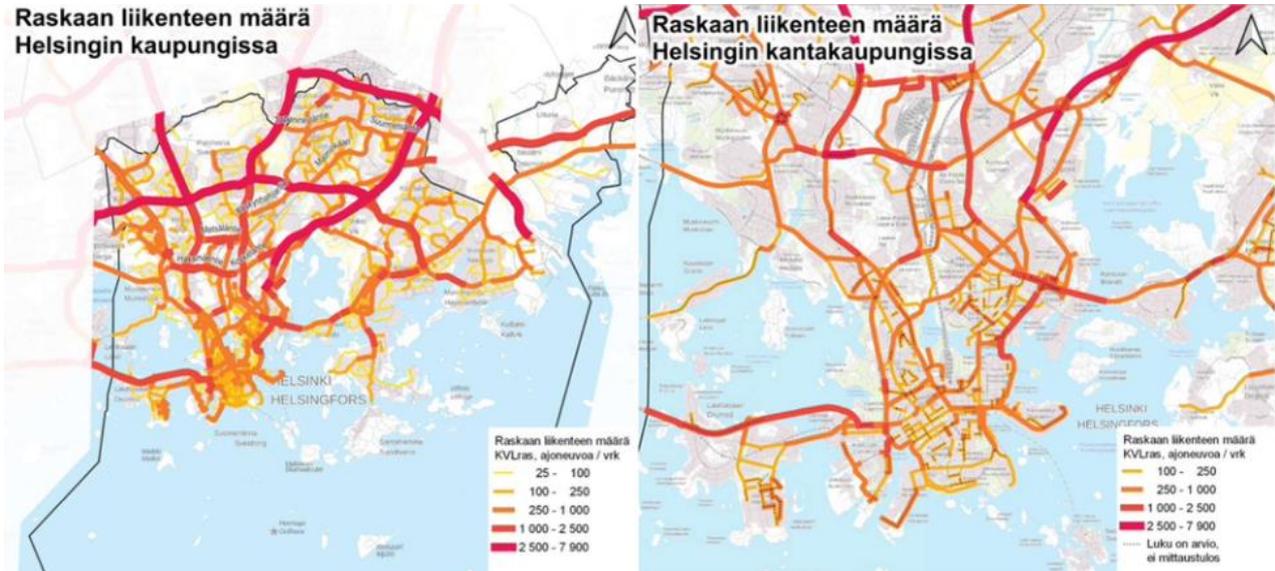
Figure 18: Traffic flow in Helsinki.

Between 2011 and 2022, the total number of logistics vehicles in the Helsinki region decreased, primarily due to the increased usage of vans. The accompanying graph illustrates these trends, showing changes in vehicle numbers (vans in red, cars in blue, trucks in green) relative to population growth (dashed line).
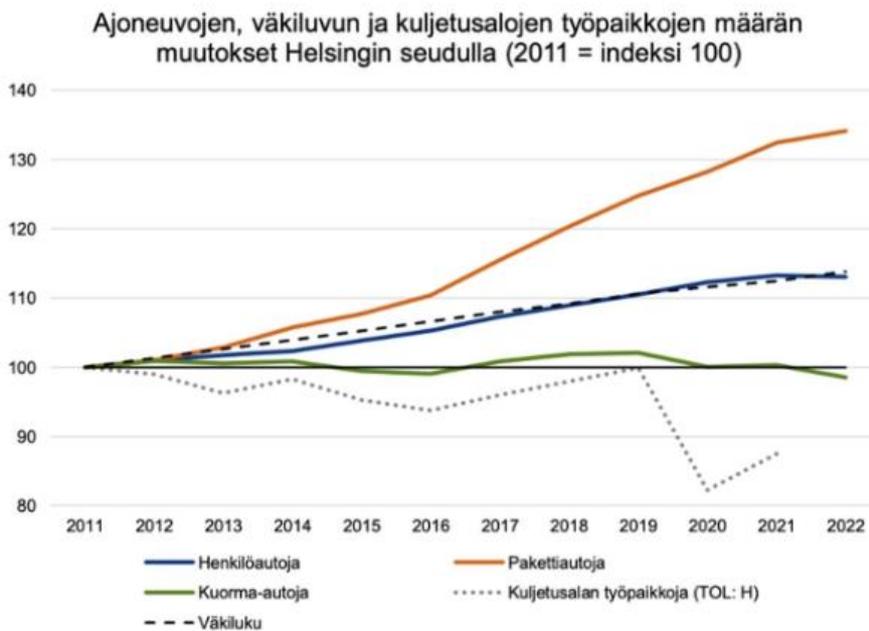
Figure 19: Logistics vehicles times series in Helsinki.

Relevant actions linked to logistics development in the City of Helsinki

The LL leader has identified a comprehensive set of policies and strategies relevant for the demonstrations, encompassing:

- **Helsinki Data Strategy:** This strategy serves as a guiding framework for the digitalization of the city, enabling effective data-driven solutions and smart city initiatives.
- **City Logistics Action Plan:** Updated in 2020, the Action plan is not structured as a Sustainable Urban Logistics Plan, but currently corresponds to the same themes as a SULP.
- **Carbon Neutral Helsinki - Action Plan**: This plan defines specific tasks and action points, driving the city towards its goal of becoming carbon neutral by 2030.
- **Monitoring of the Carbon Neutral Helsinki Action Plan**: Regular monitoring of the city's climate objectives is conducted to track progress and identify areas of improvement.
- **Sustainable Development Goals (SDGs) Alignment**: The city has aligned its strategies with the United Nations' SDGs, prioritizing key areas such as clean energy, sustainable transportation, waste management, and social equity.
- **Helsinki City Strategy**, as described in the Helsinki City Strategy for 2021–2025 that indicates the city's priority for this Council term and for the next decade.

The strategies guide the City of Helsinki towards sustainable future and sustainable mobility and logistics.

Challenges addressed by the LL

The Helsinki Living Lab tackled a set of complex and interrelated challenges rooted in the tension between growing urban freight demand and the city's **sustainability**, **liveability**, and **spatial planning** goals. One of the primary issues addressed was the persistent environmental impact of urban logistics. Despite advances in decarbonizing public transport and private mobility, freight operations in Helsinki remain a major source of emissions, due largely to the prevalence of diesel-powered delivery vehicles and the rise in frequent, small-volume deliveries driven by e-commerce. This intensification of freight activity in dense urban areas has created a significant obstacle to achieving the city's climate neutrality objectives.

At the same time, the city faced critical spatial inefficiencies. Delivery vehicles often operate in areas where infrastructure is not designed to accommodate them, resulting in congestion, double parking, and the unsafe occupation of space meant for pedestrians and cyclists. Curbside space is limited and poorly managed, leading to conflicts between delivery operations and other street users. The lack of real-time data and coordinated planning makes it difficult for city authorities to manage urban space dynamically and fairly, while ensuring that freight operations remain efficient and minimally disruptive.

These problems are compounded by the **fragmentation** of the logistics ecosystem. Logistics actors often work independently, relying on siloed infrastructure and services, with little incentive to collaborate or share resources. This fragmentation limits the potential for more sustainable and space-efficient solutions such as shared microhubs, multimodal distribution points, or real-time curb management systems. Furthermore, the logistics sector's limited integration into urban planning processes creates a disconnect between operational practices and broader city strategies for sustainable development, land use, and mobility.

Within this context, the Helsinki Living Lab sought to experiment with and implement new solutions that respond to these challenges, not only by testing innovations in logistics and digital tools but by rethinking how freight can be better aligned with the evolving needs of the city and its residents.

Actors involved in LL implementation

- **Forum Virium Helsinki (FVH):** Living Lab lead
- **A2B**: Partner
- **Rolan**: Partner
- **DB Schenker**: Stakeholder partner
- **HSL**: Stakeholder partner
- **Urban Environment Division:** Stakeholder
- **URBANE project:** Collaboration partner
- **Business Helsinki:** Collaboration partner
- **DHL Express**: Logistics service provider
- **LMAD**: Logistics service provider
- **Pakettipiste**: Logistics service provider
- **Ramboll Finland:** Digital service provider and service design provider
- **Technolution AB**: Digital service provider
- **Flow Analytics**: Digital service provider
- **Vianova:** Digital service provider
- **XYZT:** Digital service provider

3.3.2.   Implementation outline

3.3.2.1.   DISCO-CURB

DISCOCURB: This measure aims to improve the freight efficiency of urban street space in Helsinki by enabling better management of underutilized curbside areas for delivery operations. By digitizing loading and unloading zones and producing real-time usage data, the initiative seeks to support logistics drivers in planning their daily routes more effectively and to provide valuable data for the City planners to get better understanding of the current usage of the zones. The measure also explores the impact of low-emission zones on emissions originating from logistics operations and provides urban planners with new tools to optimize the design and allocation of curbside space.

Overall, DISCOCURB supports a smarter, more sustainable approach to urban freight and space management.

Measure definition

Helsinki LL's measures stemmed from the City's **Action Plan for City Logistics**, which identified a lack of strategic development and data on loading zones. Until now, zone planning has relied on logistics operator surveys, providing no objective insights into actual usage. The City lacked tools to assess whether loading zones were used properly or to support data-driven decisions on where to place new ones, and deliver sustainable, freight-efficient land use plans.

Additionally, Helsinki was exploring a **low-emission zone (LEZ)**. Helsinki LL initially planned to simulate its impact on logistics emissions on more practical level. However, due to political decisions which halted LEZ planning, the LL plans were modified towards a data-driven simulation work and the provision of CO2 reduction estimates of logistics LEZ to the City for future comparing and planning. Since the political decision halted LEZ planning, resources were shifted to other emission-reduction strategies like expanding charging infrastructure.

From the project's start, Helsinki LL aimed to develop a **real-time monitoring solutions** for loading zones. This need was jointly identified with the City's logistics coordinators. Initially, fixed monitoring installations were considered, but discussions with stakeholders revealed that a **battery-powered, movable system** was more practical due to limited electricity near loading zones. A City-led electricity mapping effort confirmed this constraint.

After consultations with service providers, a **flexible, battery-based monitoring system** was chosen. This solution allows the City to collect data from multiple loading zones over time by relocating the equipment as needed. The data helps planners assess whether zones are used as expected, underutilized, or misused (e.g., resident parking), supporting data-driven decision-making.

When presented to Tietorahti, a local logistics map service, an idea emerged to visualize real-time loading zone occupancy for drivers. Tietorahti, used by nearly 20,000 drivers daily, could integrate this data, potentially reducing unnecessary driving in congested areas.

However, monitoring existing zones did not solve the challenge of planning new ones. To address this, Helsinki LL explored **Floating Car Data (FCD)** to analyse commercial vehicle stopping patterns. This approach helps pinpoint streets with high stopping activity but no designated loading zones, supporting data-driven site selection for new zones.

Through collaboration with the City's Urban Environment Division, Helsinki LL demonstrated a dual approach: optimizing existing loading zones while implementing a tool for planning new ones.

Measure implementation

After planning and ideation, the DISCOCURB un/loading zone measures began in autumn 2024. The first step was defining objectives and initiating market dialogue with service providers.

FCD-data based planning tool measure

For the FCD tool implementation, three companies were invited to tender. After reviewing two bids, Vianova was selected to provide light commercial vehicles' (LCV) stopping data and demonstrate their planning tool. However, after selection, Vianova reported their dataset was unavailable. Helsinki LL then turned to Urban Radar, the second-choice provider.

After weeks of preparation, Urban Radar withdrew, unable to deliver the promised data. At the same time, Vianova informed Helsinki LL that they had secured a small but relevant LCV data sample. Given the challenges in sourcing data, the tendering process took longer than expected.

Ultimately, Helsinki LL and Vianova completed the FCD-based measure. Though planning began in October 2024, delays meant implementation started in March 2025. Vianova analysed Helsinki's loading zone infrastructure, using FCD stopping data, demographic insights, and infrastructure data from FVH. The tool allowed city planners to identify high-demand areas lacking loading zones, supporting data-driven planning. The measure was

Figure 20: Loading zone planning tool Helsinki.

completed by April 2025 with multiple variations of new loading zone suggestions based on different variables, such as LCV activity, safety, environmental effect, and business activity.

The new loading zone site recommendations formulated during the measure support the City of Helsinki in its ongoing efforts to implement a new loading zone development program in the city.

Loading zone monitoring measure

From the start, the project planned to monitor loading zones. Instead of fixed equipment, the City of Helsinki's Urban Environment Division opted for **battery-based, movable monitoring devices** due to electricity source constraints.

Planning began in September 2024, and market dialogue started in October 2024 to assess available solutions and product development plans. An invitation to tender was sent to 14 companies, with 9 responses. Three companies were selected: Ramboll Finland, Technolution AB, and Flow Analytics, each offering different technologies:

- **Ramboll**: Easy-to-install camera-based solution analyzing occupancy, vehicle count, and types in real time.
- **Technolution**: Movable camera-based solution with similar features and telescopic installation pole.
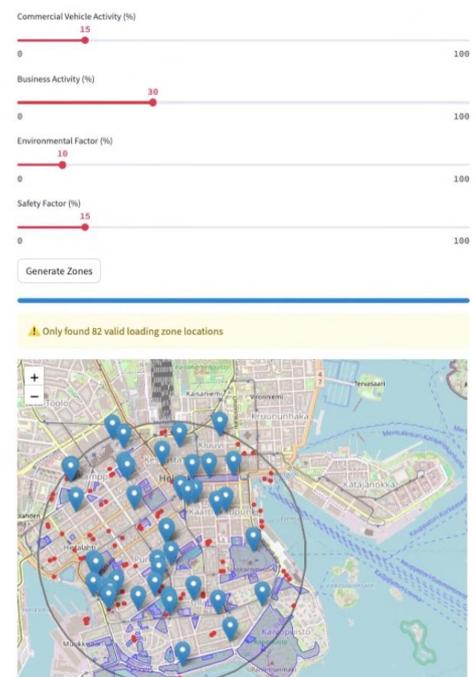- **Flow Analytics**: Movable LiDAR-based system with readiness for near-miss detection.

Implementation was delayed to January 2025 to align with the City's un/loading zone development research, allowing Helsinki LL to provide data and monitoring tools for strategic planning. Installations began in March 2025, for monitoring seven loading zones over a five-week period.

By integrating the measure with the City's strategic activities, planners and logistics coordinators gained firsthand experience with **battery-powered monitoring solutions**. City planners accessed all three data platforms, monitored activity via dashboards, and received final data after implementation.

Figure 21: Ramboll's easy-to-install camera-based monitoring system.

Real-time data was visualized in the Tietorahti map service, allowing users to monitor loading zone occupancy via the Tietorahti app for route planning. A web survey collected driver feedback.

The measure concluded in **April 2025**, with data and key findings handed to the **Urban Environment Division** for future **loading zone development**. The collected data consisted of vehicle counts, occupancy rates, vehicle types, and even counts of pedestrians and cyclists passing by the loading zones. One of the major takeaways identified from the collected data was the fact that many of the monitored loading zones suffered from private car parking, hindering the effectiveness of the un/loading operations. This information was particularly useful for the city planners, and actions targeting reducing illegal resident parking at loading zones are being planned.

In addition, the data collected from loading zones was included to the Helsinki Mobility Data Catalog, which supports the ongoing efforts to build a Digital Twin for Mobility in Helsinki.
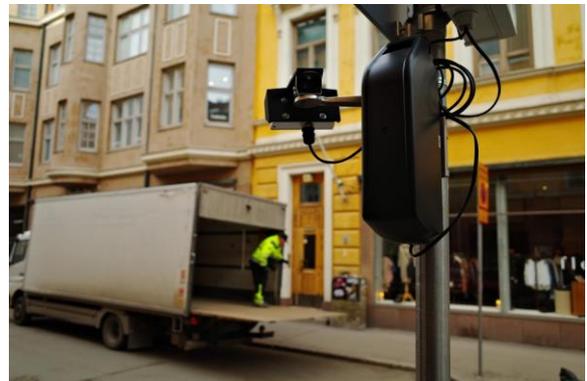

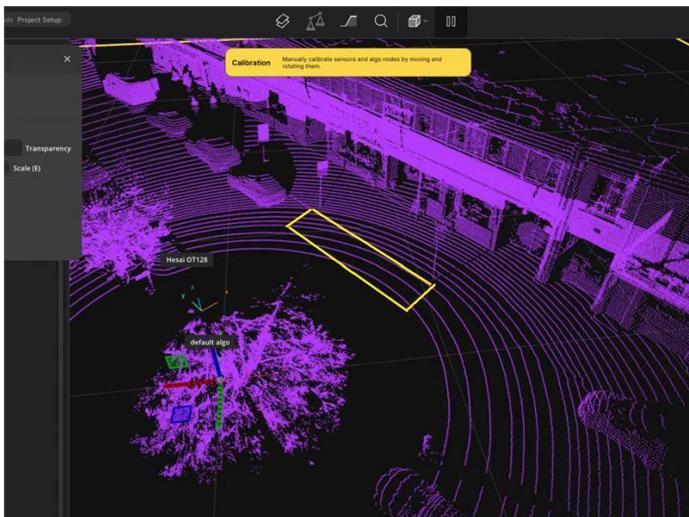*Figure 22: Technolution's movable, battery-based monitoring system.*

Figure 24: Flow Analytics' point cloud from one of the monitored loading zones. The yellow section highlights the area reserved for loading activites.
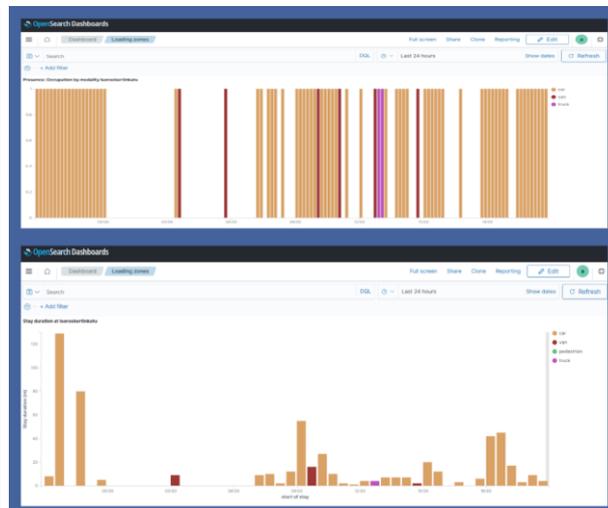

Figure 23: Technolution's dashboard visualising the collected data.

Low emission zone simulation work

Despite a political decision to halt LEZ planning in Helsinki, the Helsinki LL proceeded with a simulation to assess potential logistics sector CO_2 reductions.

Planning began in December 2024, and implementation ran from January to April 2025. The analysis used XYZT's platform and a Bridgestone LCV origin-destination dataset to simulate LEZ impacts on logistics emissions. In addition, FVH conducted a survey for local LSPs and was able to collect a data sample consisting of over 1,500 individual vehicles. In total, with the acquired FCD dataset and the survey-based data, the simulation included about 15,000 individual trips.

The simulation included calculated estimation of the share of EVs vs. gas/diesel LCVs that would be affected and calculated to the CO2 reduction potential assuming LSPs replaced restricted vehicles with EVs.

Findings were shared with the Urban Environment Division and HSL to inform future policies, including the upcoming national Land Use and Building Act. The general findings of the simulation work are presented in the figure below.

Originally, FVH did not have a dedicated budget to implement the LEZ-simulation, but due to the unspent DISCOPROXI budget, FVH was able to fund the acquisition of relevant FCD origin-destination dataset and the XYZT analysing tool from the unused DISCOPROXI budget, ensuring maximum impact without increasing costs.
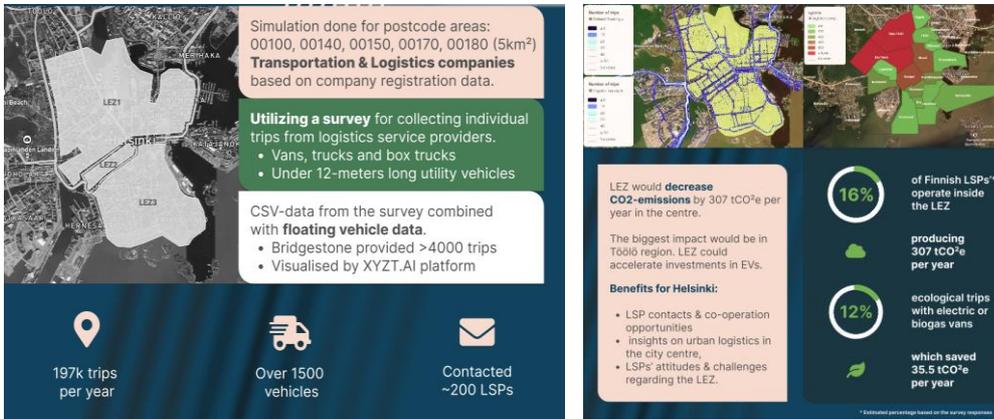
Figure 25: Helsinki LL LEZ-simulation outcomes.

Lessons learned

Several factors caused continuous rescheduling of the activities, but the challenging arising were dealt with adopting a flexible approach.

First, the FCD-based planning tool was identified as a crucial need for freight-efficient land use planning only after DISCOCURB activities started in Helsinki. This additional measure was funded by unspent DISCOPROXI budget, ensuring maximum impact without increasing costs.

Second, timeline changes were necessary. The FCD-based measure faced delays due to service provider issues, requiring two replacements and causing a two-month delay. Similarly, the un/loading zone monitoring was postponed from December 2024 to March 2025 to align with the City's development program, allowing full utilization of Helsinki LL's data.

Key lessons included the importance of ongoing stakeholder engagement, which led to the addition of the FCD tool and better alignment with City needs. Market dialogue with service providers also proved valuable before tendering, and particularly necessary for tackling implementation obstacles, and preventing delays.

Flexibility in timelines was critical. While delays in the FCD-based tool were a challenge, postponing the un/loading monitoring ensured better results by aligning with city resources.

Finally, on a more technical level, battery-based monitoring solutions proved effective for temporary data collection in street spaces, despite shorter monitoring periods compared to fixed installations. DISCOCURB significantly improved Helsinki LL's understanding of these solutions.

As for the Tietorahti map integration, the measure proved that real-time data from loading zones can be easily integrated into services like Tietorahti, and the real-time information provided is applauded by the slight majority of professional drivers. The Helsinki LL conducted a survey via Tietorahti to the professional LSP drivers, which provided valuable feedback on the service; about 60% of the respondents found the real-time occupancy visualization useful during their daily operations making delivery operations smoother, while 40% found the service somewhat unnecessary, since the route planning takes place even days before the actual delivery.
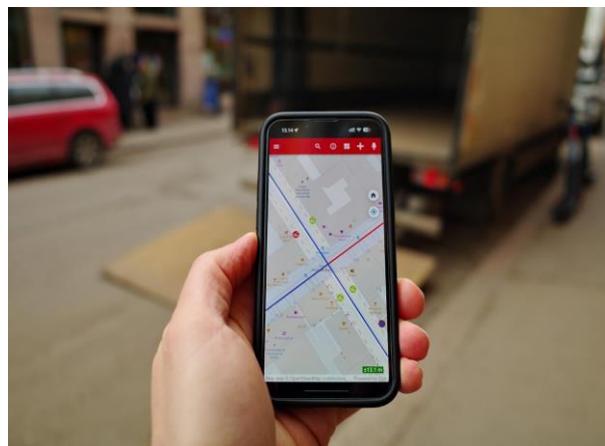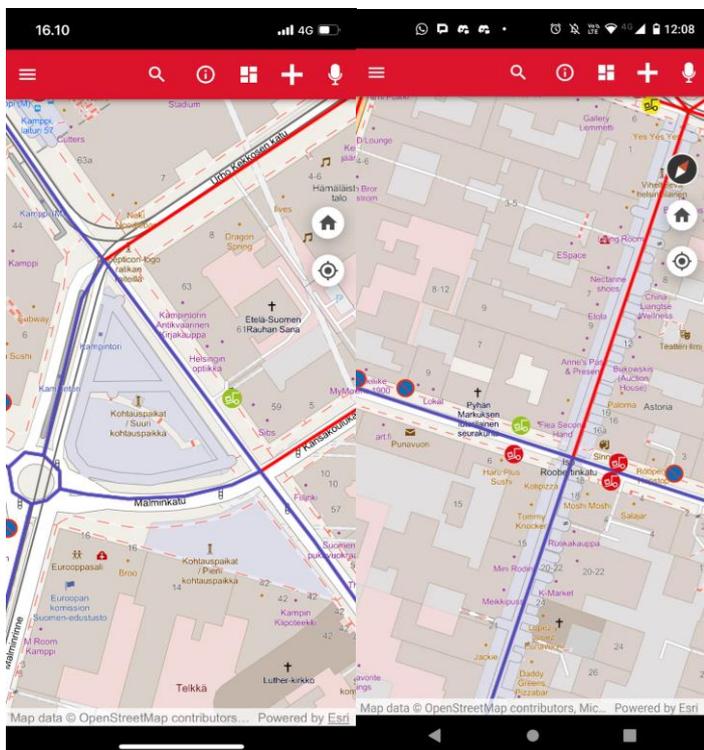
Figure 26: Real-time occupancy data visualized in the Tietorahti Map Service, utilized by 20,000 professional drivers.

3.3.2.2. DISCO-PROXI

DISCOPROXI: This measure aims to support the City of Helsinki's Action Plan for City Logistics by developing and demonstrating a multifunctional, multi-actor microhub in an urban environment. The initiative seeks to enable more sustainable delivery methods, such as cargo bikes and delivery robots, while promoting consolidation among logistics operators. By testing the Physical Internet concept through the integration of physical nodes, the measure contributes to more efficient and connected urban logistics. Additionally, it supports the development of viable business and operational models for microhubs, advancing long-term solutions for sustainable last-mile delivery.

Measure definition

Initially, the Helsinki LL envisioned demonstrating 2-3 small, container-based microhubs in the downtown area as physical nodes to connect delivery flows.
A participatory approach was used to include stakeholders such as local logistics service providers (LSPs), city departments, universities, traffic admins, and retailers in planning. The LL organized two workshops, meetings, and one-on-one discussions with LSPs to gather feedback. Additionally, a resident workshop and two surveys were conducted for direct input from local residents, while also participating in the Hyvän Tuulen Fest event.

The Helsinki LL worked closely with the URBANE project[13] (Grant number: 101069782), which focused on last-mile delivery robots and consolidation. Together, they engaged in discussions with city officials, private landowners, and other stakeholders to find suitable locations for microhubs. However, it was discovered that **Helsinki's permit process** posed challenges, as it did not support multiple container-based microhubs in public areas. This was surprising given the city's history of facilitating testbed activities.

After reviewing possible locations and permit limitations, it became clear that a demonstration with multiple container-based microhubs was not feasible due to Helsinki's strict policy on street space utilization. As a result, the decision was made, in collaboration with the URBANE project, to establish a single, larger **multi-actor microhub** at the Ruoholahti shopping center.

After extensive planning and discussions, the Ruoholahti district microhub was opened, involving partners such as A2B, Rolan, DB Schenker, and LMAD from the URBANE project, with DHL Express also participating.

Additionally, the A2B partner developed a mobile microhub concept, connecting EV fleets and cargo bikes to create a dynamic delivery model, further enhancing the flexibility of the Helsinki LL measures.

Measure implementation

<u>Multifunctional and multi-actor microhub measure</u>

The planning for the DISCOPROXI measures began in May 2023, continuing through autumn 2023 and early 2024 with participatory workshops, stakeholder discussions, and consultations with the City on location and permits.

From November 2023 to January 2024, in collaboration with the Urbane project, the Helsinki LL conducted a small, container-based microhub pilot in the Wurth Center parking lot. This pilot allowed LSPs to store and distribute parcels in the Jätkäsaari district, providing insights into potential challenges before the larger microhub demonstration.

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[13] https://www.urbane-horizoneurope.eu/.

The setup phase occurred from February to May 2024, involving space rental, LSP equipment

Figure 27: The Helsinki Multi-actor Microhub in Ruolahti Shopping Center.

mapping, layout planning, furniture procurement, and opening preparations. The microhub became fully operational in May 2024 and ran until early October 2024. It hosted five companies—A2B, DHL Express, Rolan, DB Schenker, and LMAD—serving as a base for **cargo bikes and delivery robots**. It also featured a DHL customer service point and amenities like a locker room and social space for employees. LMAD's platform served as a smart pick-up locker for residents.

From July to August 2024, A2B and DB Schenker piloted parcel consolidation, with parcels brought to the microhub, consolidated, and then delivered by A2B's cargo bike fleet.

The Helsinki LL hosted multiple delegations at the microhub and produced a marketing video in June 2024. The demonstration was also presented at several events, with further dissemination planned for 2025 at least two congresses.

After the demonstration ended in October 2024, DHL Express continued using the microhub space until January 2025. During the demo, over 1,500 deliveries were made via cargo bikes, EVs, and delivery robots. A Telraam sensor was installed to track pedestrian, cycle, and vehicle traffic in front of the microhub.

For the DISCOPROXI activities, the Helsinki LL commissioned Ramboll Finland to conduct service design work to support the demonstration. This work, starting in April 2024 and continuing until December 2024, included workshops and stakeholder interviews. It produced a concept paper in January 2025 with business and operational model suggestions, shared with the Urban Environment Division and HSL, serving as a foundation for future microhub activities in Helsinki.

Following the demonstration, the Helsinki LL continued to work on enabling future microhub projects in the city. A report detailing challenges and recommended actions for future microhub development, and other actions considering challenges in utilizing underutilized public space, will be completed by August 2025.

Mobile Micro Hub concept measure

The Helsinki LL partner A2B developed and implemented a mobile microhub concept.
Planning occurred from April to early June 2024, while the implementation ran in parallel with the multifunctional and multi-actor microhub demonstration from June to September 2024.

The concept involved A2B's EV van fleet working dynamically with the A2B cargo bike fleet. The EV fleet served as a "mobile microhub" for the cargo bikes.

During implementation, A2B used its traffic flow and parcel distribution systems to calculate efficient meeting points for the EV van and cargo bike drivers. Parcels were then transferred from the EV van to the cargo bikes, which completed the deliveries. This method allowed the EV vans to act as a base for cargo bike deliveries, improving efficiency by reducing the distance the cargo bikes had to travel from the terminal or microhub to the final delivery areas.

Figure 28: Inside the Helsinki Multi-actor Microhub.

Lessons learned

Key learnings from DISCOPROXI measures are related to microhub location planning, operation models, and the City's permit process.

Regarding **microhub location planning**, the Helsinki LL used a bottom-up approach with participating companies. However, different views on suitable locations due to varied parcel flows led to difficulties in finding a location that served everyone. For future development, it would be more efficient to identify locations based on factors like traffic, infrastructure, and the City's preferences, followed by an open call for companies with similar interests and parcel flows.

On the operation model, it became clear that a single operator is essential for smooth operations. Initially, Rolan was planned to be the operator, but due to financial difficulties, they filed for bankruptcy in early 2025. FVH took on the operator role during implementation. Service design work also identified company-specific microhubs as a potential alternative where an LSP manages operations independently.

The mobility services planned for the microhub were also impacted by Rolan's issues. E-scooter services and charging infrastructure were planned but never implemented due to Rolan's increasing difficulties during the implementation phase, and eventual bankruptcy, and the lack of time to find an alternative solution.

Regarding the City's permit process, the strict policy restricted temporary structures to underutilized areas, preventing the implementation of agile, container-based microhubs. To resolve

this, the Helsinki LL placed the microhub in a shopping center. FVH has since suggested changes to the permit process to ease future microhub development. Work on this continues in 2025.

From citizen surveys, Helsinki residents showed strong support for microhubs and environmentally friendly delivery methods, though they valued flexibility and on-time deliveries more than eco-friendliness. Thus, for success, environmentally friendly solutions must be both flexible and accurate.

Although the Grant Agreement called for 2-4 microhubs, only one was implemented due to permit issues. To compensate, the hub was larger and included more companies than originally planned. Budget adjustments supported the DISCOCURB activities, which were scaled up in Helsinki.
Lastly, the plan to acquire smart locker systems and charging stations were declined as the shopping center already had a locker system and fixed electricity. The LMAD delivery robot platform incorporated a mobile smart locker system, offering an innovative solution for parcel pick-ups.

3.3.2.3. DISCOLLECTION

DISCOLLECTION: This measure aims to demonstrate the potential of the Urban Freight Dataspace by integrating real-time curbside monitoring data from the DISCOCURB initiative in Helsinki. By connecting data on loading zone usage and street space management to the dataspace, the initiative showcases how urban freight data can support smarter planning and decision-making. The measure strengthens the link between digital infrastructure and physical logistics operations, promoting more efficient, data-driven approaches to managing urban freight flows.

Measure definition

In Helsinki, the DISCOLLECTION measures were closely linked to the DISCOCURB measures outlined above.
The core of DISCOLLECTION in Helsinki involved connecting real-time data from DISCOCURB monitoring implementations to the **Urban Freight Dataspace** to showcase the data space's capabilities.
The measure was planned in close collaboration with IMEC and WP3, with data from DISCOCURB selected in cooperation with WP3.
The original plan was to link the real-time data from DISCOCURB's un/loading zone monitoring to the data space during the implementation of DISCUCURB in Helsinki LL. However, due to schedule and resourcing challenges in WP3, only the collected data dumps from the loading zone measure were linked to the dataspace.

Additionally, the collected DISCOCURB datasets were incorporated into the Helsinki Mobility Data Catalog, which serves as a base for the development of the Helsinki Digital Twin for Mobility. The datasets included were the first urban logistics related datasets that have been added to the local Mobility Data Catalog.

Measure implementation

The DISCOCURB un/loading zone monitoring demonstration took place from March to April 2025. The original plan was to connect the real-time data to the dataspace during the demonstration's implementation phase, but due to schedule and resource restrictions in WP3, the real-time data connection did not take place during the implementation phase of DISCOCURB. However, the datasets collected during the loading zone measure implementation were included into the dataspace afterwards, as part of the Helsinki LL DISCOLLECTION implementation.
Additionally, several open data sets, including Helsinki parking data, were connected to the data space, primarily in October 2024. Furthermore, the connection of the Vianova platform to the dataspace is being considered during May 2025. This action depends on the availability of resources in WP3 and other implementations which are taking place in WP3 during May 2025.

After the DISCOCURB activities were finished, the collected data was incorporated to the Helsinki Mobility Data Catalog. The catalog serves as a basis for the future development of Helsinki Digital Twin for Mobility, accelerating the inclusion of urban freight data into the Digital Twin for Mobility.

Lessons learned

The re-scheduling of WP3 implementation affected the implementation of the Helsinki LL DISCOLLECTION measures followed the plan agreed with WP3. The connection of the DISCOCURB data to the Urban Freight Dataspace was delayed due to modification of the implementation schedules in WP3, as noted earlier in this document.
The Helsinki LL did not have a specific budget for DISCOLLECTION, but thanks to the supportive nature of other DISCO-Xs, the connection of the collected DISCOCURB datasets to the data space was implemented eventually.
The demonstration showed that the Urban Freight Dataspace can effectively incorporate datasets produced by local service providers and data from various city logistics activities.

3.3.3. Results

In planning the Helsinki LL activities, the DISCO X measures were directly connected to the City of Helsinki's Action Plan for City Logistics, which, like the DISCO project, recognizes the need to optimize urban logistics to mitigate emissions, traffic safety, and residents' well-being. The Helsinki LL addressed these challenges by focusing on reducing logistics-related emissions and enhancing urban delivery flexibility. These goals aligned with the City Logistics Action Plan, emphasizing microhub development and loading zone optimization.

The DISCOCURB measures transformed the **city's loading zone management**. Helsinki LL implemented real-time monitoring with three technologies: camera-based solutions from Ramboll Finland and Technolution AB, and a LiDAR-based system from Flow Analytics. These systems, installed in selected loading zones, tracked occupancy rates, vehicle counts, and classifications, integrating the data into the Tietorahti map service. This enabled route optimization, reducing

emissions. The shift to battery-powered, movable equipment addressed issues with fixed installations and showed the project's adaptability to real-world constraints.

Helsinki LL also piloted an FCD-data-based planning tool from Vianova. By analysing commercial LCV FCD data, it identified areas with high stopping activity and limited loading zones, guiding city planners in making data-driven decisions on new loading zone locations.

Despite a political decision to halt low-emission zone (LEZ) preparations, Helsinki LL simulated the impact of a hypothetical LEZ using FCD data and origin-destination data collected via dedicated survey, providing valuable insights shared with the City of Helsinki and Helsinki Region Transport Authority.

The DISCOPROXI measures explored **multi-actor microhubs for sustainable last-mile logistics**. Challenges with permits and location identification led to one larger microhub at the Ruoholahti shopping centre, supporting multiple LSPs and cargo bike and delivery robot operations. A2B also implemented a mobile microhub concept using EV vans for flexible urban deliveries. The microhub implementation underscored the need for dedicated operators and streamlined permits.

The DISCOLLECTION measures integrated DISCOCURB data into the Urban Freight Dataspace, highlighting the **potential for data sharing** among logistics stakeholders.

The Helsinki LL activities provided key learnings: ongoing stakeholder engagement, flexible timelines, effective utilization of FCD data, benefits of real-time data visualisation for the professional drivers and the feasibility of battery-powered monitoring solutions. Challenges with microhub implementation stressed the need for clear operational models and streamlined permits. Both the produced data and the learning of Helsinki LL DISCO-X implementations are being directly utilized by the Urban Environment Division in their ongoing efforts to build a development program for Helsinki's loading zones. Additionally, the DISCO-X implementation directly guided forward the action points listed in the Action Plan for city logistics, boosting Helsinki's work towards more sustainable urban logistics. The project demonstrated the importance of data-driven urban logistics planning, offering valuable insights and tools for future sustainable logistics development in Helsinki.

3.3.4. Beyond DISCO

Following the conclusion of the DISCO project, several measures and solutions piloted in Helsinki are showing promising developments beyond the initial project timeline. These post-project advancements focus on the scalability, continued operation, and knowledge transfer of the tools and concepts tested, with interest emerging from both public and private stakeholders.

The **FCD-based tool**, developed in collaboration with Vianova, proved effective for analysing Light Commercial Vehicle (LCV) curb use, supporting city planners in the **optimization of un/loading zone locations**. Despite difficulties in sourcing commercial FCD in the Nordic region, similar data is more accessible elsewhere in Europe, making the tool highly scalable and increasing its growth potential as a service for other cities and contexts.

For un/loading zone monitoring, the piloted solutions from Ramboll Finland, Technolution AB, and Flow Analytics showed strong potential for replication and scale-up. While the core monitoring devices were already available on the market, the pilots tested battery-based, movable installations for the first time. These flexible solutions proved particularly effective in dense urban environments where access to electricity is limited. In addition, participating companies gained valuable R&D insights, which could further enhance product development.

The Tietorahti real-time data integration proved potential in services, which visualizes real-time loading zone occupancy information directly to drivers- Services like this can reduce unnecessary driving and hence reduce emissions.

The **mobile microhub concept**, tested with local logistics provider A2B, is also expected to continue beyond the project. A2B plans to resume operations in summer 2025, having found that the concept increased the efficiency of cargo bike fleet utilization. Its scalability is promising, as it is less dependent on fixed infrastructure and more adaptable to various urban settings compared to traditional microhubs.

To support wider adoption and learning, the Helsinki Living Lab produced detailed pilot descriptions for all DISCOPROXI and DISCOCURB implementations. These include information on implementation processes, key learnings, results, and contact points. The materials have been uploaded to the Knowledge Hub and will be disseminated through various communication channels to inspire replication in other cities.

Finally, regarding the data-sharing measure, the potential for scaling up is closely tied to the engagement of service providers. In Helsinki, there was a moderate level of interest in connecting to platforms like the Urban Freight Dataspace. However, as the technology remains in an early prototype phase, interest is expected to increase once specific use cases and value propositions become clearer to stakeholders.

3.4. Thessaloniki

3.4.1.   Background and rationale of the intervention

General and logistics characteristics

Thessaloniki is a midsized city situated in northern Greece, on Thermaikos Bay, part of the Aegean Sea. It is Greece's second largest city, home to the country's second largest export and transit port, and the nearest European Union port to the Balkans and Black Sea zone.
It has a municipal population of 317,778, and a metropolitan population of 1,1 million.
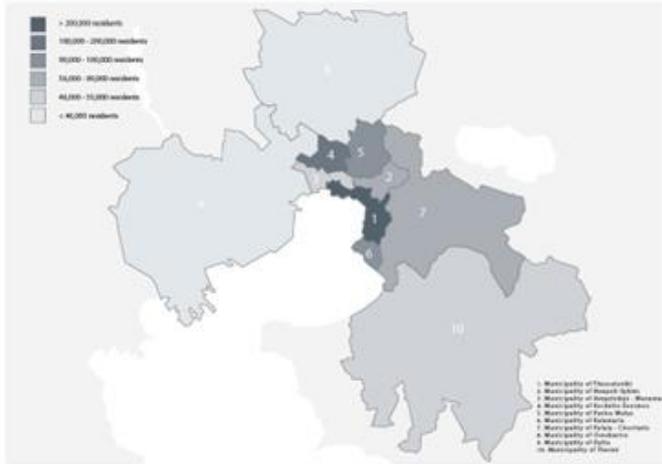
Figure 29: Thessaloniki Population Map.

Thessaloniki, characterized by its dense urban fabric, faces significant **environmental challenges** due to limited green and open spaces, currently offering only 2.6 square meters of greenery per resident—a stark contrast to the European norm of 8-10 square meters. This scarcity not only restricts accessible leisure spaces but also amplifies the urban heat island effect during sweltering summers and exacerbates water runoff issues amid heavy winter rains. The cityscape is further burdened by aging, energy-inefficient buildings, especially prevalent in less affluent areas, contributing to the city's ecological footprint and social disparity.

The everyday dynamics of Thessaloniki are notably impacted by mobility stressors. With constrained public transport alternatives, the city's residents are compelled to depend on personal vehicles, which aggravates air pollution, a pressing concern for urban health and a priority issue for city governance. The existing transportation infrastructure struggles to support current demands and falls short of accommodating future necessities or unforeseen disruptions. The absence of a comprehensive mobility strategy, coupled with fragmented transportation projects, fuels inefficiency.

Moreover, Thessaloniki is vulnerable to a variety of natural threats, including seismic activities, urban flooding, and wildfires, along with disruptive seasonal phenomena like snowfall, extreme cold, and heatwaves. These events pose interruptions to essential city services and hinder the continuity of business operations.

The average number of cars per person is 0.44 in the Region, and the city has a total of 12 km of bike lanes. The figures below provide the mobility mode shares of the municipality and metropolitan agglomeration in 2018, and the goals of the SUMP for 2025 and 2030.
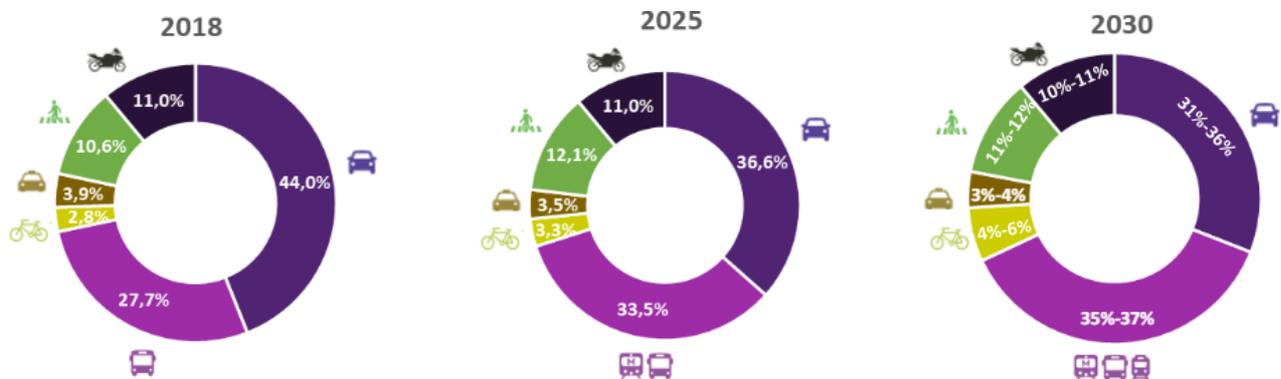
Figure 30: Mode share of Thessaloniki's Urban Agglomeration.
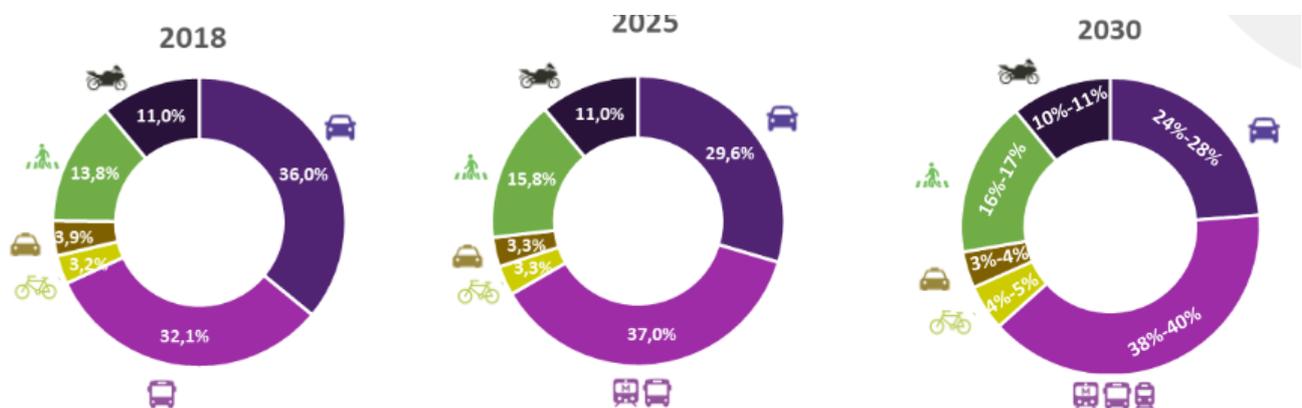

Figure 31: Mode share of the Municipality of Thessaloniki.

The city's urban logistics system is closely tied to its **economic profile and the growing trends in digitalization and e-commerce**. E-commerce has grown rapidly over the past two decades, with internet access increasing from 14.7% in 2002 to 85% in 2023. E-commerce has expanded by 28%, with 55.3% of people engaging in online shopping and an average online spending of €870 per person in the past six months. The clothing and food industries dominate online purchases, with 73.6% of clothing sales and 44.1% of food sales made online.

The urban transport and delivery sector is substantial, with around 10,000 daily parcel deliveries in West Thessaloniki, covering a total of 36,000 km per day and generating 6.5 tons of CO2 emissions. The first-attempt delivery success rate is approximately 82%, with last-mile delivery costs accounting for up to 50% of total delivery costs. Thessaloniki's diverse economy includes approximately 5,500 businesses, with retail stores comprising 41% and wholesalers 37%. Many businesses order daily, especially in the food, beverage, and HORECA sectors, and a significant 63% of businesses lack access to specialized loading/unloading areas. On average, company facilities are located 65 km from the city centre.

Challenges addressed by the LL

The Thessaloniki LL aims to achieve the city's main sustainability targets for a **CO2-neutral and zero-emission city by 2030** thanks to the reduced number of delivery vehicles circulating in public spaces, thus reducing traffic congestion and ensure better quality of life.

It aims to do so by developing a new business model which integrates **urban freight transportation data** with **cooperative city logistics schemes** and **space/land data**, to optimize the TIF HELEXPO Exhibition Centre's underutilized space as a flexible logistics hub. In particular, the measures developed by the LL are inspired by the concept of Physical Internet and have cooperative, data-driven business models at its core.

The implementation is led by CERTH/HIT, which is responsible for the DISCOPROXI, DISCOBAY AND DISCOLLECTION measures, and to facilitate the cooperation between ACS and TIF HELEXPO for delivering the DISCOESTATE measure.

Actors involved in LL implementation

- **Hellenic Institute of Transport of CERTH (CERTH/HIT)** Living Lab leader
- **TIF HELEXPO SA** Real Estate Actor
- **ACS** Logistics operator and key data provider
- **CITY OF THESSALONIKI** Urban logistics, policy, planning and innovation accelerator

3.4.2.   Implementation outline

3.4.2.1.   DISCOPROXI

DISCOPROXI: This measure aims to demonstrate innovative business models for flexible space utilization by enhancing the WareM&O (Warehouse as a Service) platform with blockchain-enabled smart contracts. By building on an existing fair pricing algorithm, the initiative seeks to facilitate transparent and efficient agreements for temporary logistics space use. The measure focuses on identifying strategically located proximity areas for loading and unloading near delivery destinations, helping to reduce unnecessary vehicle trips. By promoting smarter use of free space, DISCOPROXI supports more sustainable e-commerce logistics while mitigating negative impacts on urban quality of life and operations.

Measure definition

The uncontrolled growth of smart locker installations in Thessaloniki highlighted the risk of **public space saturation and urban fragmentation**. In response, the DISCOPROXI measure was conceived to establish a **shared, regulated network of smart lockers**—primarily in public spaces and low-traffic zones—to mitigate these risks. The measure was initially based on the observation that, without intervention, independent installations by different companies would eventually occupy every available corner of the city.

Figure 32: The logistics real estate database and the existing lockers from all operators and the first installation of 24-hr accessible smart lockers at TIF-HELEXPO premises.

The planning and specification of the measure were driven by a **participatory process** with key stakeholders, including the Municipality of Thessaloniki, ACS Courier, and CERTH/HIT. Early discussions revealed feasibility issues and generated new evidence, prompting the development of a **dynamic database** that continuously tracked existing smart locker locations. This real-time mapping provided critical insights into current deployment patterns and informed subsequent planning decisions.

Measure implementation

The implementation of the DISCOPROXI measure was executed through a structured, step-by-step process designed to regulate smart locker installations and facilitate shared operations among multiple courier companies. In the first step, the project team established a dynamic database (**Logistics Real Estate Database**) to continuously capture and update smart locker locations across Thessaloniki. This mapping exercise was essential to highlight the unregulated proliferation of lockers that, if left unchecked, could saturate every corner of the city.

In the second step, an **optimal facility location tool** provided by CERTH/HIT was used to analyse demand patterns and identify ideal sites in public spaces and low traffic zones within the borders of the Municipality of Thessaloniki. The insights from this analysis laid the groundwork for iterative consultations with key stakeholders — including the Municipality of Thessaloniki and ACS Courier— to select strategic sites for pilot installations.

Figure 33: The DISCOPROXI tool of Thessaloniki, as used to indicate the optimal locations for the installation of the smart lockers at public spaces of the Municipality.

In the next phase, stakeholder consultations were held with the Municipality of Thessaloniki and ACS Courier to agree on the most suitable locations for the lockers. During these meetings, it was decided that a questionnaire would be sent to users of the lockers in order to assess specific performance criteria and key performance indicators. This step was essential to ensure that the installations not only met operational requirements but also responded to user/citizens of the municipality needs. Following these discussions, two smart lockers were installed in public spaces and three in semi-public areas with 24-hour access.

Figure 34: The first two smart lockers installed in public spaces in the Municipality of Thessaloniki, based on the indications of the DISCOPROXI tool by CERTH/HIT.

Simultaneously, a parallel second use case was focused on **enhancing CERTH/HIT'S legacy platform WareM&O with blockchain technology**. This integration was aimed at enabling **smart contracts**, thereby allowing secure, transparent agreements among warehouse owners, courier companies, and other stakeholders. The technical architecture and operational protocols were defined and tested through pilot trials, which demonstrated the potential for a unified network supporting multi-company operations.
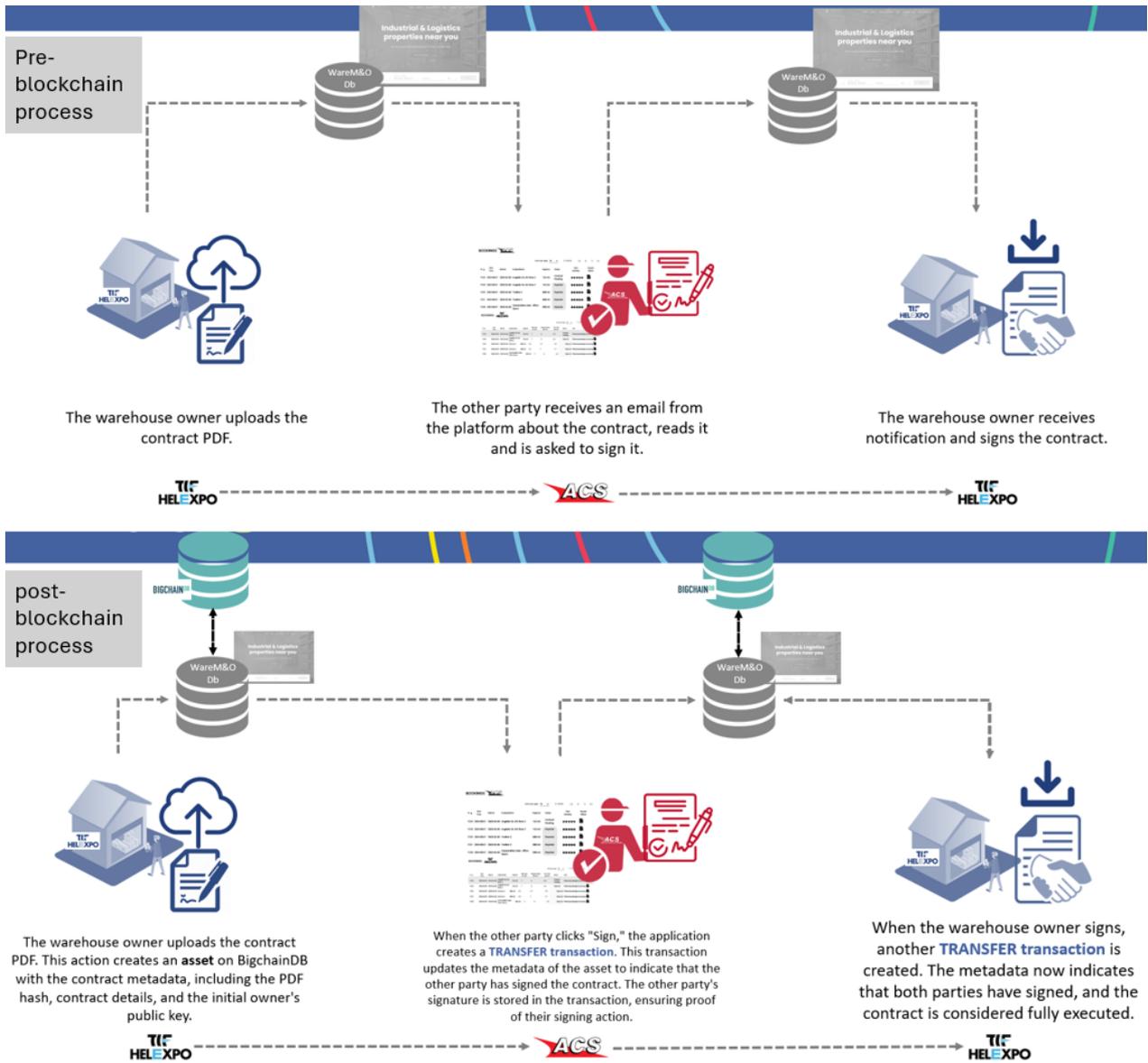
Figure 35: The blockchain integration in the contract signature capability of the WareM&O by DISCOPROXI and DISCOESTATE tool by CERTH/HIT.

Concluding, an iterative review process was employed to refine installation protocols and digital integrations based on real-time feedback. This comprehensive approach ensured that the measure not only addressed the immediate need to regulate locker placements but also laid the foundation for a sustainable, collaborative urban logistics ecosystem. Finally, data collected from user questionnaires was systematically analysed to feed into the agreed Key Performance Indicators of the DISCOPROXI piloting activities.

Lessons learned

In the first use case, one of the most valuable insights from the DISCOPROXI measure was the importance of continuous, transparent communication among stakeholders—particularly the Municipality of Thessaloniki, ACS Courier, and CERTH/HIT. While the partners agreed on the concept early on, the practical details of locker placement and access rights required multiple rounds of negotiations, emphasizing the need for structured stakeholder management to avoid delays. Although the measure aimed to address unregulated locker proliferation, obtaining municipal approvals for installations in public spaces proved more time-consuming than anticipated. Aligning locker placement with urban design standards and accessibility requirements required close collaboration with city officials, underscoring the importance of **early involvement of regulatory bodies**.

As for the second use case, enhancing the legacy WareM&O platform with blockchain presented both opportunities and technical hurdles. Establishing secure, transparent smart contracts for multi-company operations required **careful alignment of technical standards and legal frameworks**. Early prototyping and pilot testing were essential to mitigate risks and demonstrate the value of blockchain in facilitating collaborative urban logistics.

3.4.2.2. DISCO-ESTATE

***DISCOESTATE**: This measure aims to demonstrate the temporary and multipurpose use of strategically located buildings at the TIF HELEXPO Exhibition Centre as a logistics hub during non-event periods. By enabling shared transport and logistics facilities—such as freight hotels—and optimizing their use through smart tools and green last-mile solutions, the initiative supports more efficient urban logistics. DISCOESTATE promotes the adaptive reuse of existing infrastructure, reducing the need for new developments while enhancing the sustainability and flexibility of freight operations in the city.*
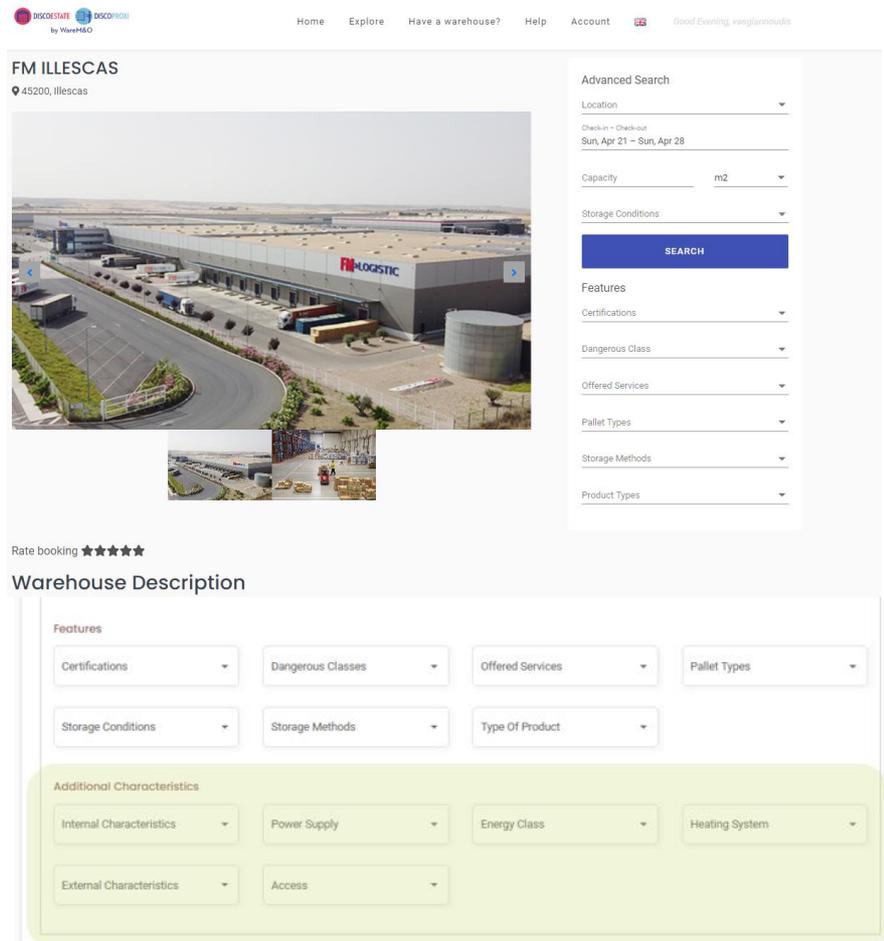
Measure definition

The DISCOESTATE measure emerged from the need to **optimize underutilized spaces at the TIF HELEXPO Exhibition Centre for logistics operations** when events are not taking place. By repurposing pavilions, shops, hubs, and office spaces, stakeholders aimed to reduce congestion in Thessaloniki's historical centre and enable more flexible, multipurpose freight solutions. A participatory approach underpinned the planning and specification of this measure, with key input from TIF-HELEXPO, ACS Courier, FM Logistic, and CERTH/HIT. Early consultations highlighted the value of integrating these venues into the existing WareM&O platform—originally designed for shared warehousing—and enriching its data model to reflect the requirements of DISCOESTATE. Feasibility studies and iterative stakeholder discussions clarified technical specifications, such as e-signature capabilities and advanced data standards, ensuring that all parties could effectively manage, lease, or share these strategic spaces.

Measure implementation

In the implementation phase, the **WareM&O platform was upgraded with e-signature capabilities**, enabling warehouse owners and tenants to finalize agreements digitally and streamlining the overall contract process. At the same time, the CERTH, ACS, TIF HELEXPO and FM Logistic standardized and enriched the data model to meet the specific requirements of DISCOESTATE—as defined by FM Logistic—ensuring that all shared spaces, from pavilions to office areas, could be monitored and managed in real time.

Figure 36: The expansion of the taxonomies within the WareM&O by DISCOPROXI and DISCOESTATE tool based on the indications of the DISCOESTATE responsible partner, FM logistic, before adding one warehouse.

A **collaborative business model was then formalized between TIF-HELEXPO and ACS**, establishing clear operational responsibilities and cost-sharing mechanisms for leasing underutilized exhibition areas as logistics hubs. With this framework in place, available spaces at TIF-HELEXPO, including pavilions, shops, hubs, and offices, were **integrated into the WareM&O by DISCOESTATE platform,** allowing for dynamic tracking of availability and occupancy. The negotiations took place for a significant period of time, but the two parties reached an agreement by using specifically the WareM&O by DISCOESTATE platform and achieved this "operational marriage" by utilizing the e-signature capability of the platform.
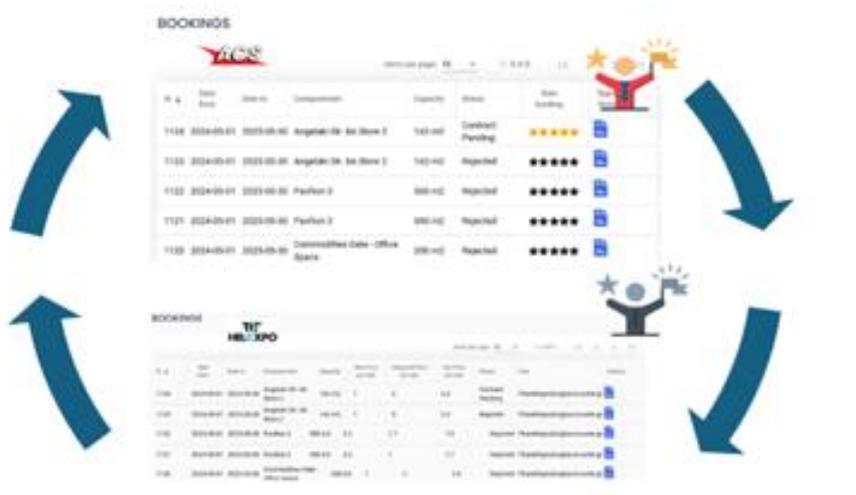
Figure 37: Booking section of the WareM&O platform indicating the agreement between ACS and TIF-HELEXPO.

Subsequently, ACS relocated its most significant shop from Thessaloniki's historical centre to the TIF-HELEXPO premises, just outside the congested urban core.

Figure 38: The migration of ACS premises from the historical centre of Thessaloniki to TIF-HELEXPO's premises and the beginning of operations.

However, before reaching full-scale operations under the DISCOESTATE measure, the Living Lab partners addressed key challenges arising from mismatched expo working hours, ongoing renovations, and restricted vehicle access at TIF-HELEXPO. To resolve these issues, TIF-HELEXPO **upgraded its infrastructure** to accommodate 24/7 logistics activity, installing articulated barriers for

narrow spaces, implementing cameras for automated access, and reprogramming the ticket issuance system. Concurrently, ACS vehicles were equipped with RFID tags, enabling secure, around-the-clock entry to the premises, even outside regular exhibition hours. By overcoming these hurdles, both partners ensured a smooth transition into the final demonstration phase, laying the groundwork for a **sustainable, multipurpose logistics hub**. From this point on, the Living Lab started collecting the key performance indicators agreed at the beginning of the implementation phase.

Lessons learned

One of the main hurdles was ensuring 24/7 access to TIF-HELEXPO's facilities for logistics operations, particularly when events were taking place. This required additional **infrastructure adaptations**—such as installing articulated barriers, RFID systems, and cameras—to accommodate round-the-clock vehicle entry. Although these measures resolved the issue, they introduced extra costs and led to slight delays in the initial timeline.

Figure 39: Infrastructure to ensure 24/7 access for ACS vehicles for seamless operations throughout the hours that TIF Helexpo is not operating

Aligning TIF-HELEXPO's Building Management System with the WareM&O platform revealed **discrepancies in data formats and protocols**. These inconsistencies demanded iterative testing and adjustments to the data model. While the final outcome supported a seamless exchange of real-time availability data, the integration process was challenging. During the proposal phase of the DISCO project and the agreement of the piloting activities, all partners were aligned on demonstrating the DISCOESTATE measure. However, the internal agreements between the directly involved project partners—TIF HELEXPO and ACS—required several iterations before finalizing a consensus, especially on the right space and the right price.

3.4.2.3.   DISCO-BAY

DISCOBAY: This measure aims to map underused infrastructure and identify potential locations for freight hotels across Thessaloniki. By enriching the Warehouse as a Service (WaaS) data space with information on unexploited municipal land and available spaces, the initiative seeks to create an integrated space availability observatory. DISCOBAY supports the strategic reuse of existing assets for logistics purposes, promoting more efficient land use and contributing to a flexible, data-driven approach to urban freight planning.

Measure definition

The limited available space within Thessaloniki has long been a pressing issue, particularly as increased logistics operations have intensified traffic and raised CO_2 emissions. Many companies face significant challenges because their storage facilities are located far from the city centre—on average, more than 60 km away—which in turn increases the distance travelled and, consequently, the environmental impact. In response to these challenges, city authorities sought to **identify large, underutilized transport infrastructures in the peri-urban area** of the historic centre. These sites offered a promising solution by potentially **reducing travel distances and facilitating more efficient cargo consolidation, ultimately contributing to lower emissions**.
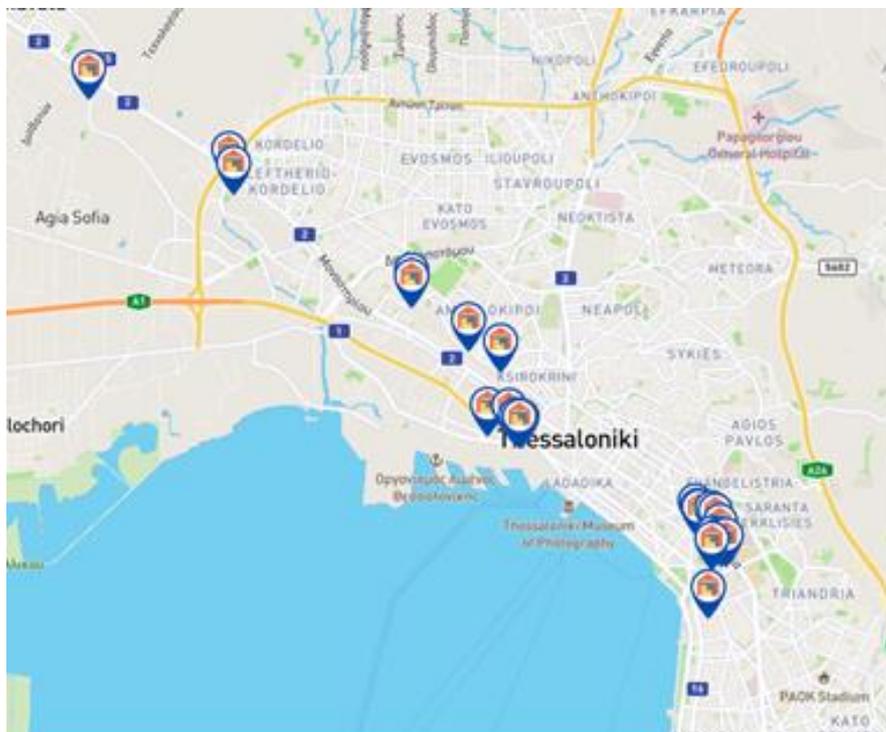
Figure 40: The available transport infrastructure in the peri-urban area of the historical centre of Thessaloniki.

Building on this context, the DISCOBAY measure was defined through a highly participatory, evidence-based approach that brought together a diverse range of stakeholders. Initially, project partners—most notably CERTH in close collaboration with the Thessaloniki Municipality, TIF, and ACS—organized a series of dialogues to identify urban transport infrastructures with high potential for conversion into consolidation centres. The selection criteria emphasized the strategic location and accessibility of peri-urban transport infrastructures near key nodes such as train stations and the port, ensuring that the chosen sites were inherently suitable. The outcomes of these discussions led to the engagement of GaiaOSE, the company that manages train assets in Greece, to integrate these facilities into the Thessaloniki urban freight data space alongside the storage assets of TIFF. This database is currently further enhanced with assets at the port of Thessaloniki, which enables

cargo bundling with waterways, thereby offering a multifaceted approach to reduce the environmental footprint of urban freight operations.

Measure implementation

The implementation of the DISCOBAY solution was executed through a structured, step-by-step process designed to ensure systematic integration and validation. In the first step, the project team conducted a detailed **mapping and survey of available transport infrastructures in the peri-urban area** of Thessaloniki, focusing on those with high potential to serve as urban consolidation centres. This initial assessment allowed stakeholders to identify strategic assets that could help reduce the average 60 km travel distance for cargo storage and lower CO_2 emissions.

In the **second step**, the Municipality of Thessaloniki, TIFHelexpo, ACS Courier, and other key actors were brought together to discuss converting underused peri-urban sites into urban consolidation centres (UCCs). This dialogue produced a shared vision and a shortlist of candidate locations in line with the DISCOBAY concept. In the **third step**, a detailed GIS mapping and onsite survey examined each candidate asset, checking ownership, access, capacity, and land use constraints, to confirm which sites could technically support last-mile logistics operations. In the **fourth step**, the selected assets managed by GaiaOSE (railway estate), TIFHelexpo, and Thessaloniki Port were integrated into a shared urban freight "dataspace." They were also connected to the WareM&O platform, enabling real-time monitoring and instant booking of available space. In the **fifth step**, a Python based microsimulation platform was built and calibrated to replicate thousands of parcel deliveries across the city. A baseline scenario (today's "eachcarrierforitself" model) generated reference KPIs for vehicle kilometres, fleet size, and emissions. In the **sixth step**, the first experimental scenario modelled a single-operator UCC at the GaiaOSE railway estate. Freight arrived by train, was sorted onsite, and the densest districts were served with an electric fleet. This cut VA kilometres on serviced routes by roughly 40 % and illustrated the potential for railroad modal shift. In the **seventh step**, a shared operations scenario allowed multiple companies to co-manage the same UCC and deploy a pooled e-vehicle fleet across the entire urban agglomeration. The result was a 60 % reduction in total van kilometres and a 30 % drop in fleet size compared with the baseline.

Finally, the insights gathered from the simulations were used to **fine-tune the implementation protocols**, leading to adjustments in data integration, operational workflows, and stakeholder coordination. This iterative process ensured that the DISCO-BAY measure was robust, adaptable, and aligned with the long-term sustainability objectives of reducing emissions and optimizing urban freight operations

Lessons learned

Throughout the roll-out of the DISCOBAY solution, several challenges provided critical learning opportunities that informed subsequent refinements. Coordination among diverse stakeholders—including public authorities, technology providers, and private logistics operators—proved to be complex, occasionally leading to delays in data integration and decision-making. To address this, the

project team instituted **regular feedback loops and structured decision checkpoints that enhanced communication and aligned stakeholder priorities**.

On the technical side, integrating legacy data with new digital systems revealed unforeseen complexities, particularly when consolidating various data streams into the simulation. These issues were gradually resolved through iterative testing and protocol revisions, resulting in smoother interoperability between systems. Furthermore, adjustments were made to the project timeline; some phases were extended to allow for more comprehensive feasibility studies and simulation testing.

3.4.2.4. DISCOLLECTION

DISCOLLECTION: This measure aims to optimize freight flows at the TIF HELEXPO Exhibition Centre during event periods by implementing advanced freight modelling techniques and data analytics solutions. By deploying smart sensors along road infrastructure and at the gates of the exhibition area, the initiative enables real-time data collection to support dynamic logistics planning. DISCOLLECTION enhances the efficiency of freight operations through data-driven insights, contributing to smarter, more responsive urban logistics management during high-traffic periods.

Measure definition

The DISCOLLECTION measure arose from Thessaloniki's need to gather, analyse, and share urban freight data for more informed decision-making. As highlighted in the Municipality's internal discussions, the city accommodates around 5,500 shops—41% in retail and 37% in wholesale—handling up to 1,100 tons of cargo daily within the central area. Nearly half (48.7%) of all freight trips terminate within municipal borders, underscoring the strategic importance of upgrading loading/unloading infrastructure and managing urban logistics more effectively. To address these challenges, a **local Urban Freight dataspace** was envisioned, with CERTH/HIT acting as the trustee and data manager. The primary aim was to create a systematic and transparent process for collecting and processing logistics data, laying the groundwork for Thessaloniki's forthcoming Sustainable Urban Freight Plan. Early consultations with stakeholders—including the Municipality, local businesses, and chambers of commerce—shaped the core features of the dataspace. These included mapping key freight actors, monitoring economic activity, and integrating real-time insights on vehicle operations.

Measure implementation

The initial step involved defining a **proof-of-concept architecture for Thessaloniki's local Urban Freight dataspace** (accessed at: uldthess.imet.gr), focusing on planning functionalities for various user groups. Three primary user pathways were established— "Manage Logistics Operations," "Plan Infrastructure", and "Access Data & Reports"—ensuring that municipal authorities, logistics providers, and other stakeholders could each find relevant tools and information.
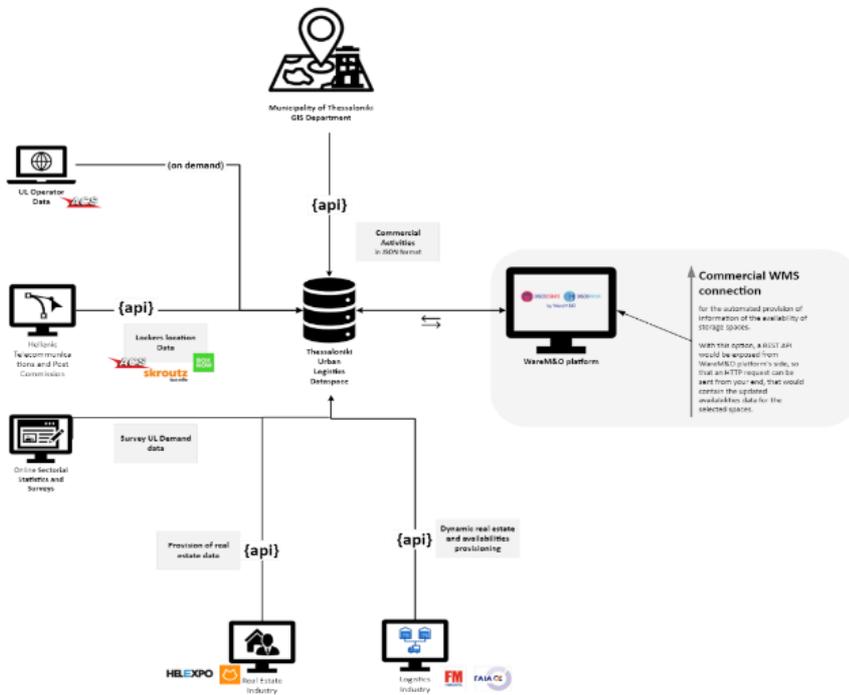
Figure 41: A high-level architecture of the local Thessaloniki urban logistics dataspace.

The dataspace was **connected to existing local systems**, including the WareM&O platforms by DISCOESTATE and DISCOPROXI, Thessaloniki "*yellow pages*" for logistics companies and the Logistics Real Estate Database developed under the DISCOBAY measure. By linking these resources, the dataspace aggregated data on freight vehicle activity, warehouse availability, and operational hotspots, supporting a citywide overview of logistics flows as shown in the figure below.
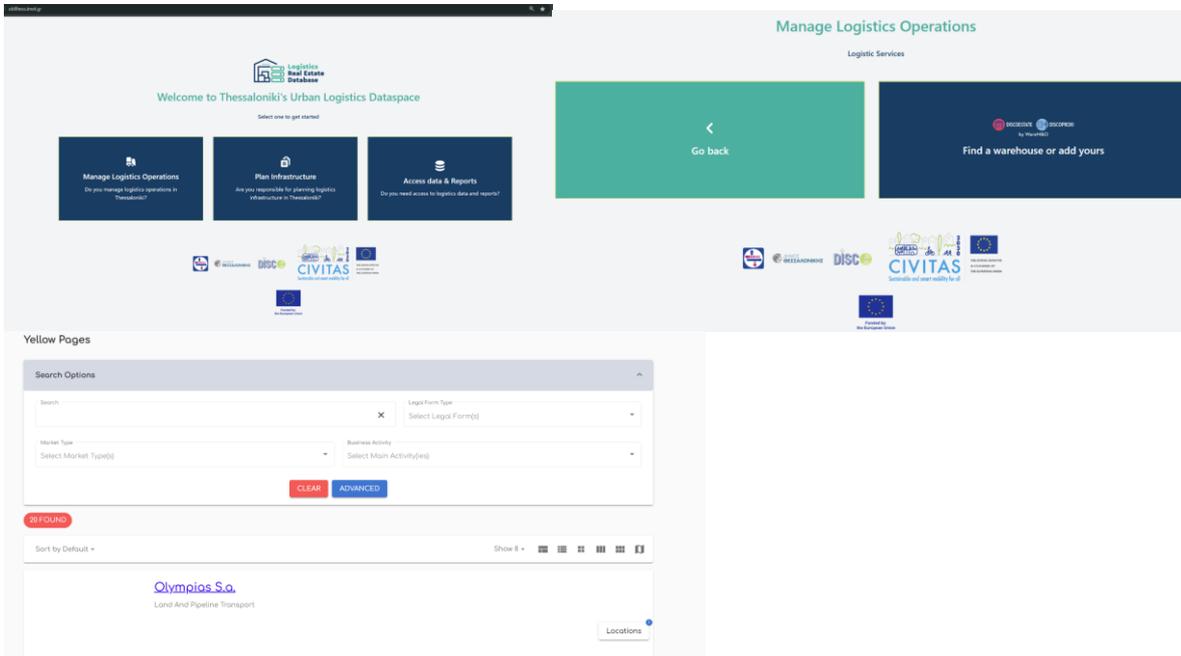
Figure 42: The user interface of the platform.

At the next stage, **surveys** conducted during Open Day events and CERTH/HIT's **recordings in strategic locations** within the historical centre were incorporated into the dataspace. This information was then visualized in the **"Who is Who"** registry and the "See the city in numbers" section, which was enhanced with **georeferenced data** for each municipal district. This step provided granular insights into **demand characteristics and freight activity patterns**, enabling more targeted policy measures.
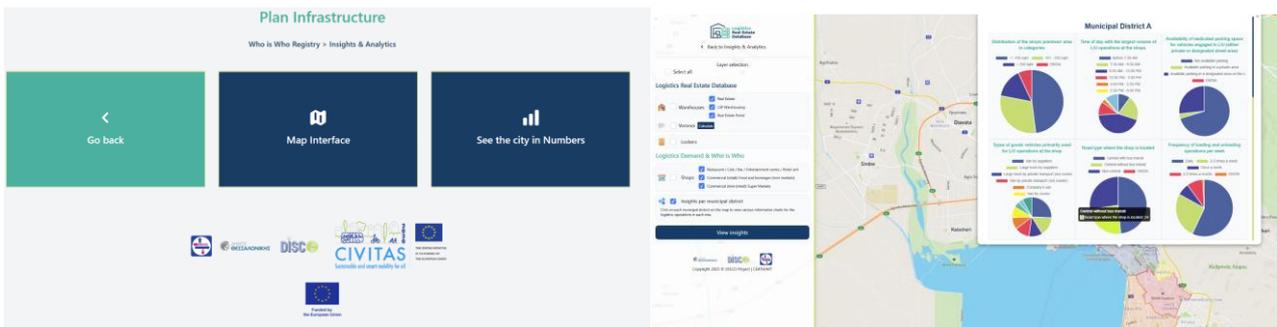
Figure 43: Map interface with data per Municipal District and the "see the city in numbers" with data per industry segments.

The final phase of the proof of concept saw improvements to the user interface, including **interactive maps and dashboards** that display aggregated data in real time. Municipal planners gained the ability to identify congestion hotspots, allocate loading bays more efficiently, and forecast demand for future policy interventions.

The consolidation of diverse data streams into a unified, transparent framework enables the DISCOLLECTION measure to address Thessaloniki's immediate need for evidence-based logistics planning. In parallel, it establishes a foundation for more advanced solutions, such as dynamic curbside management and digital permitting, aimed at reducing congestion, lowering emissions, and enhancing the overall efficiency of urban freight.

Figure 44: Documentation to dynamically retrieve data from the platform.

Finally, to support wider adoption and more advanced analyses, CERTH/HIT prepared **comprehensive documentation for interested parties to retrieve data dynamically** from the local dataspace. This resource allows stakeholders to integrate real-time information into their existing systems, paving the way for enhanced analytics, better-informed decision-making, and the ongoing evolution of Thessaloniki's urban freight ecosystem.

Lessons learned

The initial Grant Agreement outlined a focus on "*implementing advanced freight modelling techniques and data analytics solutions for optimizing freight flows at the TIF HELEXPO exhibition centre during exhibition periods, utilizing smart sensors installed on road infrastructure and gates for real-time data collection.*" As the project progressed, and in close coordination with CERTH/HIT and local stakeholders, it became clear that expanding the area of analysis to include Thessaloniki's historical centre would offer additional value. This broader scope allowed the project to generate richer insights into urban freight dynamics and support **data-informed discussions** with city officials, including the mayor, on enhancing logistics operations across the wider urban area—not limited to TIF HELEXPO.

This extended approach brought valuable opportunities but also revealed a number of challenges. Public consultation at the Town Hall and other events highlighted the diversity of perspectives among logistics companies, municipal authorities, and local businesses. Aligning these views required a flexible and iterative engagement process to clarify objectives and ensure mutual understanding. While there was general support for data collection, practical concerns—such as

data privacy and **commercial sensitivity**—required additional dialogue to establish trust and secure broader participation.

The Open Day events proved instrumental in gathering real-time feedback through roundtables and interactive tools like Mentimeter, surfacing both shared priorities and diverging opinions on freight demand and operational barriers. Despite the successful completion of freight demand surveys by 40 key logistics operators, further outreach was needed to engage a wider set of actors and maintain momentum. This underscored the importance of a structured and sustained stakeholder engagement strategy.

A notable success was the collaboration with the Chamber of Commerce & Industry, which provided survey responses from over 1,000 retailers and shop owners. Integrating these large-scale datasets into the local dataspace brought valuable insights but also required additional technical coordination and time, beyond initial projections—highlighting the need for adaptive project management when working with complex, multi-source data.

3.4.3. Results

In implementing the Thessaloniki LL activities, four measures were deployed—DISCOESTATE, DISCOBAY, DISCOLLECTION, and DISCOPROXI—to address critical urban freight needs in a city aiming for zero emissions by 2030.

The DISCOPROXI measure demonstrated the potential for a shared, regulated network of public-space lockers by building a compelling argument with the Municipality and courier companies—grounded in **user survey data** and **CERTH/HIT's planning tool**—to counter the uncontrolled proliferation of privately installed lockers and more effectively capture demand.

DISCOESTATE showed that TIF HELEXPO's **underutilized pavilions**, shops, and offices could be transformed into active **logistics hubs**. A collaborative process among TIF HELEXPO, ACS Courier, FM Logistic, and CERTH/HIT led to the integration of these spaces into the **WareM&O platform**, with agreements secured via **blockchain-enabled e-signatures**. As a result, ACS's main premises were relocated from the historical center to TIF HELEXPO, significantly reducing congestion and enhancing operational efficiency. Infrastructure upgrades—including the installation of articulated barriers, cameras, and RFID systems—enabled seamless 24/7 logistics operations.

In DISCOBAY, detailed mapping and surveys of underutilized **peri-urban transport infrastructures** were conducted to identify suitable **consolidation centers**. Assets managed by GaiaOSE, TIF, and the Thessaloniki Port were integrated into a centralized **urban freight dataspace** to support **real-time monitoring**. A **simulation platform** was then developed to test various operational scenarios, including the use of a single consolidation center and a shared model involving multiple stakeholders. Insights from these simulations helped refine operational protocols, resulting in reduced travel distances, improved cargo consolidation, and lowered CO_2 emissions.

DISCOLLECTION in Thessaloniki led to the establishment of a fully operational **urban freight dataspace** managed by the Municipality and CERTH/HIT. Data from **logistics operations**, **freight surveys**, and **sensor/camera measurements** was successfully integrated into a unified, real-time platform. Connections were established with existing local systems—including the **WareM&O platforms** from DISCOESTATE and DISCOPROXI, the city's GIS, and the Logistics Real Estate Database from DISCOBAY—to provide an aggregated view of freight vehicle activity, warehouse capacity, and operational hotspots.

Data collected during Open Day events, along with sensor and camera recordings from strategic locations in the historical centre of Thessaloniki, was visualized through interactive dashboards such as the "Who is Who" registry and the "See the City in Numbers" mapping interface. Comprehensive documentation was produced to enable **dynamic data retrieval** by external stakeholders, thereby supporting **evidence-based decision-making** in urban freight planning.

In line with broader strategies like the city's Digital Transformation Plan and its Sustainable Energy and Climate Action Plan, the Thessaloniki LL tested how an integrated, data-driven approach could foster sustainable and resilient last-mile solutions. The insights gained are now being incorporated into the city's ongoing Sustainable Urban Logistics Plan, with further expansion of shared locker networks, data-sharing platforms, and operational models planned for the near future.

3.4.4. Beyond DISCO

The results and lessons learned from the DISCO project in Thessaloniki have laid the groundwork for several scalable and transferable solutions that can continue to evolve well beyond the project timeline. These developments focus on enhancing urban logistics efficiency, reducing environmental impacts, and fostering public-private collaboration.

One such opportunity lies in the **expansion of the shared locker network**, as demonstrated in the pilot led by CERTH/HIT. Additional lockers can be deployed across Thessaloniki following the same **shared-use model**, in close collaboration with the Municipality. This model enables **multiple courier operators** to share infrastructure, improving the efficiency of last-mile deliveries while optimizing the use of public space.

Another key area for scale-up involves the **WareM&O platform**, which can be extended to **additional buildings and locations** across the metropolitan area. By enabling more sites to function as **urban logistics or micro-consolidation hubs**, the platform would support more **distributed freight operations**, contributing to reduced congestion, lower CO_2 emissions, and enhanced operational flexibility. In parallel, FM Logistics' upcoming integration of **dynamic availability data** from its **Warehouse Management System (WMS)** creates a replicable model. Other logistics actors can adopt similar approaches, forming a network of real-time, interconnected logistics nodes that promote both efficiency and collaboration.

The DISCOBAY solution also holds significant potential for replication in other urban areas. By leveraging **underutilized transport infrastructure** and integrating it into a centralized, data-driven system, the solution offers a strategic model for reducing travel distances, cutting emissions, and making better use of existing assets. The simulation tools developed during the project are easily adaptable and can be standardized for use in various city contexts. Moreover, this approach opens the door to innovative business models, such as shared infrastructure management and flexible leasing arrangements, which further support sustainable urban freight systems.

Finally, the project catalysed strong stakeholder interest in data sharing via Thessaloniki's **Urban Logistics Dataspace**. During the demonstrations, many local actors expressed willingness to contribute data, which the Municipality can collect on a recurring basis—from local shops, logistics providers, and other stakeholders. By visualizing this data through CERTH's platform, Thessaloniki can reinforce its **Sustainable Urban Logistics Plan (SULP)** with **evidence-based insights** that inform decisions to reduce congestion, improve freight flows, and create a more resilient and sustainable logistics system.

4. Compliance with the Meta Model Suite

The **Meta Model Suite** developed in WP2 is a robust, holistic digital framework that seamlessly integrates the innovative lessons and practical measures derived from extensive testing in the Living Labs. At its core, the suite is designed to guide cities on a transformative journey towards adopting PI-led urban logistics solutions by leveraging real-world experiences and advanced data-driven strategies.

Central to the suite are **dynamic digital assessment tools**—such as the **PI Readiness and Digital Maturity Assessment tools—refined through iterative feedback during the Living Lab preparatory phase**. These tools, which were informed by initial SUMP/SULP assessments conducted by the SLLs, empower city authorities to evaluate their current logistics capabilities, pinpoint critical areas for improvement, and lay the groundwork for sustainable practices.

In addition, the MMS incorporates a comprehensive library of planning scenarios developed via a rigorous two-step approach. Initially, DISCO experts generated a broad range of potential future scenarios through archetype scenario creation. The most plausible scenarios were subsequently selected using a DELPHI methodology, ensuring that the guidance is both visionary and practically feasible. These scenarios are integrated into the PI Readiness assessment, providing cities with clear directions on which PI innovations to adopt to achieve their strategic goals.

Furthermore, **the MMS encompasses the full range of DISCO-X measures**, offering detailed insights into the overall goals of each measure. This inclusion allows cities to understand the underlying principles and potential impacts of each DISCOX innovation, and to selectively choose the measures that best align with their unique urban logistics challenges. Tailored guidance is then provided based

on these chosen measures, ensuring that recommendations are directly relevant to each city's implementation needs.

Another essential feature is the MMS's guidance for connecting SLLs with the Urban Freight Data Space. By aggregating the diverse DISCO-X requirements defined by responsible partners and stakeholders, the suite assists cities in assembling the necessary tools, data, and infrastructure for their digital transition. The inclusion of a Smart Data Platform Cookbook further enables cities to effectively prepare their data exchange technologies, ensuring a seamless connection to the UFDS.

Moreover, the MMS integrates a dedicated city observatory featuring an impact assessment framework co-created by Living Lab participants and DISCO partners. This observatory not only tracks ongoing changes and improvements within each SLL but also archives historical data, allowing cities to monitor progress over time and adjust their strategies based on concrete evidence.

Overall, by combining strategic planning tools, robust operational support systems, and a resilient data backbone, the Meta Model Suite serves as a dynamic, living framework that encapsulates the practical insights from the SLLs and drives the evolution toward more sustainable, efficient, and digitally integrated urban logistics systems.

5.   Compliance with UF data sharing community

The first version of the Urban Freight Data Space (UFDS), developed and demoed during earlier in the project, incorporated various datasets from the Starring LLs. Specifically, it utilized open-source datasets from the cities of Copenhagen, Ghent, and Thessaloniki. These datasets, provided in GeoJSON format, were visualized using the UFDS data visualizer application.

Copenhagen

Copenhagen LL provided datasets from "*Open Data DK*". The datasets that were integrated are:
1. **Parking spaces**: the dataset displays legal parking spaces during the day at the street level as well as in publicly owned parking facilities and areas without a parking system (static).
2. **Parking garages** – the dataset contains information on parking garages and parking facilities operated by Copenhagen Municipality (real-time).

Ghent

Ghent LL contributed to the UFDS providing the datasets from the "*Ghent Open Data Portal*". The following two datasets were used for demonstration purposes of the UFDS Version 1:

1. **Public parking spaces and real time occupation**: the dataset describes the occupation of the parking spaces in the public parking garages in Ghent. Data are real-time and updated every 5 minutes, and include 13 garages.
2. **Street parking locations**: the dataset describes the geospatial locations of the curb-side parking space (static dataset, updated every year).

Moreover, additional datasets from the data portals of Ghent, Leuven, and Hasselt were included in later versions. Two private companies, Geosparc and BE-MOBILE, were also connected to the Data Space to use Urban Access Control tool, as explained in the DISCOLLECTION section of the Ghen Living Lab.

Thessaloniki

Thessaloniki LL provided datasets from the "*Thessaloniki Urban Logistics Data Space".* The available datasets include:
1. **Shops**: list of food and beverage establishments (ca. 1600) in Thessaloniki (supermarkets, HoReCa, mini markets).
2. **Warehouses**: list of warehouses in Thessaloniki (ca. 100) belonging to one of three owners. The dataset includes location and storage capacity information.
3. **Lockers**: list of lockers to send/receive mail and small parcels (ca. 500) belonging to one of three delivery companies.

Helsinki

Helsinki provided several datasets on city parking, traffic counts, maintenance, and buildings via the "*Helsinki Region Infoshare platform*" (HRI). However, these datasets were not included in the first UFDS version. During the first half of the project, the focus was on developing the various UFDS components, with only a limited number of datasets integrated to demonstrate usability and conduct initial testing. In the second half, as discussed below, these datasets—along with additional data from other SLLs—will be incorporated into the system.

Future Developments
In 2025, a second and potentially third version of the UFDS will be released. These versions will incorporate additional datasets, including data from Helsinki. Moreover, some of these datasets will serve purposes beyond visualization by the UFDS visualizer application. For instance, the DISCOESTATE application (CERTH's Ware M&O application) is planned to use data provided through the UFDS as a proof of concept.
Further details on the upcoming usage of these datasets will be documented in:
- D3.2 - UF Data Space Connector Store (M24)
- D3.4 - DISCO Data Space Open Software Repository Version 2 & Implementation Guide (M36)

6. Key Exploitable Results and transferability

Knowledge transfer is a critical component of the DISCO project, ensuring that innovations tested in **Starring Living Labs** can be effectively scaled up and adapted in other contexts.
During the measure implementation phase, and during each project meeting, the Starring Living Labs were asked to have in mind the transferability potential of the measures they were testing and implementing.

First, transferability is ensured by the connection between the DISCO-X measures tested in the Starring Living Labs and the **Meta Model Suite tool**, aimed at supporting all EU cities to choose the most suitable urban logistics measures for their freight-efficient land use plans, as described in the previous sections.

Second, the Starring Living Labs provided a list of **Key Exploitable Results** (as part of WP6) from their activities, including digital tools, business models, and knowledge that could be used in other contexts for replicating the solutions tested in the DISCO project.

DISCO-X	Name of result	Description of result	Type of result:	Lead Partner/ Owner
DISCOCURB	Flexible curb management: location plan tool with API to enable flexible use of loading zones	To enable flexible use of curb by producing real-time information on the availability of un/loading zones and visualizing the information for drivers in the Tietorahti app.	Digital tool	FVH
DISCOCURB	Visualization tool for loading zone planning (using Floating Car data)	To demonstrate the usage of utility vehicle fleet data to enable un/loading zone location planning for the city planners	Digital tool	FVH
DISCOPROXI	Multifunctional MicroHub	To develop and demonstrate a multifunctional and co-operated microhub concept in the City center to enable low- and zero-emission deliveries	Physical asset and business model	FVH

DISCOPROXI	Collaborative/on-demand storage capacity platform (WaaS) - WareM&O	To identify strategically positioned proximity areas as off-road places dedicated to L/U nearby destination to reduce vehicle trips; To adopt innovative business models and services for free space utilisation with smart contracts	Digital tool	CERTH, ACS, TIF-HELEXPO
DISCOLLECTION	Urban Access Control platform	The UAC is a platform that provides a link between digitized access regulation databases, planning tools from transporters and route guidance. It optimizes the transport planning for safe and efficient delivery and provides ideal routes for inner city traffic. It can suggest collaboration with Green Last Mile operators, when this is cost-efficient.	Digital tool	BeMobile/ VIL
DISCOLLECTION	Smart data platform	Platform facilitating data integration in a data space	Digital tool	IMEC
DISCOLLECTION	Digital twins for decision making (SULP)	Collect data from Logistic Service Providers to feed into the Digital Twin, as well as data from counting stations around the Inner City of Copenhagen. Simulations of different scenarios will be used in formulating the new Sustainable Urban Logistic Plan (SULP).	Digital tool	IRTX
DISCOBAY	Demonstration of multimodal delivery / pickups in the city	Demonstration of delivery of goods into the inner city with a cargobike and a barge, combined. More delivery of goods by barge.	Physical	OHB
DISCOBAY	Simulations in DT of effects of potential physical retrofit	To retrofit the Høje Taastrup terminal as a peri-urban and neighbourhood multimodal hub for reloading, adopting zero-emission vehicles through collaboration with local actors	Physical	COPENHAGEN / REGIONH
DISCOBAY	Urban Logistics Real Estate database	Mapping underused infrastructure and facilitating access to data on available empty/underused spaces managed by the municipality to create an integrated space availability observatory for Thessaloniki.	Digital tool	CERTH, Municipality of Thessaloniki

DISCOESTATE	Demonstration of temporary, multitenant and multipurpose hub	Demonstration at TIF HELEXPO Exhibition Centre as a logistics hub to operate with shared transport and logistics facilities (e.g., freight hotels)	Physical asset and business model	CERTH

Finally, transferability within the DISCO project was also carried out engaging the **Twinning Living Labs**. Throughout the project, Twinning Labs have been kept informed about ongoing demonstrations via webinars, documentation sharing through SharePoint, and direct engagement with Starring Labs. This process supports Twinning Labs in advancing their solutions from TRL 4-6 to TRL 6-7 while fostering collaboration and continuous learning.

A key moment in this exchange took place during the project meeting in Cologne in November 2025, where the Starring and Twinning Labs participated in a Scale-Up Workshop. Each Starring Lab was paired with three Twinning Labs based on the DISCO-X solutions tested, engaging in structured discussions to share implementation challenges, effective strategies, and anticipated impacts. The session also featured input from the Impact Creation Board, providing expert guidance on overcoming barriers and maximizing scalability.

Insights from this process are already being applied. Padua leveraged Copenhagen's experience with DISCOCURB to refine its use of historical delivery data and improve stakeholder engagement strategies. Barcelona identified the difficulties of transferring solutions across cities with differing regulations and congestion levels, emphasizing the need for context-aware scalability. Valencia and Zaragoza, meanwhile, gained valuable input on data-sharing agreements, microhub models, and logistics optimization tools tested in Thessaloniki, Ghent, and Copenhagen.

As the Twinning Labs move forward with their demonstrations, this continuous exchange of lessons learned will strengthen individual demostrations while contributing to a scalable framework for urban logistics innovation, ensuring that insights extend beyond the immediate project scope.

7.   Conclusions

The implementation of the DISCO-X measures across the four Starring Living Labs demonstrates the transformative potential of coordinated, data-informed, and place-based strategies for achieving **freight-efficient land use** and decarbonized urban logistics. Section 2 of this deliverable outlined the dual foundation of this approach: the strategic planning of physical logistics assets and the governance mechanisms necessary to ensure cross-sector alignment. These elements guided each Living Lab in its selection, adaptation, and testing of logistics measures.

Central to the DISCO project is the **Physical Internet (PI)**-oriented model, operationalized through the integration of shared nodes (e.g., microhubs, consolidation centres) and digital tools (e.g., Urban Freight Dataspaces, Digital Twins). The Living Labs demonstrated how cities can act as **neutral enablers** of urban logistics transformation—providing regulatory clarity, offering public

infrastructure, and facilitating stakeholder dialogue—without overstepping legal constraints that prohibit direct market intervention. This role was particularly evident in the **public-private partnerships** established in the living labs, which enabled the testing of consolidation hubs, smart lockers, and coordinated delivery operations through formalized agreements.

Another core lesson stems from the project's emphasis on **data interoperability and maturity**. The setup and orchestration of the Urban Freight Dataspace with data from all four cities revealed both the opportunities and challenges of integrating heterogeneous datasets from logistics service providers, municipalities, and digital platforms. These dataspace pilots underscored the importance of **data standardization**, governance, and security protocols, particularly when sensitive commercial or operational information is involved. Despite these challenges, the resulting platforms—linked with tools such as the WareM&O platform, UFDS connectors, and routing simulation systems—enabled advanced freight modelling, real-time monitoring, and the development of actionable KPIs. These capabilities directly informed the evolution of city-level SULPs and long-term urban freight strategies.

A key achievement across all SLLs was the successful establishment of **collaborative governance structures** involving municipalities, logistics service providers, infrastructure managers, and technology developers. These partnerships not only ensured operational feasibility but also helped embed tested solutions into the policy frameworks of each city.

Looking ahead, the integration of the DISCO-X measures into city governance frameworks and mobility plans positions the four Living Labs as frontrunners in the transition to **climate-neutral and digitally connected cities**. The lessons and tools generated from this implementation phase will feed into the Twinning Labs and the broader European community of practice, enabling further experimentation, refinement, and mainstreaming of urban freight innovations.

Ultimately, the DISCO project offers a compelling proof of concept for how freight-efficient land use, when combined with **Physical Internet principles**, data-driven governance, and inclusive stakeholder processes, can unlock a new generation of resilient, low-emission, and people-friendly urban logistics systems.