DISCO

Data-driven and Dynamic Space and Assets for Physical Internet-led Urban Logistics and Planning

D2.1 - Urban Logistics Transition Requirements

CERTH

29/12/2023

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List of acronyms

API	Application Programming Interface
B2B	Business to Business
B2C	Business to Consumer
BoL	Bill of Load
CO2	Carbon dioxide
DAC	Dynamic Access Control
DCAT	Data Catalog Vocabulary
DoW	Description of Work
DT	Digital Twin
EU	Europe
GDPR	General Data Protection Regulation
GIS	Geographic Information Systems
H2020	Horizon 2020
HORECA	Hotel/Restaurant/Café
ICBT	Impact Creation Board for Transformation
ISO	Organization for Standardization
IT	Information Technology
ITS	Intelligent Transport Systems
L/U	Land Use
LEZ	Low-Emission Zone
LL	Living Lab

LSP	Logistics Service Provider
LTZ	Limited Traffic Zone
NIST	National Institute of Standards and Technology
PI	Physical Internet
SDP	Smart Data Platform
SULP	Sustainable Urban Logistics Plan
SUMP	Sustainable Urban Mobility Plan
SWOT	Strengths, Weaknesses, Opportunities, and Threats
T	Task
TMS	Transport Management System
UAC	Urban Access Control
UFDS	Urban Freight Data Space
UFT	Urban Freight Trasport
UL	Urban Logistics
UN	United Nations
WaaS	Warehouse as a Service
WMS	Warehouse Management System
WP	Work Package

Executive Summary

Within the DISCO Project, Work Package 2, titled "The DISCO Urban Logistics and Planning PI-led Digital Transition" is focused on the dynamic use of assets and networks in city logistics through the implementation of five key DISCO-X innovations. Its main objectives include understanding the dynamics of urban logistics transition and assessing digital maturity at Living Labs. The focus of this deliverable is identifying drivers and tools essential for the digitization of urban logistics and planning, alongside promoting strategies and data needs. A significant task is developing tailored specifications for DISCO-X innovations at each Living Lab. Lastly, WP2 aims to navigate the urban logistics ecosystem at the participating cities, guiding them through the Physical Internet-led transition to achieve an efficient and integrated use of urban space, both physically and digitally.

To address the aforementioned objectives, a comprehensive approach was adopted. Central to this approach is the detailed analysis and mapping of the current state of urban logistics within the Living Labs, with a focus on evaluating their digital maturity and identifying key areas for digital transition through a SWOT analysis. The analysis uncovered a diverse array of strengths, weaknesses, opportunities, and threats across the eight participating cities of the project. It identified proactive sustainable mobility and logistics initiatives, and the use of technology in enhancing urban logistics as significant strengths. However, these are countered by administrative delays, financial constraints, and data collection issues which are present as weaknesses. Cities exhibit potential for growth by capitalizing on environmental sustainability trends and the rise of e-commerce. Nevertheless, they must navigate threats such as political instability, stakeholder resistance, urban space limitations, and data privacy concerns. These findings underscore the varied challenges and prospects within the urban logistics sector, guiding future strategic planning and implementation.

The Innovation Readiness self-assessment reveals that DISCO cities are on a promising path, with a maturity level between 65% to 70% in adopting innovative mobility solutions. However, aligning with the principles of the Physical Internet (PI) in freight mobility presents a significant hurdle. Most cities currently lack the smart infrastructure and regulatory support to effectively gather and manage freight-related data, impeding the ability to develop data-driven Strategic Urban Logistics Plans (SULP).

Next the DISCO-X innovations, fundamental to this phase, are defined to address the diverse challenges in urban logistics and planning. They focus on optimizing land use, reconfiguring city logistics planning processes, and fostering a shared use of urban assets and infrastructure. These innovations were shaped to be strategically implemented across different urban zones, from suburban areas to city centers. Building on the groundwork laid by the initial phases of the WP2 activities, the Starring Living Labs have documented their

strategies for adopting these innovations. Through bilateral meetings, goals for PI adoption were set, relevant data sources were identified, and necessary digital tools were discussed to enable the implementation of DISCO-X measures. This collaboration has shaped a PI operational paradigm for each city, which will be refined during the implementation based on the data and tools used.

To fully harness the principles of the PI, cities must improve their data collection frameworks, strengthen stakeholder engagement, and advance towards more integrated urban logistics planning. Hence, the creation and continuous development of an Urban Freight Data Space have been identified as a critical requirement to facilitate the transition to the DISCO PI-led innovations and the dynamic management of logistics assets and services. This deliverable provides a first definition of the UFDS and the requirements to enable the DISCO-X innovations implementation.

Concluding, the deliverable introduces the Meta Model Suite that will guide the cities through a structured adoption pathway for DISCO-X innovations. Its first draft architecture and functionality are outlined in this deliverable and it will play a pivotal role in enabling cities to effectively integrate innovative logistics solutions under the Physical Internet umbrella.

1. Introduction

1.1. The purpose of the deliverable

This document constitutes the Deliverable 2.1 “Urban Logistics Transition Requirements”. It was conducted in the context of the activity T2.1 “Defining digital transition baseline and specifications for the Meta Model Suite to enable transition” and defines the generalized transition paths of DISCO-X implementation, defines the specifications for DISCO-X implementation in cities and reports the maturity of DISCO cities to achieve transition to PI-led city logistics. Finally, it provides a draft overview of Meta Model Suite, and it actively contributes to the third milestone of the Project (Meta Model Suite functionalities defined).

DISCO aims at fast-tracking and upscaling to a new generation of urban logistics and smart planning; enabling the transition to decarbonized and digital cities, delivering innovative frameworks and tools, and changing the Urban Logistics and Planning paradigm with a Physical Internet (PI) – led approach. DISCO involves a community of logistics service providers, mobility and technology providers, data and infrastructure. Towards this scope, DISCO partners and stakeholders will co-design, deploy, demonstrate, evaluate, and replicate innovative, inclusive, hyperconnected and data-driven urban logistics and planning solutions. The resulting dynamic and optimal space re-allocation, integrating urban freight within an efficiently operated network-of-networks (PI-led), exploiting underused lands and assets, will include both fixed and mobile infrastructure, based on throughput demands.

To achieve its objectives, DISCO is pursuing the implementation of five DISCO innovations for dynamic use of assets and networks in city logistics:

1. **DISCOCURB:** Digital and dynamic curb side management of loading on street parking zones. Demonstration of citywide approach for curb management with advanced data analytics, implementing curb performance metrics and optimize loading/unloading dock management system and dynamic LEZ and spatial management, via Digital Twin (real-time information, dynamic space management, smart parking) (Abel et al., 2021; McCahill, Weinberger, & Shoup, 2016; Eisele, 2014; Pacrez, Lipscomb, Ayuk, Stokes, & Patterson, 2020; Rosenblatt, 2020; San Francisco Municipal Transportation Agency, 2014).
2. **DISCOPROXI:** Proximity-based last mile solutions with optimal routing and consolidation at localized micro-hubs with low emission vehicles. DISCOPROXI aims at the demonstration of adopting proximity areas, typically micro-hubs, where dedicated space for loading and unloading serve nearby destinations (typically for small scale operations engaging a very limited number of people) (Demir, Syntetos, & van Woensel, 2022; Giuffrida et al., 2022; Lyons & McDonald, 2023; Moradi, Sadati, & Çatay, 2023; Özarık, Veelenturf, Van Woensel, & Laporte, 2021; Tiwari & Sharma, 2023).

3. **DISCOESTATE:** Temporary, multistorey, and multipurpose model for optimized use of underused buildings for last mile logistics operations - Demonstration of strategically positioned and temporarily used buildings. It implies a new cross–sectorial collaboration model for shared use in consolidation centres, supported by clear regulation, and incentives. By identifying and repurposing underutilized spaces for logistics activities, such as micro-distribution centers or smart lockers, cities can optimize the use of available urban land (Holguin-Veras et al., 2021; Schachenhofer et al., 2023). DISCO aims at demonstrating temporary, dynamic use and re-purposed underused buildings (e.g., Exhibition Centre in Thessaloniki) for hosting logistics activities and optimization of their use through smart solutions.
4. **DISCOBAY:** On demand model for warehouse use rolling out sustainable transport modes – This is a demonstration on optimization of temporary leaving quarters with shared transport facilities and their added value as new multimodal consolidation centres operating freight logistics delivering goods. DISCO considers this model a way of making good use of unused/unexploited public and private urban lands managed/owned by railway operator for achieving the planning and operation of the city optimal multimodal hubs (Supply Chain Hub) for last mile deliveries. (Deloitte, 2017; Sert et al., 2020)
5. **DISCOLLECTION:** Advanced data collection methods to optimize real-time vehicle routing, incentivized and dynamic access permission and smart network management - Demonstration of data collection and valorization and application of advanced freight modelling techniques and smart data analytics solutions for optimizing freight flows. It will include integration of data driven techniques to SULP development of dynamic access control adopting AI & machine learning and planning tools. (Chase et al., 2013; Capka, 2008).

For each DISCO X innovation, existing tools and applications will be enriched and integrated with other systems and technologies for making proof and assessing the impact each innovation has to the achievement of sustainable PI city logistics operation within the DISCO Living Labs. In order to meet environmental and social goals, the dynamic operation of networks and the dynamic and optimal space reallocation in city logistics require an ecosystem approach. In the context of WP2 "The DISCO urban logistics and planning PI-led Digital Transition", the priority objectives are:

- Understand Urban logistics transition dynamics at LLs to identify digital maturity.
- Define upscaling drivers and tools leading to urban logistics and planning digitization and promote strategies and data needs.
- Draw common specification for DISCO X innovations implementation at Living Labs.
- Navigating urban logistics ecosystem at DISCO Living Labs through the PI-led transition process for achieving shared use of urban space physical and digital.

The current landscape of Urban Logistics and Planning in DISCO Living Labs is characterized by variety of challenges stemming from the rapid urbanization, the access control to city centers and the ever-growing demand for timely and efficient goods delivery. Traffic congestion, air pollution, and the spatial constraints of urban environments pose significant hurdles for traditional freight management systems. To address these challenges, innovative solutions have emerged at the intersection of technology and logistics. Last-mile delivery optimization using route planning algorithms, smart city initiatives, and the integration of e-commerce platforms with urban logistics networks seek to enhance the efficiency of goods movement within cities.

The rapid development of technology paved the way for cities to adopt innovative and technology driven mobility and logistics solutions to enable their transition to sustainable and zero emission city model. Towards this direction, the concept of Physical Internet to city logistics is supported by DISCO; this concept can be beneficial, but it also faces many difficulties. City logistics is a domain with very fragmented data availability for optimal planning and operation under shared, optimal and dynamic models.

In this context DISCO is following the Living Lab approach in demonstrating its innovations in cities. DISCO-X innovations are planned and demonstrated within ecosystems[1] of public (cities) and private (city logistics industry) actors in a process of continuous development of knowledge dedicated tools, collaboration, and dynamic data sharing. The readiness and the maturity of these ecosystems to achieve these developments and transition to PI-led city logistics, is continuously assessed and improved during the lifecycle of the project. The outcomes of this process will be consolidated by the end of the project in the DISCO Meta Model Suite that will support city planners and city logistics industry to pave the way of dynamically shared and optimally managed urban freight operations. More specifically, this deliverable contributes to:

- Understand the generalized functioning & the requirements for making the DISCO-X Innovations Operational in City logistics environments.
- Define specifications for the DISCO X implementations at the involved cities.
- Assess the barriers & enablers for DISCO-X innovation adoption.
- Assess maturity of the DISCO cities in transitioning to PI-led city logistics & discuss the role of planning.
- Summarize requirements for the Urban Freight Data Space (UFDS) creation.
- Define the first cut view of the DISCO Meta Model Suite.

[1] The Urban Mobility ecosystem approach was recently introduced to represent city as a biological ecosystem and include the interrelations between the main elements of their urban mobility system (Karim, 2017).

1.2. Structure of the Document

Chapter 2 outlines the scope and methodology of WP2 in the DISCO project, focusing on the steps implemented for this deliverable and highlighting the requirements and approaches for digital transition in urban logistics and planning. It also examines the interrelations of these efforts with other tasks within the project. **Chapter 3** presents a detailed examination of the DISCO-X innovations and their implementation requirements. This includes a relation of each DISCO-X innovation to the Physical Internet (PI)-led city logistics operations at urban nodes and covers specific innovations such as DISCOCURB, DISCOPROXI, DISCOESTATE, DISCOBAY and DISCOLLECTION. Each innovation is explored in terms of its challenges, practical examples, scope, tools, data requirements, regulations. Towards the end of each subsection a generalized path for transition to implementation is presented. Building upon the foundational knowledge established in Chapter 3, "The DISCO-X Innovations Definition & Implementation Requirements," **Chapter 4** delves into the practical aspects of implementing these innovations in the Starring Living Labs. This chapter is centred around the insights gained from bilateral meetings conducted with these Living Labs. **Chapter 5** is dedicated to defining the Urban Freight Data Space (UFDS) for PI-led city logistics transition, outlining the requirements to enable DISCO-X innovation implementation and discussing the DISCO-X tools connectivity requirements. In **Chapter 6,** the maturity of cities in transitioning to PI-led city logistics and the role of planning is investigated. This includes an analysis of the innovation readiness of the participant cities, assessments of their Sustainable Urban Mobility and Logistics Plans (SUMP/SULP), and a comprehensive SWOT analysis for each city which was then validated by the ICBT (Impact Creation Board for Transformation) of DISCO. **Chapter 7** provides a first cut-view of the Meta Model Suite, detailing its components such as the Knowledge Hub, Transition Enabling Framework and the role of the DISCO-X Innovations and their required tools. Finally, Chapter 8 concludes the deliverable, synthesizing the insights and developments presented throughout the document.

2. Methodology for UL Transition Requirements

This section presents the overall scope and the methodology of WP2, and the more detailed methodological steps implemented for this deliverable. Overall, the research work performed aimed to consolidate knowledge and tools to guide stakeholders through the Physical Internet-led transition process by facilitating shared usage of urban space, physical, and digital infrastructure.

2.1. Aim and Methodology of WP2 for urban logistics and planning digital transition

WP2 is designed with multifaceted objectives to comprehensively address the transition dynamics of urban logistics at Living Labs with the following goals:

- Firstly, the aim is to map and analyses the current state of urban logistics transition dynamics across Living Labs, focusing on identifying and assessing the digital maturity within these systems.
- Secondly, the framework aims to provide substantial support to Living Labs by enabling them to anticipate future market demands through a structured approach, thereby fostering resilience and adaptability.
- Thirdly, the objective is to define the critical drivers and tools essential for upscaling urban logistics and planning digitalization while advocating for strategies and data prerequisites necessary for this transformation.
- Fourthly, the plan involves drawing cohesive specifications for five DISCO-X implementations, crucial for the successful transition toward digitalization. Additionally, this framework will establish an Impact Assessment mechanism, evaluating the implementation process and the life cycle of the transition.
- Finally, the overarching goal is to empower local authorities and businesses by harnessing urban logistics innovations, implementing data-driven planning actions that align with the needs of citizens and local economies, thereby achieving a fully digitalized and interconnected DISCO-X system through updating SUMP/SULP documents for each city.

The flowchart of Figure 1 describes the procedure that will be followed in WP2 from the initial definition of the DISCO-Xs to the update of the planning documents for each city.

Figure 1: Process for bridging PI-led city logistics solutions with city's planning.

In accordance with the DoW, each DISCO-X innovation, prototype guidance to implementation, tools for fine tuning and urban freight data space interoperation are assigned to a partner with relevant background which will be determined as DISCO player/responsible. To grow common knowledge among the project partners and clarify the value proposition of DISCO-X innovation to the cities of the project, the DISCO player outlined the solutions offered by DISCO-X and establish the minimum criteria tailored to each solution to be implemented. Each living lab has already defined measures for paradigm shift to PI-led city logistics, using/promoting individual DISCO-X innovations. In living labs, the city logistics innovation adoption is served by maturing the dynamic data availability, the tools supporting operations of DISCO-X innovations in real environment, business collaboration of private actors and regulations/incentives and new planning by the municipalities. This deliverable fulfills the first three steps of Figure 1; which will be determined as input for T2.3 (Step 3), T2.1.4 (Step 4) and T2.5 (Step 5). The following table (Table 1) contains the different DISCO solutions together with the typology of the measure in terms of Digital, Physical and Business:

Table 1: Classification of the DISCO innovative measures within Impact Domains (source: DoW)

Elements that influence digital transition in urban logistics

Innovation measures typology	IMPACT DOMAINS: Shared solutions	Connected logistics	Smart logistics	Urban network management	Agile storage and last-mile distribution
DIGITAL	TESS_01_DISCOPROXI	TESS_04_DISCOLLECTION GHE_01_DISCOPROXI COPE_04_DISCOLLECTION BARC_02_DISCOLLECTION	GHE_03_DISCOLLECTION HEL_03_DISCOLLECTION ZAR_03_DISCOLLECTION	PAD_02_DISCOLLECTION	HEL_01_DISCOCURB COPE_01_DISCOCURB BARC_01_DISCOCURB
PHYSICAL	TESS_02_DISCOESTATE	COPE_03_DISCOBAY	VAL_03_DISCOBAY	PAD_01_DISCOPROXI	VAL_02_DISCOESTATE
BUSINESS	GHE_02_DISCOBAY	COPE_02_DISCOPROXI VAL_01_DISCOPROXI	ZAR_01_DISCOPROXI	HEL_02_DISCOPROXi	TESS_03_DISCOBAY

The DISCO project involves 8 Living Labs designed for testing and demonstrating innovative urban logistics and planning solutions. These Living Labs fall into two groups: the Starring Living Labs and the Twinning Living Labs. In addition to the Living Labs, four Follower cities and regions will be observing and working out how the lessons learned might be applied in their own circumstances. The Starring Living Labs represent the initial set that will implement and test DISCO's solutions, offering valuable feedback and insights crucial for refining and enhancing these solutions. Meanwhile, the Twinning Living Labs will replicate and adapt the solutions developed by the Starring Living Labs to fit their own local contexts. The Twinning Living Labs will also contribute feedback and insights to further refine the solutions.

The DISCO project's goal is to expand the reach of its solutions beyond the initial Starring Living Labs by engaging the Twinning Living Labs. This expansion ensures efficient learning within the DISCO lifespan, facilitating the transfer of knowledge from Starring Living Labs to the Twinning Living Labs and to Follower cities and regions, and enabling further knowledge transfer on a national level.

Towards this goal, this deliverable has two main goals:

(i) **To define the requirements necessary for a city to successfully implement DISCO-X innovations,** and

(ii) **To propose the Physical Internet operational paradigm tailored for each Starring Living Lab, aiming to facilitate their preparation for the impending implementation.**

For this purpose, this specific deliverable follows a 5-step methodology described in the Figure 2.

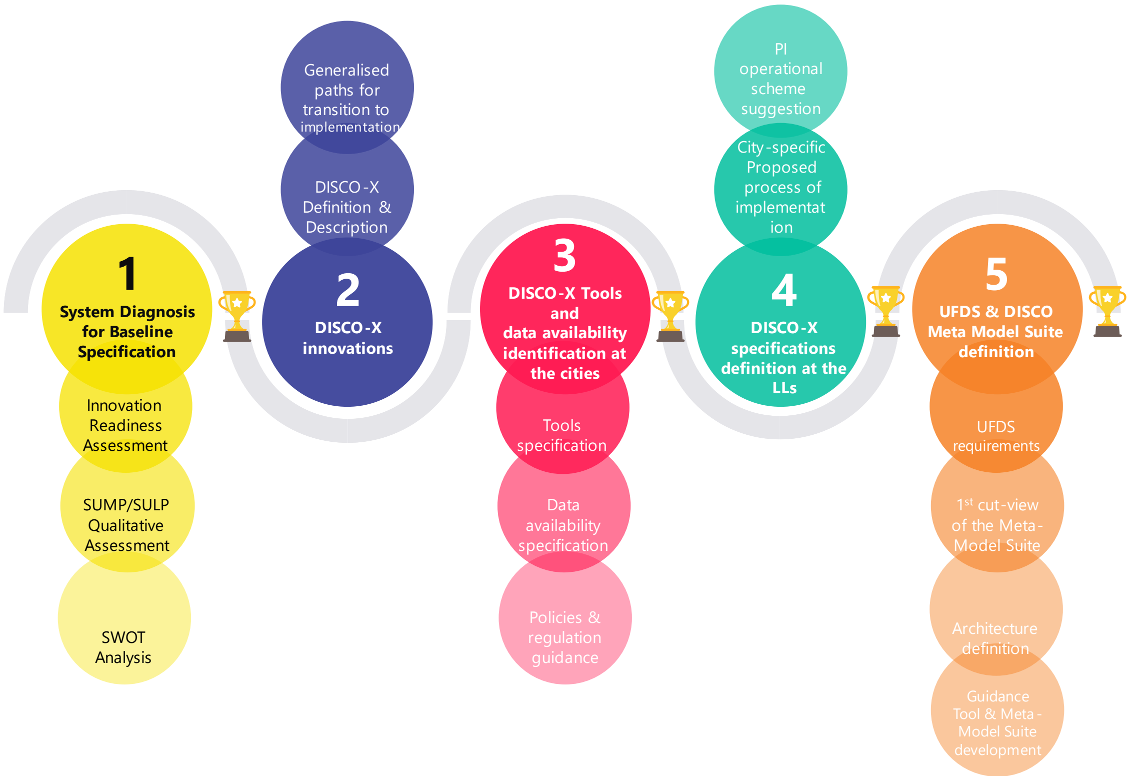


Figure 2: The general methodology followed for the deliverable.

Figure 2 depicts the general methodology for this deliverable. The process begins with the first step of system diagnosis to evaluate the existing urban logistics ecosystem of a city, assessing readiness for innovation and identifying weaknesses through a SWOT analysis. Also, the results of the SWOT analysis were validated by the LL and the ICBT. Concurrently, the second step involves the definition and description of DISCO-X innovations, including necessary tools, data, supportive policies, and regulations for their adoption. The insights from the first two steps are utilized in the third step to outline DISCO-X tools, data availability at the cities, and tool specifications. This step also involves validating the DISCO-X requirements with cities based on their specific use cases and capabilities.

The fourth step is about the creation of individualized PI operational schemes for each Living Lab, which, also, includes proposing city-specific processes of implementation. The final step introduces the DISCO Urban Freight Data Space and the Meta Model Suite, which assist cities in selecting appropriate DISCO-X solutions based on their capacities and requirements, serving as a guide to successful implementation. The Meta Model Suite, while outlined here, is subject to future enhancements and development. Each trophy of the figure represents one major outcome of the methodological framework. The first one includes the maturity assessment of cities towards PI-led innovation. The second one includes DISCO-X requirements and the generalized transition paths, the third one is the suggested PI-operational paradigm at Starring Living Labs and the last one is the draft version of Meta Model Suite.

In a nutshell, the methodology initiates with a comprehensive assessment of the cities' readiness for innovation, followed by detailing DISCO-X innovations and their implementation requirements. These findings are then leveraged to propose a tailored implementation path for each city's use case. The result of this process is the initial definition of the components of an online platform, the Meta Model Suite, which will guide the cities in transitioning their logistics and urban planning towards a PI-led approach.

2.2. Iterative process for DISCO-X measures definition and requirements

The DISCO-X innovation framework embodies innovative urban logistics solutions underpinned by the fundamental principles of the Physical Internet paradigm. This section delineates the process that was followed by the Work Package 2 leader to prepare the core characteristics of the DISCO-X innovations and outlines the distinctive prerequisites associated with each individual DISCO-X iteration (refer to Figure 3).

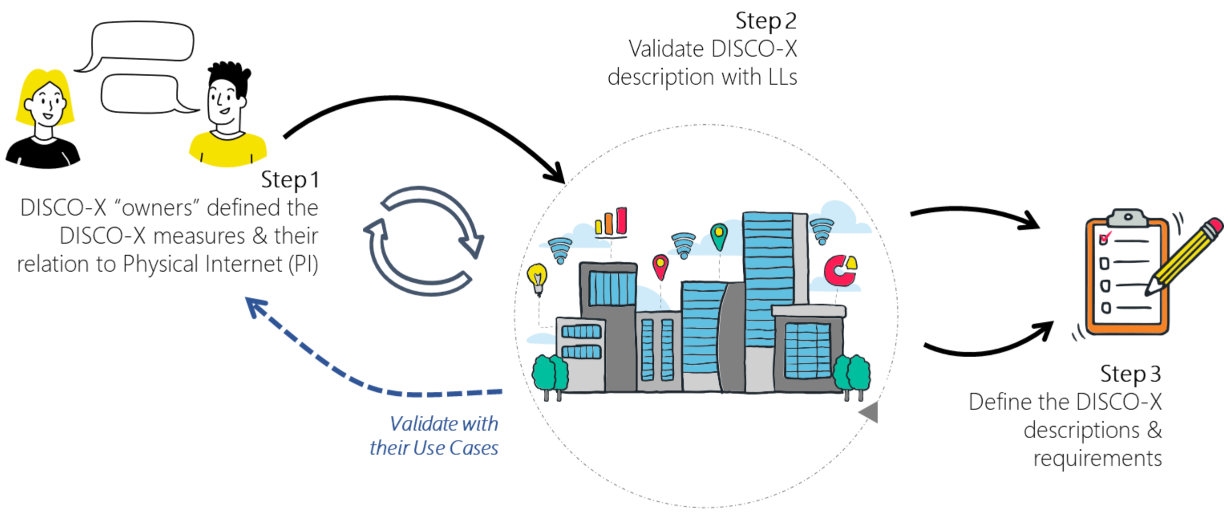


Figure 3: The methodology of DISCO-X definition and requirements.

The DISCO-X innovations shaping process was highly collaborative and cyclical, involving multiple iterative cycles and bilateral meetings between the DISCO-X players and cities. The DISCO-X players, drawing on their expertise and relevant literature, outlined the innovations and their interplay with the Physical Internet concepts. However, the objectives sometimes differed from the cities' goals, or the cities lacked the resources to fully implement the DISCO-X concepts as originally proposed by the DISCO responsibles/players. As a result, the cities were briefed on the proposed DISCO-X innovations and provided feedback based on their unique use cases, capabilities, and ambitions. This back-and-forth refinement process led to several revisions and ultimately, the establishment of a preliminary DISCO-X description and requirements as shown in the figure below. These DISCO-X requirements templates are presented in detail in Annex 1.

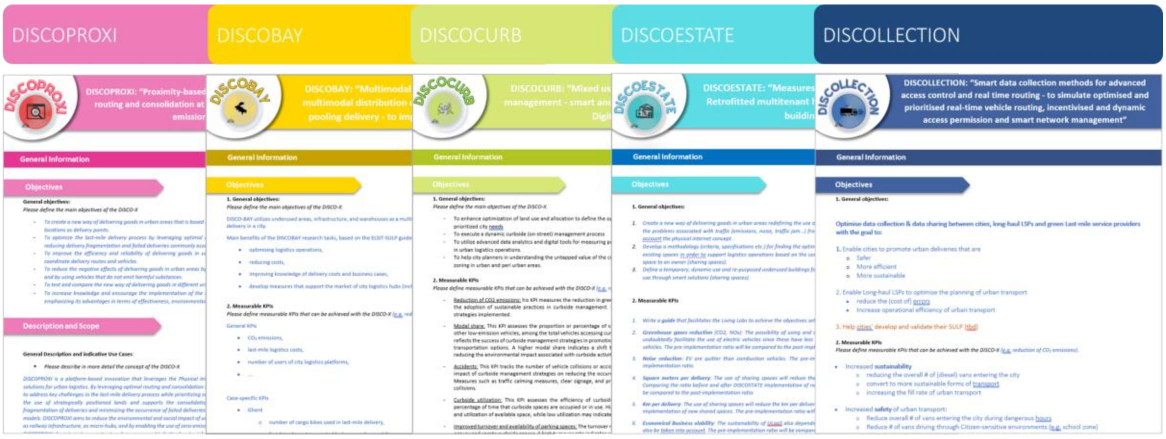


Figure 4: The DISCO-X requirements templates

It is important to highlight that during this phase, a consensus emerged among the partners and the cities that the DISCOLLECTION innovation would serve as a horizontal solution—available for all cities to adopt, rather than being tailored to individual city measures. This approach positions DISCOLLECTION as a universal tool within the project, facilitating data sharing under the umbrella of the Urban Freight Data Space and integration across different urban contexts.

2.3. Interrelations with other tasks

The results of the System Diagnosis and SWOT analysis (Subtask 2.1.1) will directly feed the definition of the proposed transition paths (Subtask 2.1.2) and the cities' typology (Subtask 2.1.4). Also, indirectly, they will be used for the development of the Physical Internet-led Digital Transition Tool (Task 2.2) and the update of SUMP/SULP to the cities (Task 2.5). Additionally, the Draft DISCO-X requirements will be the baseline for the DISCO-X Meta Model Suite innovations (Task 2.3) and will be used as input for the WP3 Data Spaces (Task 3.1). The proposed transition paths will be used as input to the WP4 Starring Living Labs to help cities get prepared for the implementation of the DISCO-X innovations. Also, these proposed transition paths will be used to create a generalized transition path to Physical Internet-led city logistics (Subtask 2.1.4).

3. The DISCO-X innovations definition & implementation requirements

3.1. Relation of DISCO X innovations to PI-led city logistics operation at Urban nodes

DISCO is contributing to the take-up and upscaling of innovative, best practice, and replicable data-driven logistics solutions and planning in the Living Labs following the Physical Internet paradigm (ALICE, 2020; Dong & Franklin, 2021; Sharma et al., 2022; Ambra et al., 2019). In this context, DISCO-Xs are understood as a set of innovative solutions to address the challenges of urban logistics and planning. These solutions are designed to be economically viable and sustainable, driven by relevant technologies, and demonstrate the convenience of consolidation and the ability for driving reconfiguration of logistics operations (McKinnon et al., 2015).

At urban nodes, reconfiguring city logistics to become PI driven requires to:

- Optimize the potential mix of strategically positioned land, owned by public authorities with privately managed logistics infrastructure for minimizing number of tonne kilometres and efficiently match emerging last mile delivery logistics demand to new generation of city logistics supply,
- Change the process of city logistics planning making Municipalities central to a new planning process that will be based on a better understanding of the impact of increasing transport and logistics patterns on the climate and environment, the resilience and robustness of the transport & logistics networks, and of the urban infrastructure,
- Create the business and the technological conditions for more dynamic and shared use of existing logistics infrastructure and services in an urban area and development of new zero pollution services.
- Develop the governance at city that will leverage the actor's & citizen's collaboration and the city logistics ecosystem capacity to adopt innovation.

The DISCO-Xs are developed and deployed by technical and business innovators partners who are working to generate innovation-based growth for involved stakeholders and are tested and demonstrated in a set of Living Labs that are designed to replicate and adapt the solutions to their own local contexts.

Figure 5 illustrates the holistic proposal of the DISCO X innovations towards a dynamic management & a shared use of land and assets in an urban node, with the aim to provide seamless & green accessibility of the city logistics flows (Crainic & Montreuil, 2016; Ballot & Montreuil, 2013). Each of the four concentric circles are representing a zone of an urban node for which the DISCO-X is offering a PI driven value proposition for planning and Operation of last mile logistics.

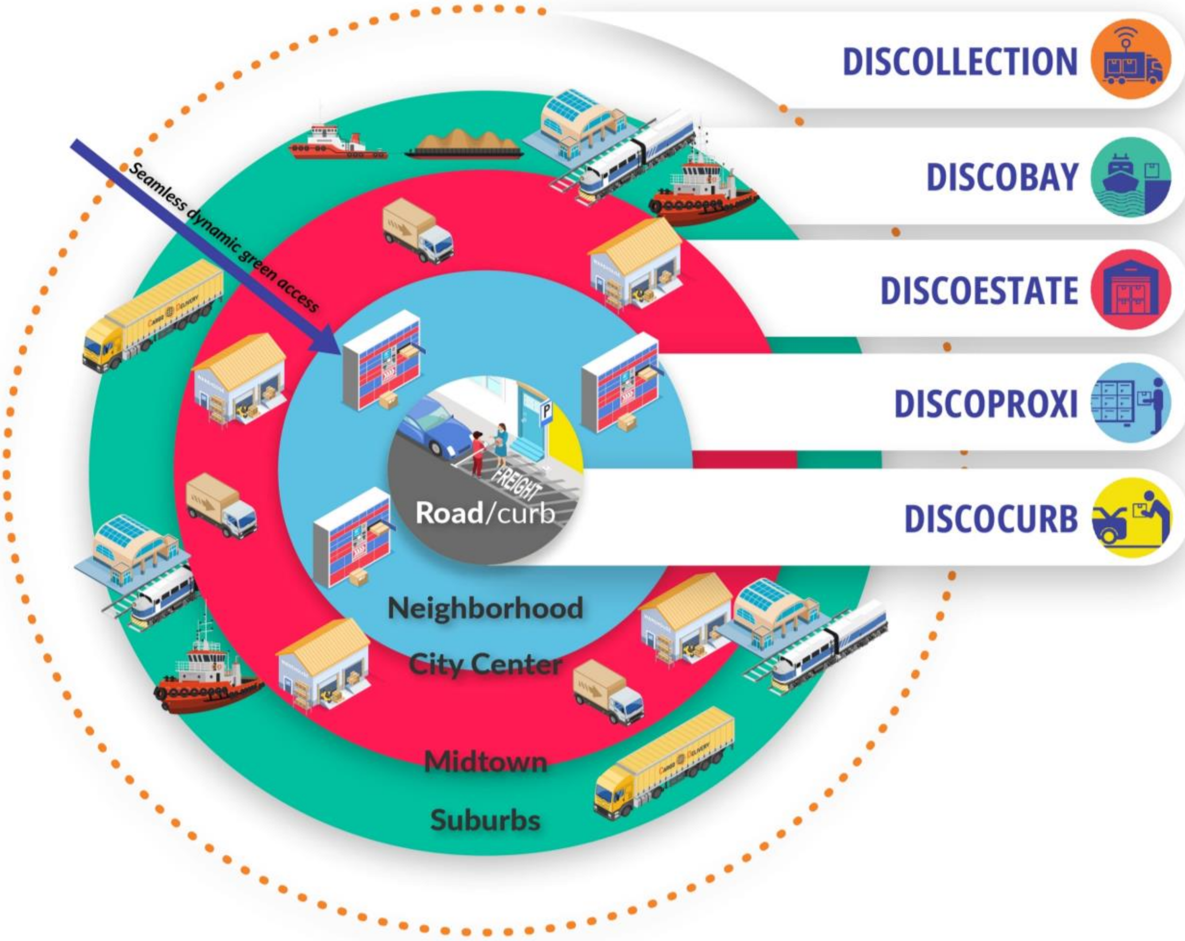


Figure 5: A Spatial Perspective of DISCO-X Innovations within the Physical Internet paradigm of Urban nodes.

The TEN-T is reaching the Urban node at remote nodal points in the suburbs. Traditionally, at these locations the major logistics centers are created (being "nuisance land uses") serving long haulage flows and a lengthy last mile starts from these points by trucks to reach final destinations positioned in the inner city. **DISCOBAY**, is targeting to these long haulage flows of the city to turn them to multimodal by utilizing underused transport infrastructures/terminals which present huge potential in driving the goods towards the centre of the urban core with green modes (by rail, inland waterways, electric vehicle with sufficient loading capacity etc.). The PI-led proposition of DISCOBAY enables the planning and the shared, dynamically used, cost-effective and digitally enabled operation of such multimodal infrastructure and last mile service, avoiding additional investments and CO2 emissions. A shared and digitally enabled, use of such a logistics multimodal node and of the next green mode service are important for urban node sustainability and for the economic viability of such an operation, since additional mode change is always adding costs and complexity to logistics.

At midtown of the urban nodes area logistics SMEs have developed their distributions centres and warehouse while new generation of fulfilment centres are emerging in an attempt to reduce transport cost and delivery time. Cost of land is increasing in these areas and empty buildings are increasing as a result of urban transformation. As logistics become more demand responsive and just in time, the unused capacity of Distribution Centres & Warehouses provide opportunities for free space offering to third parties. **DISCOESTATE**, PI-led offering aims at dynamically manage short term use of unused capacities by matching logistics demand & supply & offer digital support for business agreements also for green modes sharing. This approach has positive impact in cities land use development, since through optimized use of underutilized buildings/warehouse capacities the demand for developing new logistics infrastructure is reduced together with the cost of logistic operations offered in the as a service model.

At 'neighbourhood' level, zero last mile delivery solutions should be implemented respecting access control & low emission related regulations of the cities. The PI-led offering for efficient management of last mile operations at this urban node level is provided by **DISCOPROXI** which aims at dynamic planning operation and management of the micro hubs for fulfilling demand variations by offering customized and adaptable, to the residential and commercial vicinities, hub infrastructure and green B2B & B2C city logistics operations.

The dynamic & optimal management of capacities in accordance with the demand, which is the focus on PI paradigm, it may also be applied in the efficient management of street space. Urban nodes streets are hosting multiple uses (car parking, charging stations, electric car & micro mobility sharing infra, etc) and are subject to optimal & dynamic use of its infrastructure capacity. **DISCOCURB**, PI-led offering is focusing on the dynamic management of the on-street parking capacity to better balance with the demand of the immediate areas adjacent to city centre streets for contributing to the effective goods movements.

Although **DISCOLLECTION** is depicted as the outermost circle among the five innovations, it fundamentally interlinks them all. It serves as the cohesive element that unites every aspect of data sharing across the innovations. As will be detailed in the subsequent subsections of this report, DISCOLLECTION equips the Living Labs with the necessary tools to onboard their data onto the Urban Freight Data Space, thereby enabling the effective utilization of DISCO solutions.

All DISCO-X innovations may create an impact in distinguished parts of the city; if combined, may cover the whole urban node requirements for climate neutral & efficient city logistic through data and technology driven PI paradigm (Montreuil et al., 2012).

This chapter combines the comprehensive input gathered from DISCO-X players, delineating the specific challenges associated with each DISCO-X and their connection to the Physical Internet concept. It also includes a realistic use case demonstrating the application of DISCO-X. Furthermore, the chapter delves into detailed aspects for each DISCO-X, encompassing the scope of innovation, both physical and digital infrastructures, data prerequisites, business models, regulatory frameworks, and the overarching pathway for a generalized transition. For each Generalized Transition Path, a number of first steps can be considered as early drop or easy wins. The steps after the early drop describe the procedures that need to be done to reach the full implementation of the DISCO-X or the scale up of the measure. The questionnaire used for this process is available in Annex 1, and the requirements of each DISCO-X innovation together with their generalized transition paths are presented in the subsequent sections.

3.2. DISCOCURB

3.2.1. DISCOCURB Challenge & PI-led response

The problem that DISCOCURB comes to solve for cities and their urban spaces is the inefficiency and suboptimal use of curbside spaces in them. The current curbside management practices often lack the use of advanced data analytics and digital tools, leading to challenges in optimizing land use allocation and managing loading/unloading areas in urban logistics operations. This inefficiency results in congestion, delays, and reduced accessibility for logistic operators, businesses, residents, and transportation services. **DISCOCURB** aims to address these issues by implementing a dynamic curb side management process using advanced data analytics and digital tools. By doing so, it seeks to enhance the performance of loading/unloading areas, determine the optimal allocation of curb side capacity, and cater to the diverse needs of the city. The integration of dynamic curb side management with other urban planning initiatives allows for a coordinated and comprehensive approach to maximize the value and functionality of curbside spaces.

Given the goal of DISCOCURB to contribute to optimize urban logistics and transportation operations, it is also strongly related with Physical Internet with which shares this objective. Then, overall, Physical Internet aims to create a global, interconnected and sustainable logistics system based on principles of modularity, standardization and collaboration.

3.2.2. A practical example of DISCOCURB

A municipality faces challenges with curbside management, leading to congestion, delays, and reduced accessibility. Local businesses struggle to efficiently access curbside areas for loading and unloading goods, causing disruptions in supply chains and customer satisfaction. Residents find it difficult to find parking spaces, impacting the overall liveability of the city.

To address these issues, a city decided to implement a comprehensive curbside management solution with the integration of a Digital Twin. Using a digital twin, the city planners simulate various allocation scenarios based on real-time data and curbside activities to find the most efficient distribution of parking spaces. The Digital Twin also reflects the current state of curbside spaces, allowing city officials to monitor utilization, occupancy, and real-time changes in the environment. This enables the city to identify bottlenecks and inefficiencies, leading to targeted improvements. To implement this solution the city needs to install sensors and cameras at curbside spaces to collect real-time data, which is then fed into the digital twin.

3.2.3. DISCOCURB's Scope of Innovation

DISCOCURB refers to the overall approach to be implemented by the city to address the challenges of curbside management. It represents a data-driven, technology-enabled, and dynamic process that supports the objectives of enhancing curbside use allocation and executing dynamic curbside management utilizing advanced data analytics and digital tools. It is not just a single solution or technology but represents an integrated approach that combines various elements to optimize the use of curbside spaces effectively. DISCOCURB relies heavily on data analytics and real-time information to make informed decisions and drive actions.

3.2.4. DISCOCURB Tools, Systems and required infrastructure

DISCOCURB is focused on how a city can utilize the curbside in a smart, dynamic and connected way. Depending on the city's technological capabilities, a specific set of tools, systems, and digital infrastructure can enable the city to apply the Physical Internet concept at the curbside level of its urban areas. This allows for the most dynamic and interconnected utilization of curbside spaces possible.

- **IT sensors and cameras:** These sensors can be embedded in individual parking spaces to detect the presence or absence of vehicles. They provide real-time data on parking occupancy, enabling accurate monitoring and management of curbside spaces. Smart sensors can be magnetic, ultrasonic, or infrared-based.
- **Digital Twin (or in alternative advanced data analytics tool):** A digital twin can operate as digital content aggregator that will be connected to these IT sensors and other data sources to gather real-time information about curbside utilization, occupancy, and logistics activities. This data can be visualised and used to monitor the status of curbside spaces, identify bottlenecks or congestion, and make informed adjustments to curbside management strategies on the fly. By doing so, the cities can identify optimal times and locations for loading and unloading activities, contributing to both a more streamlined urban traffic flow and logistics operations flow.
- **Smart Curbside Booking system:** These systems enable logistics operators or delivery services to book designated loading and unloading zones in advance. They provide a streamlined process for reserving time slots, managing logistics operations, and avoiding conflicts with other curbside users.
- The integration of a Smart Curbside Booking System with a **Mobile Application** will offer a seamless and accessible platform for the various stakeholders, including logistics operators and city residents, to interact with and utilize curbside spaces effectively as it will provide real-time information on curbside space availability, allowing users to make reservations on-the-go. The application can provide notifications, maps, and depending on the city's chosen business model, even payment options or serve as a communication channel, providing updates on curbside regulations, traffic conditions, and any changes in reservation status.
- Lastly, **Digital Street signage** (or similar infrastructure) is needed to communicate the current parking status and availability to the potential users that don't use a mobile application to get notifications on-the-go.

This data-driven approach ensures that decisions are based on actual usage patterns and helps city planners understand the demand for curbside spaces at different times and locations. The city can then dynamically adjust curbside regulations, such as loading/unloading zones and parking restrictions, based on the current needs and traffic conditions. This dynamic process ensures that curbside spaces are utilized optimally throughout the day, reducing congestion and enhancing overall efficiency.

3.2.5. DISCOCURB Data Requirements

For **DISCOCURB**, the essence lies in leveraging real-time or near-real-time data, which is crucial for awareness of curbside space usage, for accurately defining and managing these areas within a city, for ensuring compliance with regulations and for informing and optimizing curbside management strategies.

- **Occupancy Data:** Real-time data on the occupancy status of curbside spaces is essential for tools like smart parking sensors and occupancy detection systems. This data indicates the availability or occupancy of parking spots, loading/unloading zones, or other curbside areas.
- **Geospatial Data:** Geospatial data, including maps, boundaries, and coordinates, is necessary for accurately defining curbside zones, parking areas, and other relevant geographical features. It provides the spatial context required for effective dynamic curbside management.
- **Enforcement Data:** Data related to enforcement activities, such as violation records, citations issued, and enforcement officer logs, enables monitoring of compliance with curbside regulations. It helps identify areas of non-compliance and informs enforcement strategies.
- **Traffic Patterns:** Understanding traffic patterns, such as peak hours, rush periods, or seasonal variations, is essential for planning curbside management strategies. Traffic pattern data informs decisions on the allocation of curbside resources, enforcement strategies, and the timing of operational activities.

3.2.6. DISCOCURB Business models

To ensure viability, DISCOCURB requires the establishment of specific business models. These models should be designed to address the unique challenges and opportunities offered by smart curbside management, based on the needs of various stakeholders involved.

- **Technology Providers Business Model:** Tech companies that offer smart city solutions, data analytics platforms, and digital tools can partner with the cities to provide the necessary technological infrastructure for DISCOCURB. The technology providers can benefit from user feedback and insights gained during the pilot implementation, which can be used to further refine and improve their solutions for broader market applications.
- **Consultancy Services:** Data analytics firms specializing in urban mobility and logistics can offer their expertise to cities. They can assist in analyzing the real-time data collected from the curbside management system, providing valuable insights to optimize land use allocation, pricing strategies, and traffic flow. These firms can adopt a consultancy-based

business model, charging cities for their services and expertise in data analysis and urban logistics optimization.

- **Logistics Service Providers:** Cities can offer incentives to these companies to adopt the DISCOCURB solution, which can lead to improved last-mile delivery efficiency and reduced delivery congestion.

3.2.7. DISCOCURB Regulations

Given that curbside spaces are a critical aspect of urban infrastructure, their management through well-thought-out regulations is essential for dynamic, safe, and efficient functioning.

- **Zoning and Designation of Curbside Spaces:** Cities should establish clear zoning and designation of curbside spaces to accommodate different activities such as parking, passenger pick-up and drop-off, goods delivery, and loading/unloading. This involves designating specific areas for each activity and clearly marking curbside spaces with appropriate signage and markings.
- **Time Restrictions and Pricing:** Implementing time restrictions and pricing mechanisms can help manage curbside demand and encourage turnover. Time limits on curbside parking can ensure a constant flow of available spaces, while pricing strategies such as metered parking, variable pricing based on demand, or congestion pricing can incentivize efficient use of curbside spaces.
- **Permitting and Licensing:** Establishing permit and licensing systems can regulate curbside activities such as delivery and passenger pick-up services. This helps ensure compliance with regulations, manage congestion, and maintain order at curbside spaces. Permits may include specific requirements, such as designated time slots or vehicle types for certain activities.
- **Emergency and Special Event Protocols:** Cities need to develop flexible regulations to manage curbside spaces during emergencies or special events, ensuring adaptability and resilience.
- **Equity and Fair Access:** Cities need to set regulations to ensure equitable access to curbside resources, preventing monopolization of spaces and prioritizing needs based on community impact.

3.2.8. DISCOCURB Generalised path for transition to implementation

The DISCOCURB PI-led innovation is poised for implementation in Helsinki and Copenhagen, and in the second stage in Barcelona. This innovative approach is structured around a methodically designed transition path, developed through extensive data collection from these cities. The following figure encapsulates the insights concluded from implementing DISCOCURB in these cities, offering a visual representation of this transformative urban mobility solution.

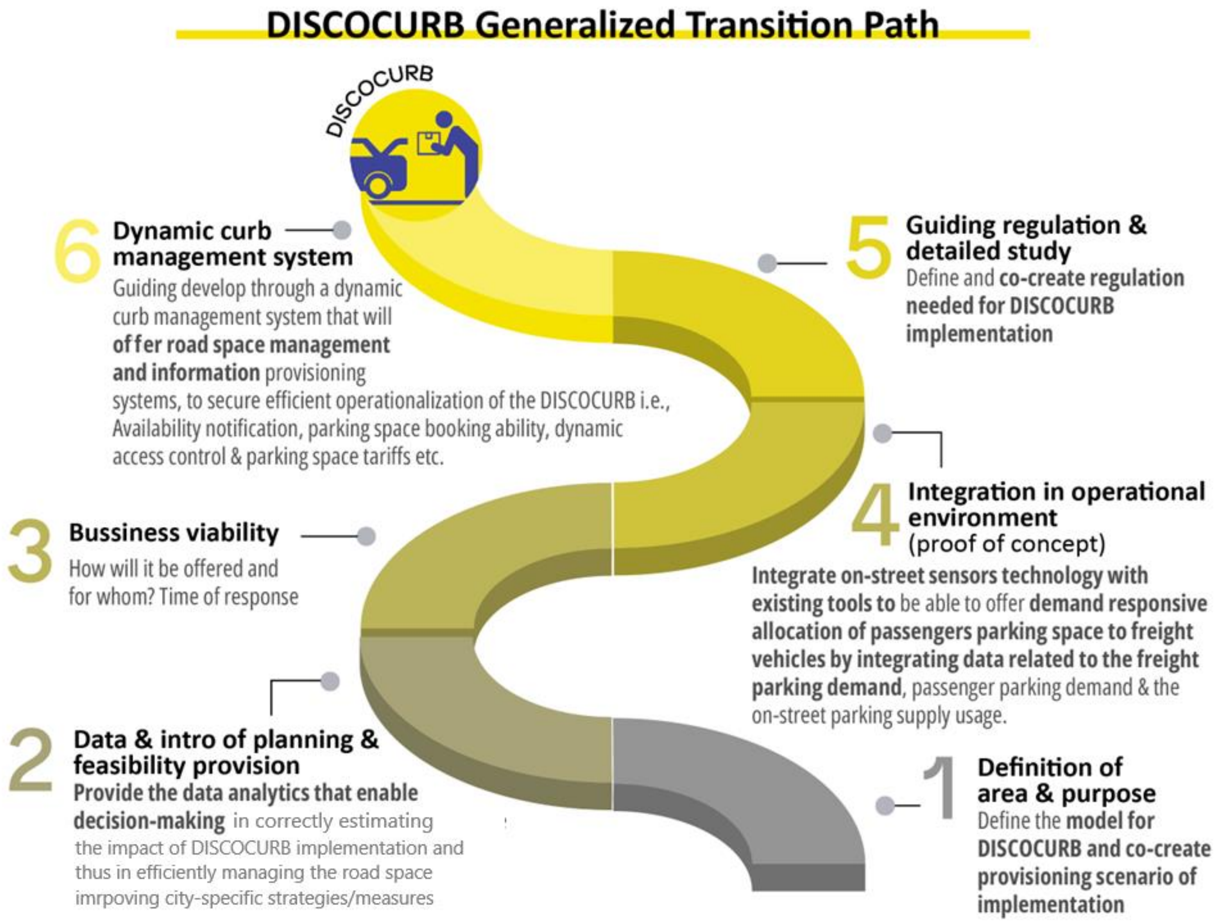


Figure 6: The generalized transition path for the implementation of a DISCOCURB measure

The image outlines a structured approach for the procedure that a city should follow to successfully implement the DISCOCURB, which focuses on optimizing urban curb management. The process starts by clearly defining the scope and objectives of DISCOCURB, which involves setting up the model and collaborating on the plan for implementation. Following this, there is an emphasis on gathering and analyzing data to ensure that planning and feasibility are grounded in robust analytics, thereby forecasting the impact of DISCOCURB and aiding in the management of road space in alignment with sustainable urban strategies. The third step assesses the business viability of the system, considering the marketability, target clientele, and service responsiveness. Next, the framework calls for proof of concept by integrating sensor technology into the operational environment. This integration is intended to enable a responsive allocation of parking spaces based on actual demand and usage data. Moving forward, the framework suggests undertaking regulatory guidance and detailed studies to establish the rules and standards necessary for the system's operation. Finally, it culminates with the establishment of a dynamic curb management system that interacts with other road space management systems, ensuring operational efficiency through features like real-time availability notifications, parking space reservation capabilities, and dynamic pricing for access and parking. Considering the different potential of the DISCO cities, the early drop of DISCOCURB will not be the same for all of them. For the case of DISCOCURB, the early drop is expected to be up to the fourth step of the Generalized Transition Path which is namely the Proof of Concept.

3.3. DISCOPROXI

3.3.1. DISCOPROXI Challenge & PI-led response

One of the main challenges in City Logistics is delivering goods efficiently and sustainably to customers in dense urban areas. Goods usually start their journey from a warehouse near the city and then move to a fulfilment or distribution centre before reaching the destination. The last step

involves transporting goods from microhubs or urban consolidation centres, which are smaller-scale facilities within the city, to multiple locations in a limited time. In response to the escalating demand and intricacies of last-mile delivery, particularly driven by the expansion of e-commerce and online shopping, collaborative logistics approaches (shared logistics) present a hopeful resolution. These approaches entail resource and facility sharing among various stakeholders, aiming to streamline delivery operations while curbing costs, emissions, and congestion. Nonetheless, the task of identifying appropriate sites for microhubs poses a challenge, given the scarcity and high cost of urban spaces. This is where DISCOPROXI comes in.

3.3.2. A practical example of DISCOPROXI

A bustling urban neighbourhood nestled near the heart of a metropolitan city is characterized by its narrow streets and a blend of residential areas, commercial zones, and historical landmarks. Traditional delivery trucks congesting the roads have become an unsustainable norm, leading to pollution and inefficiency. This is where DISCOPROXI shines as a beacon of innovation. By establishing micro-hubs on the periphery of these neighbourhoods, DISCOPROXI effectively transforms the last-mile delivery process. These strategically placed hubs serve as mini warehouses that receive goods from larger distribution centres. From there, eco-friendly cargo bikes and electric vehicles take over, weaving through the cityscape with ease and precision.

The introduction of shared warehousing allows for a collaborative environment where multiple businesses can store their goods, significantly reducing the need for redundant deliveries. With advanced technology, DISCOPROXI considers regulated access to these zones, ensuring only permitted and eco-friendly modes of transportation are used. Users - customers benefit from the convenience of automated lockers, retrieving their parcels at their leisure and reducing the hassle of missed home deliveries. In this practical example, DISCOPROXI not only alleviates urban congestion and emissions but also enhances the efficiency of last-mile deliveries, setting a new standard for sustainable urban logistics.

3.3.3. DISCOPROXI's Scope of Innovation

DISCOPROXI is an innovative solution specifically designed for urban zones referred to as 'neighbourhoods' situated in proximity to urban centres. The term 'neighbourhood' in the context of DISCOPROXI is characterized by:

- **Areas** restricted to conventional vehicles, like Low-Emission Zones or closed historical city centres.
- **Zones** with significant commercial activity requiring consistent supply, thus drawing substantial freight movement to their road networks.
- **Residential regions** with a pronounced demand for deliveries.

Such a neighbourhood is controlled through advanced technological solutions that:

- **Regulate Access:** Ensuring that only permitted modes or entities can enter or operate.
- **Offer Shared Warehousing:** Allowing multiple operators to use common storage space, maximizing efficiency.
- **Promote Green Last-Mile Delivery Routing:** Encouraging environmentally friendly methods for final delivery routes.

At the heart of DISCOPROXI's strategy are 'micro-hubs.' These hubs:

- **Facilitate Storage and Redistribution:** They are equipped for warehousing and redistribution tasks.
- **Provide Lockers:** Assist consumers in retrieving their goods, especially when home deliveries are either impractical or unsuccessful.
- **Offer Green Mobility Services:** Prompting locals to opt for sustainable transportation modes, such as micro-mobility, e-bikes, and cargo-bikes.

Moreover, DISCOPROXI plays a pivotal role in the decision-making processes. It assists in pinpointing the optimal locations for micro-hubs, determining the sizes of 'neighbourhoods' and warehouses, and formulating the necessary business models for shared operations within a cohesive warehousing framework. It also offers insights into how cities can make this system advantageous for both them and the businesses involved.

In its essence, DISCOPROXI's mission is to address the challenges posed by traditional methods of last-mile deliveries and freight transport. The goal is to supersede these with more sustainable and efficient mobility solutions, ensuring eco-friendly and well-regulated urban freight logistics.

3.3.4. DISCOPROXI Tools, Systems, and Required Infrastructure

These are designed to facilitate the efficient, sustainable movement of goods, especially in dense city landscapes where traditional delivery methods face significant challenges. The following tools and systems are essential components of the DISCOPROXI PI-led approach, each playing a crucial role in transforming urban logistics and delivery processes:

- **Observatory Online Database:** This can be a system that catalogs city logistics infrastructure, tracking the locations, capacities, and potential spaces for logistics use.

This can be a tool that functions as an advanced GIS platform, allowing users to locate and evaluate suitable infrastructure for diverse activities. It provides detailed information about facilities, including size, location, accessibility, and safety features, along with operational rules and special requirements. It offers functionalities like search, filter, sort, and comparison, and may include ratings and reviews, exemplified by the WareM&O function in Thessaloniki, Greece.

- **Planning Tools:** These can be tools that utilize data and algorithms from various sources, such as weather, traffic, and demand patterns. They are essential in aiding operators and companies to refine their planning processes, including determining the optimal locations for facilities, vehicle routes, and inventory levels.
- **Operational Tools:** are tools that use data and algorithms from various sources to help users enhance their operational processes. They help in optimizing vehicle routes and managing inventory levels, and offer features for data analysis, simulation, visualization, and reporting, all aimed at boosting day-to-day productivity and profitability.
- **Routing Tools for Green Delivery:** This can be a tool crucial for identifying efficient and eco-friendly delivery paths within urban areas, thereby minimizing environmental impact. It can assist logistics providers in optimizing their routes dynamically, accommodating the various transport modes, and ensuring swift cargo transitions.
- **Access Management Systems for Zones & Microhubs:** This can be a system necessary for controlling entry into designated low-emission zones and microhub infrastructures, ensuring secure and regulated access, which is vital for maintaining order and security in urban logistics operations.

3.3.5. DISCOPROXI Data Requirements

To effectively implement DISCOPROXI, several key types of data are required. These data sets provide critical insights into various aspects of city logistics, aligning with the principles of the Physical Internet. In this context, the necessity for real-time and near-real-time data becomes paramount, enabling a highly responsive and interconnected system that mirrors the efficiency and adaptability of digital internet in the physical space of urban logistics.

- **Logistics Real Estate:** including Operating logistics actors, microhubs, warehouses, distribution centre's locations and other facilities used for the storage, sorting, and transportation of goods, unoccupied areas within these facilities, which can be leased or utilized by businesses for various purposes.
- **City Geospatial Data, City last mile regulation Data & zoning:** including digital network maps, boundaries of zones, land uses, locations are necessary for defining neighbourhoods including applied regulation, for locker & micro hubs installation & operation& data for supporting routing.
- **LSP Demand Data:** Real-time volumes of demand, capacity available at microhubs, demand Load factors per vehicle, type and size of vehicle, type and size of cargo, delivery deadlines, specialized handling, seasonal fluctuations – patterns.

- **Usage History:** Static Data demand per zone neighbourhood, demand variation, pick up/ drop off time windows, microhubs, proximity service area, share of routes etc, such as peak hours, rush periods.
- **Origin and Destination Data:** Provides insights into the most frequented delivery routes, all essential for planning.
- **Business optimization & Proximity Last mile assessment Data:** Actors goals for collaboration, carbon footprint & cost/efficiency assessment data.

3.3.6. DISCOPROXI Business models

To effectively implement DISCOPROXI, various business models are crucial, each addressing key aspects of urban logistics. These models incorporate innovative solutions like parcel lockers, cargo bikes, intermodal transport, and crowdsourced delivery, all aimed at enhancing efficiency and sustainability in city logistics.

- **Parcel Lockers as Micro-Hubs Business Model:** DISCOPROXI is about the innovative use of parcel lockers as micro-hubs, strategically located in nearby areas to facilitate package delivery. This model is designed to make deliveries more accessible, safer, and more convenient for customers, effectively reducing the occurrence of multiple trips and missed deliveries. Moreover, these parcel lockers are integrated with smart network management systems, enhancing the capability to plan and group deliveries efficiently. This not only streamlines the delivery process but also contributes significantly to the overall efficiency and effectiveness of urban logistics systems.
- **Cargo Bikes Business Model:** A key objective of DISCOPROXI is to mitigate the environmental impacts associated with goods delivery in urban areas, and this is adeptly addressed through the use of cargo bikes. These low-emission vehicles are employed for transporting cargo from the platform's microhubs to nearby areas, offering a faster, more flexible, and eco-friendlier delivery option. Beyond their environmental benefits, these cargo bikes are equipped with sensors and communication devices, enabling real-time monitoring and coordination of deliveries. This setup not only ensures prompt service but also provides valuable data that supports the development of optimal routing techniques, further enhancing the efficiency of urban logistics.
- **Intermodal Freight and Passenger Transport Business Model:** DISCOPROXI is closely intertwined with the concept of intermodal freight and passenger transport, promoting a diverse mix of transportation modes for delivering packages. This model is instrumental in enhancing the efficiency and reliability of deliveries, significantly reducing the environmental footprint of transportation activities. Furthermore, it offers customers increased flexibility and convenience by allowing them to choose the most suitable pickup or delivery points. This approach to package delivery represents a shift towards more sustainable and customer-centric urban logistics solutions.
- **Crowdsourced Delivery Business Model:** The crowdsourced delivery approach embraced by DISCOPROXI leverages the existing mobility networks of ordinary people, employing them as carriers for package delivery. This model capitalizes on proximity-based city logistics, making it extremely convenient for individuals to participate in the

delivery process. It not only reduces delivery costs and increases service availability but also provides income and social opportunities for the carriers. By leveraging the carriers' personal modes of transportation, such as cars, bikes, or public transport, crowdsourced delivery introduces a highly flexible and scalable solution to the challenges of urban logistics.

3.3.7. DISCOPROXI Regulations

These regulations form the framework for managing and optimizing urban freight activities, addressing everything from the efficient use of space to the sustainability of delivery methods. Here are the key regulatory components that lay the foundation for such initiatives:

- **Zoning and Land Use Regulations:** Essential for facilitating environmentally strategic freight transfer in urban areas. These regulations determine how different parts of a city can be used for commercial, residential, or logistics purposes, impacting where freight transfer points like microhubs or parcel lockers can be located.
- **Operational Standards for Logistics Services:** Guidelines that dictate how logistics services should operate within urban environments. These standards ensure that operations are efficient, safe, and comply with city regulations, covering aspects such as vehicle types, operating hours, and delivery procedures.
- **Legal Framework for Shared Logistics Infrastructure:** Necessary to govern the shared use of logistics facilities like microhubs and parcel lockers. This framework ensures that multiple logistics providers can use these facilities collaboratively and efficiently, addressing issues like access rights, usage fees, and maintenance responsibilities.
- **Streamlined Permitting Processes:** A simplified, and quick permitting process is key to reducing delays in setting up and operating logistics infrastructure. This agility is crucial to adapt to the fast-paced nature of urban logistics and the ever-changing demands of city delivery systems, ensuring that the necessary infrastructure can be deployed and utilized without unnecessary bureaucratic holdups.

3.3.8. DISCOPROXI Generalised path for transition to implementation

The DISCOPROXI PI-led innovation, aimed at establishing a generalized operational scheme and business model, is planned for implementation in all four DISCO Starring cities (Ghent, Helsinki, Copenhagen and Thessaloniki). Figure 7 encapsulates the insights that will be obtained from implementing DISCOPROXI in these cities, offering a visual representation of this transformative urban logistics solution.

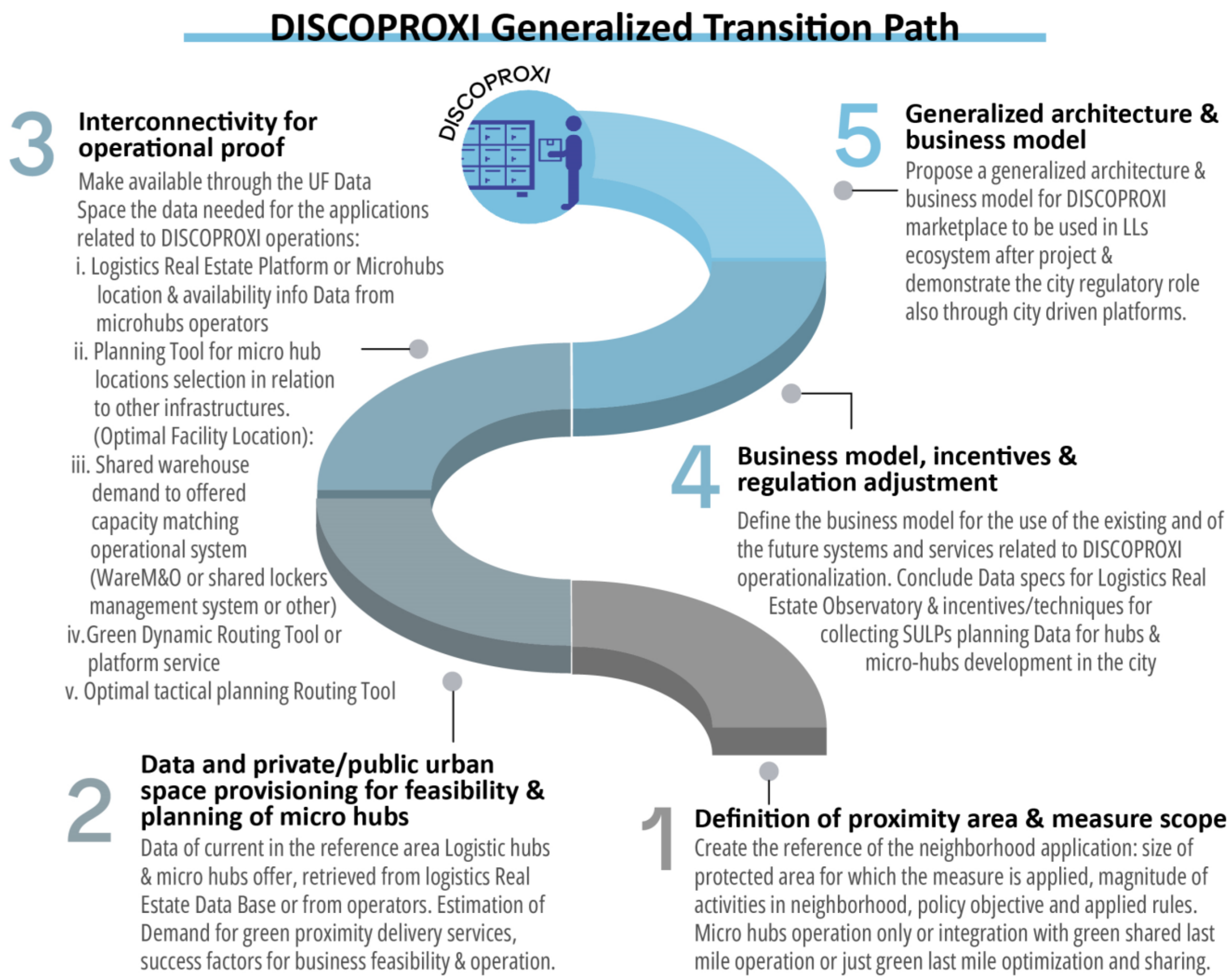


Figure 7: The generalized transition path for the implementation of a DISCOPROXI measure

The DISCOPROXI Generalized Transition Path provides a detailed strategic implementation framework for urban logistics optimization. Initially, it defines the scope and geographical boundaries for micro-hub deployment, considering local regulations and the integration with eco-friendly logistics operations. Subsequent efforts focus on data analysis to support the planning and viability of these micro-hubs, utilizing information from existing logistics platforms to collect the demand and operational success. The third phase emphasizes the importance of data interconnectivity, facilitating operational proof by leveraging urban freight data spaces for applications such as micro-hub planning and optimal routing. This includes tools for aligning warehouse capacity with demand and integrating green routing solutions. The penultimate step involves refining the business model, aligning incentives, and adjusting regulations to support the anticipated DISCOPROXI services. This includes establishing data specifications for logistics observatories and planning techniques for the sustainable development of urban freight hubs. The final step proposes a scalable architecture and business framework for DISCOPROXI, aiming to foster its adoption in urban living labs and demonstrating the city's regulatory role through the support of city-driven platforms. This approach underlines the city's commitment to sustainable urban logistics and the promotion of shared infrastructure. In this case, the early drop can be considered the transition path up to the fourth step -which is the development of business model- and for some cases the third step -which is the proof of implementation-.

3.4. DISCOESTATE

3.4.1. DISCOESTATE Challenge & PI-led response

The core issues addressed by DISCOESTATE include the increasing demand for home deliveries, traffic congestion, elevated pollution levels, and noise disruptions in urban areas. Traditional logistics models involve multiple companies operating their own hubs, fleets, and facilities, leading to inefficiencies and overuse of urban space.

DISCOESTATE mitigates these challenges by offering a solution for minimising the number of hubs to be used in the city for daily deliveries. This will lead the cities to achieve efficient and sustainable deliveries, it will decrease the resources needed in the traditional business model as space, distances, energy consumption, and number of vehicles. It will replace the business model where each logistic company has its hub, its fleet, its facilities, and its equipment because all the last-mile distribution will be managed by a single company. In a larger city, where there will be more than one hub then more than one managing DISCOESTATE company will be required.

3.4.2. A practical example of DISCOESTATE

In practical terms, DISCOESTATE involves the transformation of selected urban spaces into multi-use logistics hubs. These hubs are strategically located to serve broad areas efficiently. They are equipped with advanced technology for managing and tracking deliveries, ensuring a smooth flow of goods through the city. Electric vehicles, specifically designed for urban logistics, are utilized for last-mile deliveries, further reducing the environmental impact. The implementation of DISCOESTATE requires collaboration between city planners, logistics companies, and technology providers. It involves investing in infrastructure upgrades at selected hub locations, integrating logistics management software, and deploying a fleet of electric delivery vehicles. The result is a streamlined logistics model that enhances the efficiency of urban deliveries, improves the quality of life for residents, and supports sustainable city development.

> *A tested use case is the municipally hub 'Plaza Mayor' in the centre of Madrid where a few parking lots were retrofit to a hub for deliver goods with electric vehicles in the LEZ of city centre. Plaza Mayor use case has been replicated in the city of Zaragoza. An old repair car garage has been retrofitted to a microhub.*

The next figure illustrates the transformative impact of the DISCOESTATE innovation on urban logistics.

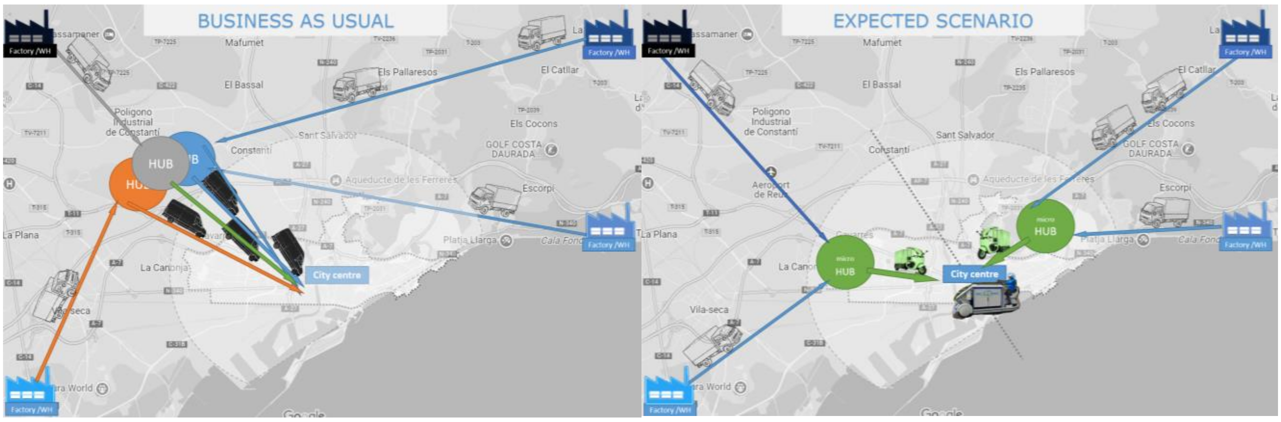


Figure 8: The business-as-usual scenario that DISCOESTATE innovation comes to cover and the expected scenario that DISCOESTATE comes to cover.

Figure 8a portrays the current 'business as usual' scenario, where individual logistics companies operate their own hubs and fleets, leading to a congested and inefficient urban environment. This setup results in multiple hubs scattered across the city, with overlapping delivery routes contributing to increased traffic, pollution, and noise.

In contrast, Figure 8b depicts the 'expected scenario' after the implementation of DISCOESTATE. This forward-looking model consolidates logistics operations into fewer, multi-use hubs that are strategically located to serve large urban areas. These hubs, possibly utilizing existing urban spaces such as parking lots or repurposed buildings, act as central points for sorting and dispatching goods using electric vehicles for last-mile deliveries. This system not only streamlines the delivery process but also significantly reduces the environmental footprint of urban logistics.

3.4.3. DISCOESTATE's Scope of Innovation

DISCOESTATE defines temporary, dynamic use and re-purposed underused buildings for hosting logistics activities and optimisation of their use through smart solutions (sharing spaces). It will establish a multipurpose warehouse, not tied to an economic model or a single type of business or product. Nor will it be tied to a single supplier/customer but will be open to any need for the distribution of goods.

The key areas of efficiency and sustainability enhancement in DISCOESTATE include:

- **Space Optimization:** By sharing logistics hubs among multiple users, DISCOESTATE maximizes the use of available space, reducing the need for additional construction in urban areas.
- **Fleet Management:** The system employs a non-dedicated fleet approach, meaning the vehicles used for deliveries are not tied to a single client. This flexibility allows for more efficient use of transportation resources.
- **Equipment Efficiency:** Resources such as servers, software licenses, and printers are shared among users, cutting down on individual investment and maintenance costs.
- **Workforce Utilization**: The model optimizes Full-Time Equivalent (FTE) employment, ensuring that labour hours are used effectively and efficiently.
- **Reduced Pollution:** Centralizing logistics activities in shared hubs and using a non-dedicated fleet contribute to lowering emissions, thereby significantly reducing the overall environmental impact of urban deliveries.

3.4.4. DISCOESTATE Tools, Systems and required infrastructure

For DISCOESTATE, multiple physical and digital infrastructure were defined as requirement for cities that intend to implement the solution.

- **Logistics Real Estate & Space Database:** The Logistics Real Estate & Space Database is a critical tool for cataloguing and managing the city's logistics infrastructure and the use of shared logistics facilities and including their specifications. This dynamic database allows for the continuous updating and optimization of space usage, particularly considering the potential for repurposing various urban spaces for logistics purposes. It is an essential component for effectively managing the logistics landscape of a city, ensuring the efficient use of available spaces and resources.
- **Sensors for Operational Protocols:** Sensors for Operational Protocols are necessary to monitor various aspects of the logistics operations, including building accessibility, capacity, and environmental conditions. These sensors play a vital role in informing the utilization of warehouse spaces, ensuring that operations within these areas adhere to environmental standards and regulations. This monitoring is crucial for maintaining efficient and sustainable logistics practices within urban environments.
- **Security and Access Control Systems:** Security and Access Control Systems are integral to safeguarding the facilities, goods, and managing the diverse flow of stakeholders involved in DISCOESTATE. These systems are designed to efficiently handle the access of logistics staff, suppliers, clients, and other users, ensuring both safety and operational efficiency. The ability to manage and monitor various users is key to maintaining the integrity and security of the logistics operations.
- **Warehouse management system (WMS):** The Warehouse Management System (WMS) is a critical component for DISCOESTATE, designed to streamline all aspects of warehouse and hub management. This includes processes such as receiving, storage, picking, packing, shipping, and inventory tracking. The WMS must be particularly adaptable to the dynamic

and multipurpose nature of DISCOESTATE warehouses, capable of handling a diverse array of products and logistic processes. This adaptability is essential due to the shared space's variety of uses and the different types of goods and services that will utilize it.

- **Last mile delivery system (TMS):** The Last Mile Delivery System (TMS) plays a pivotal role in managing the transportation of orders from the nearest distribution hub to their final destination. A key focus of this system is route optimization, especially considering the use of non-fuel vehicles in line with DISCOESTATE's environmental objectives. Future enhancements of the TMS may include AI integration for optimizing routes based on various factors like traffic, weather, and intelligent volume forecasts, further aligning with the initiative's sustainability goals.
- **Order Management System – Control Tower:** The Order Management System – Control Tower, is envisioned as a comprehensive tool that orchestrates logistics processes and provides an end-to-end view of orders. It facilitates real-time tracking and data sharing with all involved stakeholders, from suppliers to clients. This system will require clients to connect and obtain a unique and standardized identifier for their deliveries, ensuring efficient and accurate management of the logistics process. Integration with the city's urban planning and traffic management systems is also critical for enhancing overall efficiency and responsiveness.

3.4.5. DISCOESTATE Data Requirements

The datasets needed for the regular implementation and operation of DISCOESTATE measure to enable the PI-led principles are:

- **Volumes:** Senders are required to provide forecasts of their shipment volumes as well as the actual volumes, 24 hours before the intended delivery. This information is critical for effective logistics planning within DISCOESTATE. Accurate volume data helps in anticipating the space and resources needed, allowing for better optimization of warehouse space and aligning logistics processes with real-time demand. This foresight aids in reducing bottlenecks and ensuring a smooth flow of goods through the system.
- **Delivery Time:** Senders must communicate their delivery schedules 24 hours in advance, or they must adhere to a pre-established global agreement. This requirement ensures that DISCOESTATE can efficiently manage and allocate resources to meet delivery commitments. Timely delivery data allows for precise scheduling and routing, minimizing delays, and optimizing the overall logistics operations. It also aids in synchronizing various logistics activities, enhancing the system's responsiveness and reliability.
- **Delivery Restrictions:** Any specific delivery restrictions, such as time, location, or other logistics-related constraints, need to be communicated by the senders. This data is vital for tailoring the logistics operations within DISCOESTATE to comply with these restrictions. Understanding these limitations enables the system to adjust its operations accordingly, ensuring that deliveries are carried out in adherence to local regulations, customer preferences, and logistical capabilities, thereby enhancing service quality and compliance.
- **Type of Products:** Information regarding the type of products being shipped, including details on whether they are palletized, bulk, dangerous, and their dimensions, is essential.

This data enables DISCOESTATE to determine specific handling, storage, and transportation requirements tailored to different product types. It ensures that goods are handled safely and efficiently, and that the storage and transportation methods are appropriately aligned with the nature of the products, thereby mitigating risks and optimizing resource usage.

- **Warehouse Availability Data:** Sourced from Warehouse Management Systems or Building Management Systems, this data delineates the parameters for storage space usage, including capacity, time, and conditions. It is crucial for managing warehouse space effectively within DISCOESTATE. By understanding warehouse availability, the system can ensure that storage capabilities are in sync with logistics demands, leading to better resource utilization and operational efficiency.
- **Storage Demand Data:** This data is key to fine-tuning the balance between supply and demand for warehouse space within DISCOESTATE. It aids in aligning storage availability with the actual demand, ensuring that resources are not underutilized or overstretched. Effective management of storage demand data helps in maintaining an equilibrium between available logistics resources and the needs of the system, leading to enhanced efficiency and reduced operational costs.
- **Digitized Snapshot of Warehouse Infrastructure and Cargo Monitoring:** If available, this data adds an extra layer of depth to resource management capabilities in DISCOESTATE. It involves a real-time overview of warehouse infrastructure and cargo monitoring, aiding in the continuous observation and optimization of the use of warehouse space and cargo handling. This digital snapshot is instrumental in making informed decisions, leading to improved management of logistics resources and processes.

3.4.6. DISCOESTATE Business Models

To ensure viability, DISCOESTATE requires the establishment of specific business models based on the needs of various stakeholders involved:

- **Centralized Hub Managed by a Single Company:** In this business model, all suppliers deliver their goods to a single, centralized hub (or multiple hubs, depending on the city's size) dedicated to serving the entire city or designated zones within it. This hub is managed by a company responsible for the overall coordination and distribution of goods. The management company then collaborates with one or several external last-mile delivery companies to transport the goods throughout the city or assigned areas. This model simplifies the logistics chain by consolidating various suppliers' goods in a single location, which can lead to increased efficiency in distribution and reduced logistical complexities. It also potentially lowers transportation costs and environmental impact due to reduced duplication of delivery routes. However, this model requires significant coordination and integration between the central hub manager and various last-mile delivery services to ensure timely and efficient delivery across the city.
- **Building Owners as Micro-Hub Providers:** This model leverages the assets of building owners, utilizing their available storage spaces or empty buildings to create localized micro-hubs. Building owners become active stakeholders in the logistics chain by offering their properties for storage and distribution purposes. These micro-hubs are strategically located

throughout the city to facilitate quicker and more efficient distribution, particularly for last-mile deliveries. This model promotes the repurposing of underused urban spaces and supports a decentralized approach to logistics, potentially reducing congestion and environmental impact. It also allows for greater flexibility and scalability in logistics operations, catering to varying demand across different city areas. However, this approach requires robust coordination and technology integration among building owners, logistics service providers, and customers to ensure effective space utilization and seamless distribution.

- **Community-based Logistics Partnerships:** A potential business model for DISCOESTATE could involve forming community-integrated logistics partnerships. In this model, local businesses, community organizations, and residents collaborate with logistics providers to create a network of micro-distribution centers. These centers, located in residential areas, local businesses, or community spaces, serve as nodes for receiving and dispatching deliveries within their vicinity. This approach not only shortens delivery routes but also integrates the logistics system more closely with the community, potentially enhancing local employment opportunities and reducing the environmental footprint of deliveries. The model relies heavily on community engagement and trust, ensuring that logistics operations are harmonized with the community's needs and rhythms. It could lead to a more personalized and community-centric approach to urban logistics, fostering stronger local economies and sustainable city development.

3.4.7. DISCOESTATE Regulations

Given that DISCOESTATE aims at the transformation of selected urban spaces into multi-use logistics hubs, the following regulatory framework can used to support its implementation:

- **Operation Timetable Compliance:** This regulation mandates a well-defined operation timetable for logistics activities, including specific considerations such as night shifts and traffic jam restrictions. Adhering to these timeframes is crucial for minimizing disruptions in urban areas, especially in densely populated cities. Night shift operations might be encouraged to alleviate daytime traffic congestion, but they must comply with local noise ordinances and other relevant regulations. Additionally, adherence to traffic jam restrictions helps in reducing the environmental impact of logistics activities and enhances overall urban mobility. Compliance with this regulation ensures that logistics operations are harmonized with the city, promoting a balance between efficient logistics and quality of urban life.
- **Data Standardization and Security:** This regulation focuses on the standardization and security of data used in logistics operations. It emphasizes the need for all actors in the logistics chain to adopt standardized data formats, enhancing the efficiency and accuracy of information exchange. The regulation mandates that all data transfers between systems must be encrypted, regardless of the protocol used, ensuring data integrity and security. Furthermore, all systems are required to be interconnected through APIs with the central Orchestration tool. The use of JSON format over the HTTP protocol is specified for these interactions, facilitating seamless and secure communication across different logistics

platforms. This regulation is pivotal in creating a cohesive, secure, and efficient digital infrastructure for logistics operations, crucial for the success of systems like DISCOESTATE.

3.4.8. DISCOESTATE Generalised path for transition to implementation

The DISCOESTATE innovation, led by the Physical Internet (PI), focuses on the exploitation and the creation of business models to support the implementation of the solution. This solution will be implemented exclusively in Thessaloniki. The upcoming Figure 9 provides a visual representation of the insights gained from the implementation of DISCOESTATE in various cities, showcasing the impact of this innovative urban mobility solution.

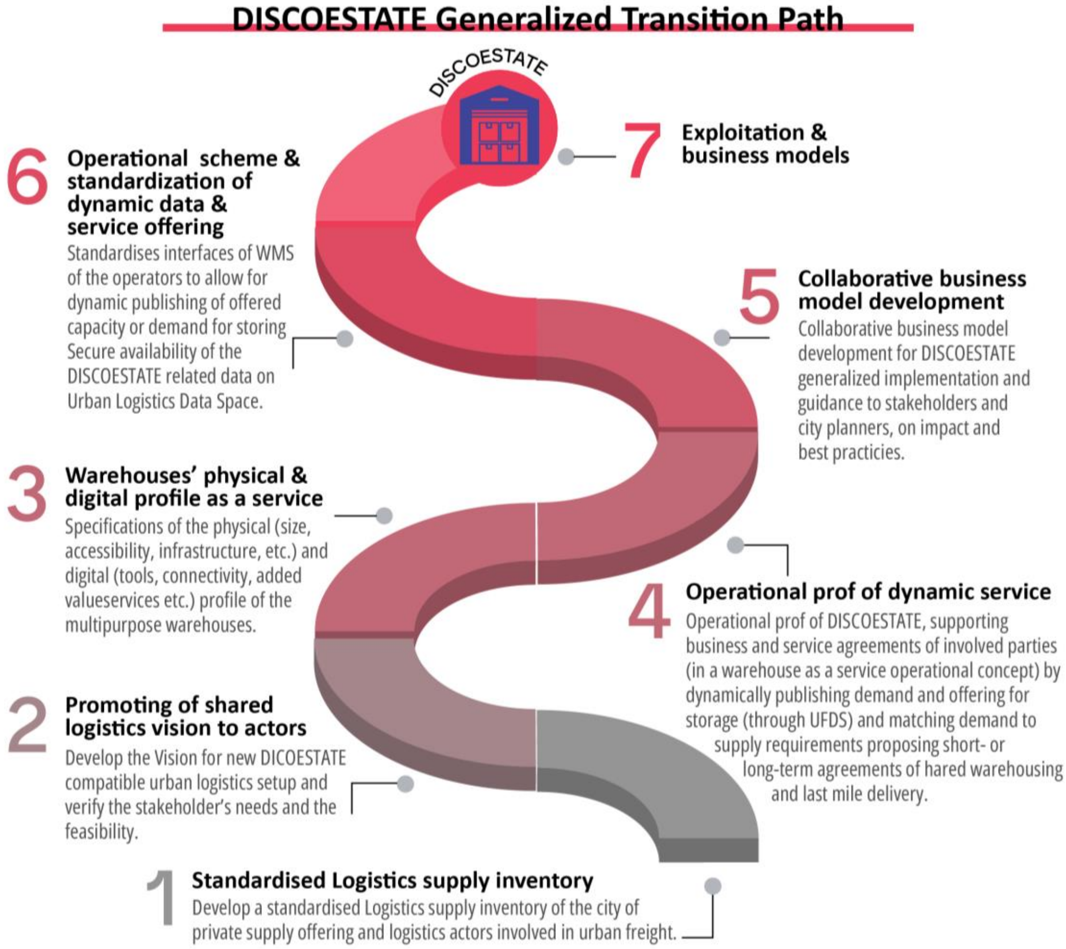


Figure 9: The generalized transition path for the implementation of a DISCOESTATE measure

The Generalized Transition Path for DISCOESTATE comprises seven key steps designed to enable cities to fully utilize the solution and establish business models that facilitate its implementation. The initial and crucial step involves developing a standardized logistics supply inventory, which encompasses all available offerings and the associated actors. This is a platform that contains all the available demand of the city. Following this, cities should formulate a vision for an innovative, user-need-driven multipurpose warehouse setup. The subsequent stage entails gathering detailed specifications of the physical infrastructure, as well as the tools and services to be integrated into the service and this can lead to an operational proof of concept for the dynamic service. This part will provide the tool with all the available offering of the city and the logistics real estate database (and potentially the city's dataspace) will be the central node of the operational scheme for the cities. Ultimately, cities are required to establish collaborative business models for the implementation of DISCOESTATE, focusing on managing dynamic data effectively. The overarching goal of the DISCOESTATE solution is its scale-up and widespread exploitation. In this case, the early drop will include the operational proof of dynamic service which is mentioned in the fourth part of the DISCOESTATE transition path.

3.5. DISCOBAY

3.5.1. DISCOBAY Challenge & PI-led response

Many European cities are implementing zero-emission zones in their core areas, while the distribution of consumer goods, supply of companies and other urban logistics chains have not been adapted to this new situation. The Physical Internet concept offers various pathways to improve this, for example by consolidating freight and sharing warehouse space. Existing multimodal freight hubs near urban cores present opportunities to use consolidated low-carbon (container) transport to deliver part of the urban goods right at the edge of the urban core. From there, electric, or other low-carbon transport modes could perform the last-mile. Some of these hubs could shift their capacity towards urban delivery, while many hubs are currently underusing their capacity. Around these hubs, often there is underused (warehouse) space, which could also contribute to last mile urban logistics. DISCOBAY is meant to capture this potential.

3.5.2. A practical example of DISCOBAY

The use of DISCOBAY is focused on cases where multimodal hubs can be geared towards low-emission urban distribution. Cities with at least one sustainable multimodal hub near the urban core can use DISCOBAY. The cities have either an underused hub and warehouse space to create a temporary city logistics hub; or an underused area near the infrastructure, which can be redeveloped into such a hub. Hubs can be either large nodes in the European Ten-T corridor network or smaller multimodal nodes in (sub)urban areas.

Chapelle International, near the northern ring of Paris, is an example of a city logistics hotel, based on a freight rail terminal. It is conveniently located next to a metro station, which still has underused potential for parcel lockers and micro-distribution via the metro. XPO in Paris runs a pilot project with a small barge container hub at the Seine boulevard.

Amsterdam City Logistichub, located in the port area close to the western ring road, is an example of city distribution with possibilities for water transport, both high-volume barge supplies and last-mile distribution via canal boats. DHL has a pilot project with parcel boats.

3.5.3. DISCOBAY's Scope of Innovation

DISCOBAY is a stepwise approach to engage underused transport and warehouse capacity of multimodal nodes near the urban core, in effort to improve the efficiency and environmental performance of last-mile urban logistics. To achieve this goal, cities set measurable goals matching the geographical and policy context, gather data, test the basic functionality of a data-driven interface prototype. The tested prototype can be developed into a fully functional tool beyond DISCO WP2. The DISCOBAY approach identifies the key-features to improve the use of multimodal hubs, defines the city's relevant stakeholder network and goals, performs a quick-scan of available data, and simulates the functioning of the tool in a prototype for adaptation and reporting. Based on the results, outlines further operationalization and monitoring of the tool. The approach is flexible regarding the specific high-volume multimodal transport node (rail, barge, trimodal), to allow different European cities to participate in and contribute to DISCOBAY. The key performance indicators (KPIs) can therefore also vary per city, for example number of containers (TEU) or other units used for last-mile logistics, CO2 emissions reduced, number of zero-emission vehicles or charging stations, warehouse net area near the hub used for last-mile, and air quality (PMx).

3.5.4. DISCOBAY Tools, Systems and required infrastructure

DISCOBAY underpinned the necessity for physical and digital infrastructure in order to enable the concept of Physical Internet by spotting the underused peri-urban spaces (multimodal nodes) to enhance the efficiency and the performance of the last mile logistics.

- **Sensors & Digital Infrastructure [Physical]:** This infrastructure is essential for the monitoring of the infrastructure capacity by potentially including sensors in warehouses and terminals.
- **Data aggregation platform (or Digital Twins tool) [Digital]:** This system is crucial for the efficient operation of the DISCOBAY measures. It will collect data from the different data sources, and it will harmonize and serve this data to algorithms that will apply matching between demand and supply.
- **Big Data analytics [Digital]:** Apart from the Digital aggregation platform, this digital tool will collect the data from the sensors and the digital infrastructure of the warehouses and terminals in order to apply analytics. The outcomes of this analysis will highlight the feasibility of the operations together with identifying the potential seasonality, trend.

DISCOBAY needs a Standardized Urban Database to manage transport infrastructures and capacities, essential for planning and operation. Spatial Planning Amendments are required to enable logistics operations within urban infrastructures, defining operational frameworks. Sensors & Digital Infrastructure are needed for monitoring capacities in terminals and multimodal units, crucial for operational planning. Big Data Analytics is vital for assessing the feasibility of operations and guiding strategic decisions in urban logistics.

3.5.5. DISCOBAY Data Requirements

The datasets needed for the regular implementation and operation of DISCOBAY measure to enable the PI-led principles are:

- **Terminal operator data:** Terminal operator capacity data in a daily updated GIS. Logistics operators maintain their own data, usually not in a common framework with other operators, unless there is a program that organizes this.
- **Warehouse data:** Warehouse occupancy and capacity data in a daily updated GIS. This GIS database should be connected to the terminal operator data of the warehouses in order to have real-time information about the storage capacity of the space. Real estate stakeholders have private data of their investments and projects.

3.5.6. DISCOBAY Business Models

Different Business Models of the implementation of DISCOBAY are the following:

- **Collaborative Logistics Hub Model:** A collaborative logistics hub model is centered around establishing shared logistics hubs near urban cores, where various companies can consolidate and redistribute goods using low or zero-emission vehicles for last-mile delivery. This approach significantly reduces the need for each company to maintain individual distribution centers, leading to decreased traffic congestion and emissions in urban areas. Revenue is generated through membership or subscription fees from companies using the hub, along with charges for additional services like sorting, packaging, and specialized delivery options. This model not only enhances operational efficiency but also promotes sustainability by minimizing the environmental impact of urban logistics.
- **Data-Driven Optimization Service:** This model leverages advanced AI and machine learning algorithms to provide an optimization platform for existing logistics infrastructure. This service analyzes real-time data on warehouse capacities, delivery schedules, and transport availability to streamline logistics operations. Revenue streams include subscription fees for access to the optimization software, charges for integration consulting services, and the potential sale of aggregated data insights. This model improves the efficiency of logistics operations, reducing redundant transportation, and thereby cutting down on emissions, aligning perfectly with environmental sustainability goals.
- **Green Last-Mile Delivery Service:** The Green Last-Mile Delivery Service focuses on providing eco-friendly delivery options using a fleet of zero-emission vehicles, such as electric vans and cargo bikes. Integrated with collaborative logistics hubs, this service ensures that the final leg of the delivery process is environmentally friendly. The model generates revenue through delivery fees based on various factors like distance, speed, and volume of goods. Additionally, partnerships with e-commerce platforms and advertising opportunities on the delivery fleet offer further financial benefits. This model directly addresses urban emission challenges, making it a sustainable choice for city logistics.

3.5.7. DISCOBAY Regulations

The essential regulation for the implementation of DISCOBAY is the following:

- **Mandatory Information Sharing Regarding Warehouse and Terminal Capacity:** Mandatory information sharing on warehouse and terminal capacities mandates stakeholders in the logistics sector to share data about the availability and utilization of storage and transportation facilities. This policy enhances operational efficiency by optimizing the use of space and resources, leading to reduced trip frequencies and lower emissions. It encourages collaboration among logistics operators, warehouse owners, and transport companies, fostering a more integrated and efficient logistics network. The implementation of this policy requires a robust framework for data sharing, addressing concerns about data accuracy, security, and competitive sensitivities. Compliance and enforcement mechanisms are essential to ensure adherence to these information-sharing requirements, which in turn facilitates more informed and agile decision-making in logistics operations.

3.5.8. DISCOBAY Generalised path for transition to implementation

The DISCOBAY PI-led innovative solutions, aimed at establishing a business model for using underused transport infrastructure for city logistics; this solution will take place in Thessaloniki, Ghent and Copenhagen. This innovative approach is structured around a methodically crafted transition path, developed through extensive data collection from these cities. Figure 10 encapsulates the insights concluded from implementing DISCOCURB in these cities, offering a visual representation of this transformative urban mobility solution.

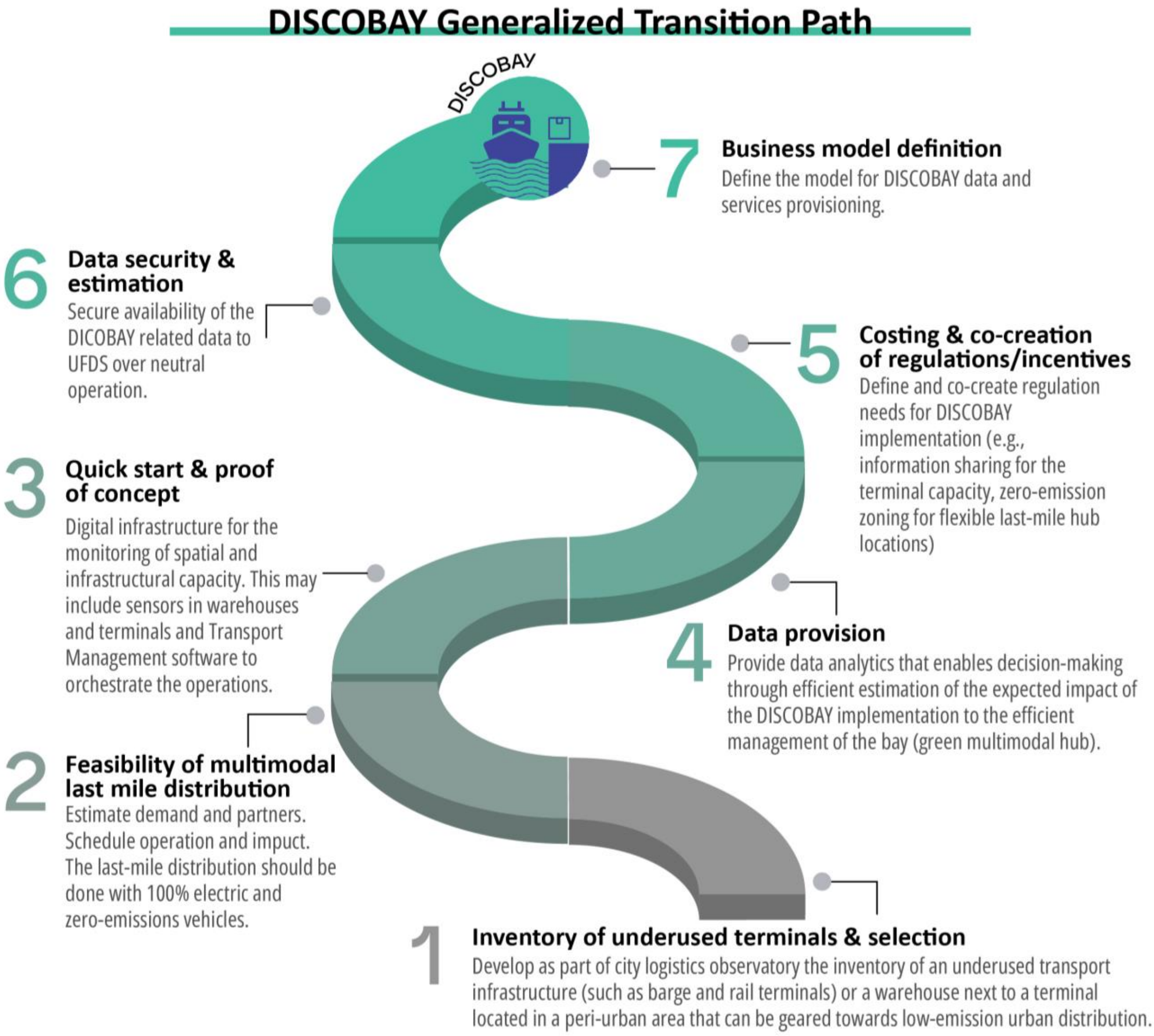


Figure 10: The generalized transition path for the implementation of a DISCOBAY measure

The DISCOBAY Generalized Transition Path delineates a seven-step process aimed at transforming underutilized transportation infrastructures into a sustainable urban distribution network. At first, the city needs to focus on cataloguing and selecting underused transport facilities close to urban areas to be repurposed for eco-friendly distribution. At a next step, city needs to involve assess the demand and pinpointing partners for a multimodal last-mile distribution network that operates solely with electric or zero-emissions vehicles while the next is about establishing the necessary digital infrastructure for monitoring capacities, possibly incorporating sensors and transport management software for effective operations orchestration. In Step 4, data analytics are utilized to support decision-making and gauge the impact of implementing DISCOBAY as a green multimodal hub. Then, city seeks to define and jointly develop the regulations and incentives essential for

DISCOBAY, such as policies for terminal capacity sharing and zero-emission zones. The next step emphasizes the critical nature of securing DISCOBAY-related data, ensuring its availability through a neutral operation. Concluding the framework, it outlines the business model for the provision of data and services within DISCOBAY, establishing the economic foundation for the initiative's continuity and growth. For the case of DISCOBAY, the early drop was considered to include the first three or four steps of the generalized transition path including the Proof of concept and the Data provision respectively.

3.6. DISCOLLECTION

3.6.1. DISCOCOLLECTION Challenge & PI-led response

One of the key value drivers of a Data Space is the amount and quality of onboarded data sets. However, onboarding a dataset to the Data Space requires installation of costly Data Space Connectors, which is a major barrier for participants to provide their data to a Data Space. Secondly, connecting raw data to the Data Space is not enough. Provided data needs to be aligned with the defined data standards and requirements of the Data Space in order for participants to find and consume the data.

DISCOLLECTION refers to the solutions provided to support cities in onboarding and structuring their data at a cost-effective way. Within DISCOLLECTION, a platform will be provided to support participants in onboarding their data to a centralised data hub and structuring it according to the Data Space requirements. The platform itself is connected to the Data Space, serving as a go-between for the connected and non-connected actors in the Data Space. This way, DISCOLLECTION offers as a temporary solution to make access to the Data Space more widely available for consumption within the rest of DISCO-X solutions.

3.6.2. A practical example of DISCOLLECTION

A European city wants to connect to the DISCO Data Space to make use of the DISCO Meta Model Suite solutions and optimise their logistics flows. However, the city does not have the necessary in-house skills to set up a Data Space connector. All the data of the city is managed by a two-man team. Neither of them has experience in onboarding data to a Data Space or structuring a dataset according to the necessary rules. Instead of hiring external consultants to onboard their datasets directly to the Data Space, the city sets up a Smart Data Platform, provided as part of the DISCOLLECTION solution. The city onboards their raw data on the Smart Data Platform (e.g., via data scrapers) and with the help of an instruction guide, they are able to structure their datasets in the necessary format. The Smart Data Platform itself is connected to the data space, enabling all onboarded data sets to be part of the broader Data Space Catalog.

The city convinces a logistics service provider to provide some of their transport order data to the Data Space as part of a joint project. However, the company is not willing to invest in setting up a

Data Space connector, since there is yet no revenue money connected to their data provision. Instead, the city onboards this new data set onto the existing Smart Data Platform. The data is now available on the Data Space and can be accessed by other participants in the Data Space that adhere to the required data usage policies. A digital twin solution that is also connected to the Data Space uses the data of the city access rules and the logistics flows to calculate the impact of specific access rules to gain valuable information in regard to the evaluation of specific policies.

3.6.3. DISCOLLECTION's Scope of Innovation

DISCOLLECTION refers to a Smart Data Platform with an integrated Data Space connector for cost-effective onboarding of data to the Data Space. The Smart Data Platform is designed as a secure data storage platform that allows for scalable solutions on IoT-centric timeseries data. The DISCOLLECTION Smart Data Platform (SDP) fulfils 2 main functions within the DISCO Data Space:

1. **Onboarding raw data assets to the Data Space**
   Through the SDP, users can onboard data sets to the Data Space and define the data sharing policies.
2. **Converting raw data sets**
   The SDP enables data providers to convert their raw data sets into Data Space-compatible data sets that can be discovered & consumed by others.

The key advantages of using the Smart Data Platform (SDP) are as follows.

- **Integrated connector:** The integrated Data Space connector allows data in the SDP to be discovered & consumed by other Data Space participants eliminating the need for data providers to set up, customize and deploy their own UFDS Connector.
- **Collect time-series data:** The SDP is optimized to ingest & query time series data. Time-series data is a crucial component for logistics planning optimization, yet ingesting time-series data requires a different approach than ingesting static data.
- **Conversion guidance:** The SDP offers guidance to data providers on how to convert their logistics data sets to adhere to the specified standards and ontologies that already exist in the wild or will be developed within DISCO or the other DISCO-X innovations.
- **Self-hosted:** Cities can host their own SDP. With each city hosting their own platform, the SDP enables a semi-decentralized setup.

Multi-tenant: One SDP can manage multiple user profiles, enabling software providers or LSPs to manage their own account, without intervention of the hosting city.

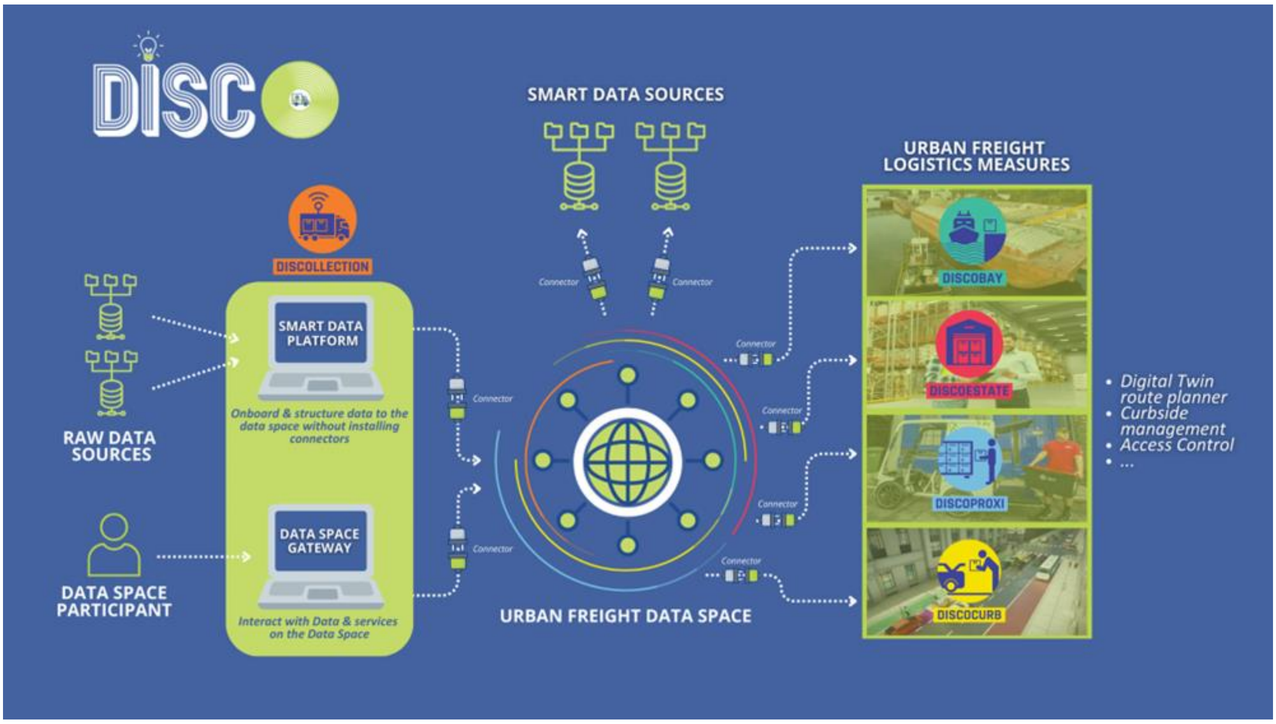


Figure 11: Architecture of the Smart Data Platform that will be developed under the context DISCOLLECTION innovation

3.6.4. DISCOCOLLECTION Regulations

The regulations for DISCOLLECTION are related to **Compliance and Security.** The management of sensitive data is of high importance; thus, a formalized data processing agreement is necessary when sharing personal or sensitive data through the dedicated shared data platform, ensuring adherence to European data protection regulations (GDPR).

3.7. Conclusions

In the way towards exploiting the full potential of the DISCO-X innovations, each city navigates a unique path characterized by distinct stages of adoption and adaptation. These stages, conceptualized as the generalized implementation path, offer a structured approach to achieving the overarching goals of the Physical Internet (PI) paradigm within the unique urban logistics ecosystems of the participating cities.

Within this framework, "early drops" or "first wins" act as pivotal achievements, often anticipated around the 3rd or 4th step of the generalized transition path. These wins are not just milestones but also:

- Tangible validations of the DISCO-X approach, demonstrating practical efficacy.
- A form of feasibility assessment result, indicating the potential for full-scale implementation of the measures.

- Catalysts that build confidence and promote increased involvement, attracting new stakeholders for the measures' scale-up and expansion. This expansion will facilitate more data provisioning opportunities, embracing the Living Lab's ecosystem concept.
- Incentives for additional investment and deeper commitment to the transformation led by the Physical Internet (PI) principles.

The early successes are essential—they not only validate the strategies in place but also ensure sustained momentum, instilling a sense of trust and anticipation for the complete realization of a Physical Internet-driven urban logistics networks of the participating cities.

4. Specifications of DISCO-X implementations at the Starring Living Labs

4.1. Introduction

Building on the knowledge of Chapter 3 (The DISCO-X innovations definition & implementation requirements), cities presented in a LL scoping document their plans on how to adopt DISCO-X innovations for implementing their measures. Bilateral meetings with the Starring Living Labs were conducted to understand/exploit possibilities for migrating to PI-led city logistics paradigm when defining their approaches to measures implementation. For each DISCO Starring living lab the bilateral meeting focused on:

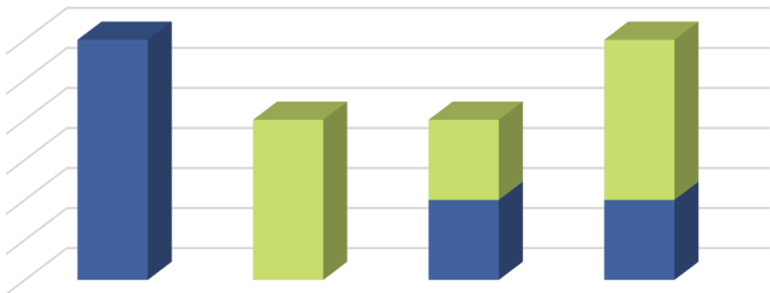
- Defining their goals in relation to PI adoption and the LLs operational approach related to the implementation of each DISCO-X that based on the DoW is empowering each city logistics measures.
- Identifying the data sources in the city ecosystem and the availability and shared use, through UFDS, especially of the data related to the implementation of each DISCO-X the LL intends to adopt. The inventory of relevant to DISCO-X implementation data in each city was collected and accumulated the information provided by the cities and enriched with further desk research conducted by CERTH.
- Mutual understanding about tools and digital service available in the city ecosystems by the local partners and those offered by the DISCO-X promoters that can be used for enabling the implementation of the DISCO-X measure in each LL. The first Inventory of the available tools is presented in Annex 5.
- Concluding on possible PI operational paradigm for each DISCO-X adoption in each city and on a process path for transitioning and achieving the “early drop” (until M18 of DISCO lifecycle) and the full testing of PI-led measures at LLs.

The consolidated outcome of the above-described process and analysis of input is presented in, the next paragraphs per each Starring Living Lab and DISCO-X measure. The individual process the LLs will follow for implementing the DISCO-X measures will be regularly updated by the LLs and will be monitored in the context of WP4 during the project’s lifecycle. The next phase of the work in WP2 will focus on developing and enhancing tools offered for DISCO-X implementations to meet the needs of the cities in testing the measures and pursue the activities for the achievement of the PI operational paradigm depicted for each measure & city. The questionnaire used for this process is similar to the template presented in Annex 1.

The PI operational Paradigm scheme proposed for each measure and city is organized in accordance with the 4 enabling pillars of PI: **Data Sources** which included all the different types of data that were considered important for the specific DISCO-X; Data **Integration and Processing** which includes the different systems that were used to collect and harmonize the data; this part will afterwards feed the next stage of **Analysis and Validation**. The analysis and validation part includes all the different dedicated algorithms needed to support the implementation of DISCO-Xs. Finally, the last part is the **End Service and Testing** which includes the final products developed for the operation and the potential assessment of the different solutions.

It should be noted that the PI operational paradigms presented in this chapter show a proposed scheme of the operational implementation of the measures and are expected to be modified and adjusted to reach their final format during implementation based on tools and data usage in each LL. The scheme, however, always involves the UFDS in facilitating integrated view and access to data needed for DISCO -X implementation at cities. The UFDS is considered central to DISCO approach for PI-led city logistics achievement. Not all the cities are at the same level of maturity for reaching a UFDS operation but the main requirements for the UFDS were elaborated based on the DISCO-X Innovation descriptions (by the DISCO-X responsibles) and by the LLs requirements for data exchange in implementing the measures and on practices identified at LLs regarding data aggregation, collection & use for logistics planning and operation.

Given that the DISCOLLECTION measures are satisfied by the IMEC's Smart Data Platform, 10 DISCO-X solutions will be implemented in total across the four Starring Living Labs. As detailed in Table 1, each solution is characterized by its typology, which is categorized by one of three categories: Physical, Digital, or Business. The classification of these DISCO-X solutions into two categories — operational and feasibility — is based on the aims of the Living Lab and the innovation's typology while it also considers the expected outcomes of each DISCO innovation (Figure 12).



	COPENHAGEN	GHENT	HELSINKI	THESSALONIKI
OPERATIONAL		2	1	2
FEASIBILITY	3		1	1

Figure 12: Living Labs' Measure types

This analysis revealed that in Copenhagen, all three use cases are operational, while in contrast, Ghent's two use cases are also fully operational. Helsinki presents a balanced scenario, with one use case operational and the other feasibility. Lastly, Thessaloniki shows a majority of operational use cases (2) compared to feasibility ones (1).

4.2. Ghent Starring Living Lab

4.2.1. Ghent's GHE_01_DISCOPROXI

The DISCOPROXI measure in Ghent was described as such:

> To upgrade and integrate the Urban Access Control (UAC) system, that connects and integrates transport planning systems of logistics companies with city access and traffic regulations. This optimizes and downsizes unnecessary and dangerous logistics traffic in the city center. The UAC will calculate costs and environmental impact (CO^2 emissions) of the planned deliveries, and propose sustainable alternatives for last-mile delivery, performed by specialized sustainable inner city logistics operators.

Ghent's initiative is centred around an Urban Access Control (UAC) system, a two-pronged tool that offers both pre-routing and on-route functionalities, aiding in smooth urban logistics by integrating transport planning systems and city access and traffic regulations. The goal is to ensure smooth delivery paths, avoiding surprises like restricted zones, while also promoting green/sustainable last-mile operations with data-driven arguments (such as downsized costs and zero-emission delivery).

Ghent's DISCOPROXI measure is enhancing the functionalities of the Urban Access Control (UAC) system to integrate transport planning systems with city access and traffic regulations. The UAC system is poised to enhance the efficiency of urban deliveries and promote sustainable last-mile solutions by assessing and proposing optimized delivery routes that comply with city regulations and reduce environmental impact. The first step in Ghent's implementation path for the DISCOPROXI measure will be to define the supply of green last-mile operators and ensure the availability of their data, whether it's real or simulated. This will establish a strong understanding of the current capabilities for green deliveries within the city. Subsequently, the UAC system will utilize this information to offer pre-routing advice and on-route adjustments to delivery operators, aligning with the city's goal of reducing traffic and emissions in the city center. By leveraging real-time data, the UAC will calculate the most efficient delivery routes and propose sustainable alternatives, facilitating a transition towards zero-emission delivery services. The implementation path for this measure includes assessing operator satisfaction with new routing proposals, defining demand data for the UAC system, enriching the BEMOBILE route planner with UAC information, and testing the feasibility of shared green delivery services. Each step is designed to ensure the measure's alignment with Ghent's broader environmental objectives and the practical needs of logistics operators. The data and insights gathered through the UAC system will be made available via Urban Freight Data Space, allowing for continuous improvement and adaptation of the system.

The measure's suggested implementation process to its full implementation, as shown in the left part of the figure below, showcases Ghent's comprehensive approach to a more sustainable and efficient urban logistics environment.

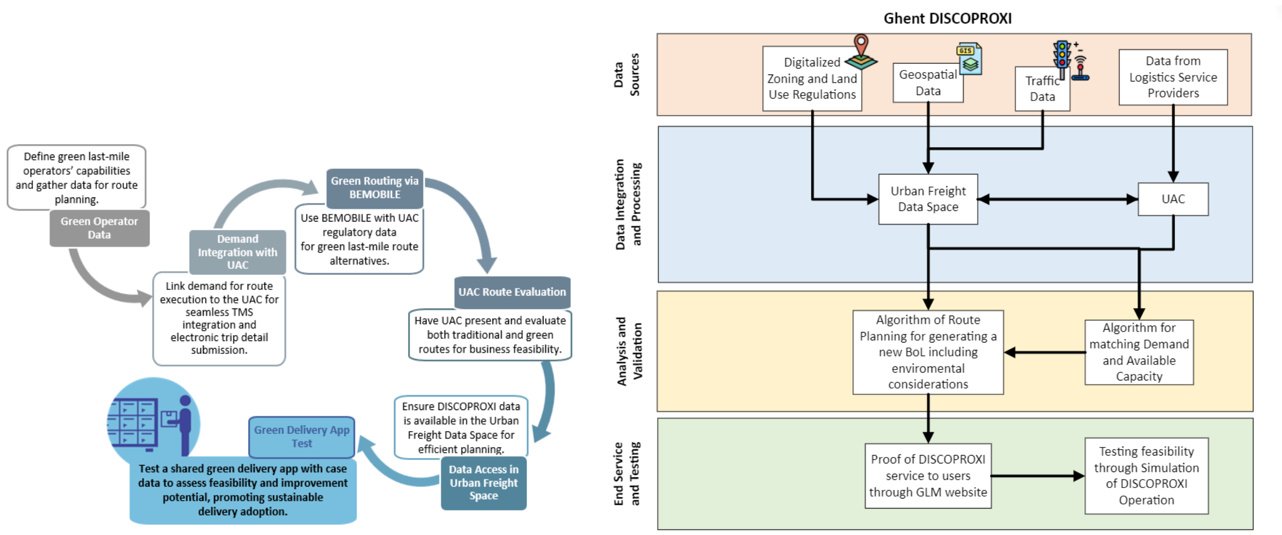


Figure 13: The suggested implementation process (left) and the suggested PI Operational Paradigm (right) for Ghent to achieve the DISCOPROXI measure

Finally, the proposed implementation process was further analyzed considering the data sources, the tools and the services available in the city and the expected outcomes of the DISCO-X solution. In this context, the suggested PI Operational Paradigm (right part of Figure 13) was designed for the DISCOPROXI of Ghent. First, there is a comprehensive data collection strategy, encompassing the digitization of zoning and land-use regulations, geospatial mapping, traffic pattern analysis, and the assimilation of logistics service provider data. Following data acquisition, an integration process is executed within an Urban Freight Data Space and a presumed UAC, which serves as a node for data consolidation and preprocessing. Core to the analysis, there are two innovative algorithms: the first for environmentally conscious route planning that generates a new Bill of Load (BOL), and the second for the alignment of logistics demand with available capacity, ensuring an optimized match. The culmination of the research is embodied in a dual-phase validation process, where the DISCOPROXI service is subjected to a proof of concept via the GLM website, enabling user interaction and feedback, and a rigorous simulation-based testing protocol to ascertain the operational feasibility of the system. This process highlights a data-driven and environmentally friendly approach to revolutionizing urban freight dynamics, ensuring the research is firmly rooted in practical application and sustainability.

4.2.2. Ghent's GHE_02_DISCOBAY

The DISCOBAY measure in Ghent was described as such:

To implement alternative, optimal and sustainable routes and delivery methods, to promote the use of cargo bikes and urban waterways barging.

Ghent's DISCOBAY measure is about leveraging the city's multimodal Barge terminal to establish a low-carbon transportation hub. Located approximately 5 kilometres from the urban center, this hub is poised to serve as a launching point for electric autonomous water shuttles that will deliver goods to the urban core. Additionally, electric cargo bikes will be used to complete the last-mile deliveries, complementing the water-based transportation. The overarching aim is to reduce urban emissions and alleviate congestion by increasing the use of consolidated, eco-friendly transport methods for the city's logistics needs.

Ghent's DISCOBAY measure will conduct testing related to waterway logistics as part of an alternative proposed solution of the Urban Access Controller (UAC). The UAC will play a pivotal role by evaluating logistics service providers' (LSPs) planned transport against sustainable last-mile alternatives, with a special emphasis on waterway logistics facilitated by Ghent's Living Lab partner UWL/OHB. The type of goods, such as building materials and waste—which already have an economically viable precedent for waterway logistics—will be a critical factor in the UAC's decision-making process. The focus on economic viability is intended to ensure that the implementation of waterway logistics extends beyond a mere demonstration and becomes an integral part of the city's logistics framework.

Within the logistics domain, the measure will explore the potential for delivering building materials to the inner city, managing waste transport, and investigating additional possibilities like parcel delivery through a combination of barging and cargo bike use. The utilization of hubs for loading and unloading ships will be central to this operation.

Ghent will initiate its DISCOBAY measure by having logistics operators submit route execution demands to the Urban Access Controller (UAC), which will interface with Transport Management Systems to process e-Bill of Loading. The BEMOBILE route planner, incorporating UAC regulations, will calculate green last-mile routing alternatives. The UAC will then present these alternatives, including the integration of waterway logistics with cargo bike deliveries, to the operators. The UAC will also match demand with the capacity for waterway logistics, ensuring the regular operation of these sustainable logistics solutions. Finally, Ghent will test the effectiveness of multimodal and green deliveries, focusing on the app's ability to handle different good types and assessing the economic viability of the waterway logistics.

The figure below (Figure 14) illustrates the suggested implementation process (based on the information above) and the suggested PI operational paradigm (by combining this information with further technical details of the city) that were designed to guide Ghent towards the implementation of the DISCOBAY measure.

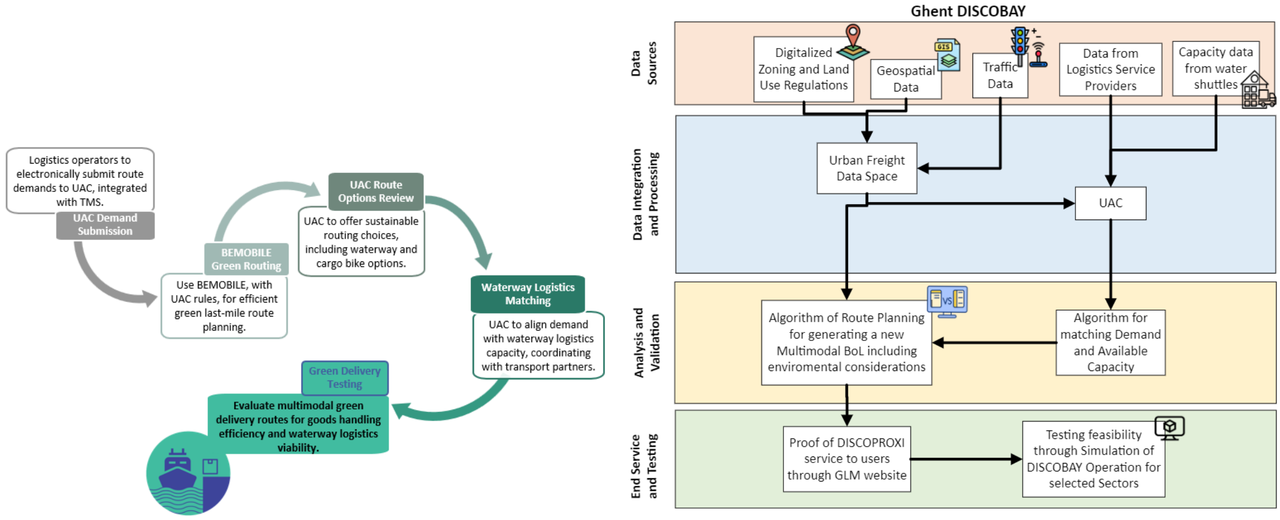


Figure 14: The suggested implementation process (left) and the suggested PI Operational Paradigm (right) for Ghent to achieve the DISCOBAY measure

When it comes to the PI operational paradigm of Figure 14, an extensive data gathering process, aggregating digitized zoning and land-use regulations, geospatial information, traffic flows, logistics providers' data, and capacity data from water shuttles to support a multimodal transport framework in the Data Sources section. This data is then assimilated and refined within an Urban Freight Data Space and analyzed by the UAC, ensuring comprehensive data oversight in the Data Integration and Processing section. Central to the Analysis and validation section, there are two key algorithms: one for sustainable route planning that generates a new multimodal Bill of Load (BoL) with environmental considerations, and another for efficiently aligning demand with available logistics capacity. The framework transitions into the End Service and Testing section with a dual-faceted validation approach, offering a proof of concept via the GLM website for user engagement and employing simulations to test the DISCOBAY operation's feasibility in selected sectors. This process underpins the project's commitment to sustainable, data-informed decision-making and robust testing for practical urban logistics applications.

4.3. Helsinki Starring Living Lab

4.3.1. Helsinki's HEL_01_DISCOCURB

The DISCOCURB measure in Helsinki was described as such:

> To implement a Fast-Track dynamic curb management enabling flexible use of dedicated loading/unloading zones and parking zones/spots (i.e., mobile micro-hub concept) and simulation of a Dynamic Low-Emission Zone (LEZ)

After conducting workshops with Helsinki's Living Lab to gain a good understanding of the measure, it was concluded that the DISCOCURB measure will be articulated through two distinct cases, each addressing different aspects of urban curb management:

Case 1: Dynamic Curb Management
The first case is centered around dynamic curb management, where Helsinki aims to deploy ground sensors and camera systems to monitor selected loading/unloading zones and parking spots. This demonstration test seeks to identify the most suitable technologies for the Finnish climate, particularly to determine which devices can withstand the harsh winter conditions of the Finnish Capital.

The end goal is to provide real-time data about the availability of these zones to logistics operators and drivers through the Tietorahti app. This application not only offers route planning and traffic updates but will also be enriched with parking availability data. The data collected will benefit city planners by providing insights into usage patterns, aiding in future urban planning and infrastructure enhancement decisions. Additionally, this case intersects with the 'mobile micro hub' concept that A2B is exploring to optimize parcel delivery within the city.

Case 2: Dynamic Low Emission Zone
The second case explores the implementation of a dynamic low emission zone. Helsinki is collaborating with logistics operators to gather data from their fleets to understand the operational impact before and after the introduction of such zones. This 'before and after' study will focus on how emission restrictions affect delivery routes and vehicle usage, without setting up an actual low emission zone. Instead, the city will analyze the data to anticipate changes in delivery operations and fleet compositions, providing valuable feedback for both logistic companies and urban policymakers considering future low emission zones.

Both use cases are instrumental in guiding Helsinki's vision for DISCOCURB, which emphasizes flexibility and real-time management of urban spaces. The city is leveraging its control over most parking areas to integrate these innovative approaches, with the intent to enhance efficiency and reduce the environmental footprint of urban logistics.

In the DISCOCURB implementation path for Helsinki, a systematic approach is adopted, beginning with the assessment of climate-resilient sensor technologies suitable for the city's unique conditions. This is followed by the careful selection of strategic areas for sensor installation, ensuring alignment with low emission zones and dynamic curb management needs. The installation and integration of these sensors with Helsinki's existing traffic and parking management systems is a crucial step, ensuring seamless data collection and curb space management. Rigorous testing of IoT technology is then conducted to confirm data accuracy and reliability, particularly focusing on occupancy metrics essential for dynamic management. Data collection and visualization are facilitated through the TIETORAHTI system, providing real-time insights into loading zone and parking spot availability for logistics operators and drivers. The path also includes operational testing of curb spaces for multiple functions, including as mobile warehouses or microhubs, and gathering user feedback to gauge satisfaction and identify improvement areas. A pivotal aspect is the development of a viable business model for shared mobile warehouse operations and the establishment of a regulatory framework to support dynamic curb usage. Finally, the implementation path culminates in a comprehensive analysis of outcomes from these implementations, setting the stage for a city-wide rollout of the DISCOCURB measure, integrating learned lessons and adjustments.

This procedure is presented in a stepwise approach as the suggested implementation process at the left part of Figure 15 which is the suggested implementation process for Helsinki towards DISCOCURB.

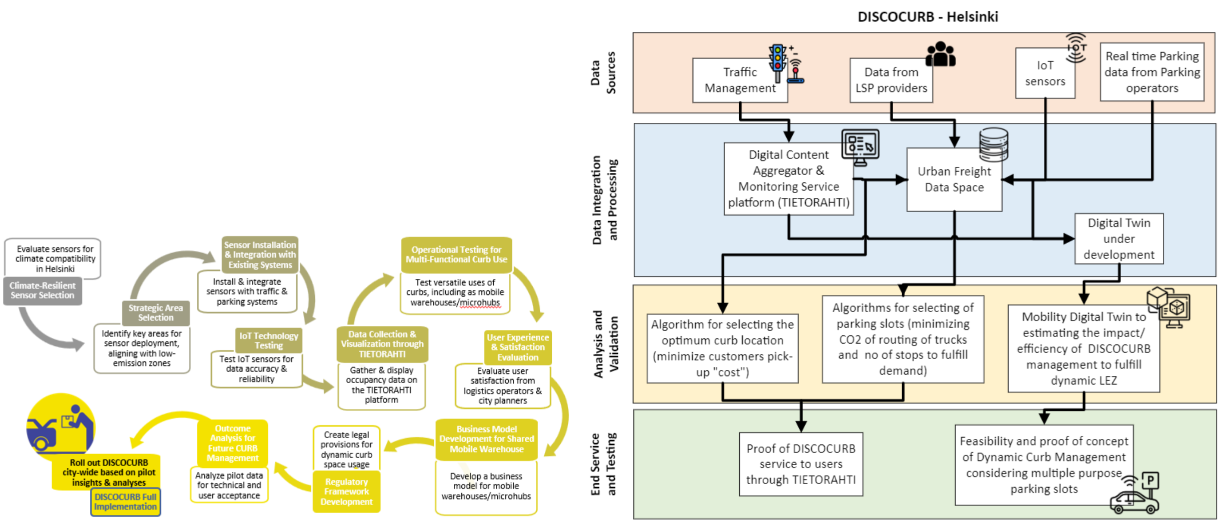


Figure 15: The suggested implementation process (left) and the suggested PI Operational Paradigm (right) for Helsinki to achieve the DISCOCURB measure

The DISCOCURB measure in Helsinki integrates data analytics to optimize urban traffic and curb management and the proposed PI operational paradigm is included in the right part of Figure 15. It commences with the collection of diverse datasets from traffic management systems, logistics service providers, IoT sensors, and parking operators to gather a comprehensive real-time traffic and logistics profile. This data is then synthesized and monitored via a platform named TIETORATTI and an Urban Freight Data Space, which presumably also contributes to the development of a Digital Twin for urban planning. Algorithms are developed to strategically allocate curb space to minimize customer pick-up costs and to select parking slots that mitigate CO_2 emissions and traffic disruption, aligning with sustainable urban logistics practices. Moreover, a Mobility Digital Twin evaluates the project's impact on dynamic Low Emission Zones. The approach culminates in a user-accessible proof of service through TIETORAHTI and a multifaceted proof of concept that assesses the feasibility of managing parking slots for various uses, demonstrating a commitment to innovative, data-informed urban freight management solutions.

4.3.2. Helsinki's HEL_02_DISCOPROXI

The DISCOPROXI measure in Helsinki was described as such:

> To develop a new business physical platform model allowing companies to better locate and operate in a network of multifunctional micro-hubs to be set up at under-used urban spaces, existing properties, and infrastructure in the urban and peri-urban areas. The micro-hubs would bring benefits to the residents and local economies as well (e.g., shared e-scooters, e-bikes with adjoining charging stations, maintenance and storing services for bikes, and pick-up-lockers).

Helsinki is progressing with the DISCOPROXI measure by embracing the concept of micro-hubs, which are currently in the 'Proof of Concept' stage citywide. The measure aims to utilize movable containers as versatile hubs that act as both consolidation points for logistics operations and convenient access points for city residents. These hubs are designed to merge logistic services with micro-mobility solutions, providing a combined benefit to the urban transport network and the community.

Focusing on optimizing urban space, Helsinki is identifying underutilized areas suitable for these hubs. The strategy involves situating the micro-hubs in locations that foster high logistic activity and are close to city attractions, thereby ensuring their effective use and accessibility. The Ruoholahdentori area has been selected to demonstrate this initiative. There, the aim is to demonstrate how these hubs can support efficient, sustainable logistics and enhance the convenience for residents, leveraging multi-modality and green transport methods at a localized level.

Helsinki's implementation of the DISCOPROXI measure, as envisioned in their Living Lab, heralds a transformative approach to urban space utilization, marrying the functionality of logistics with urban mobility services. The implementation path for DISCOPROXI in Helsinki culminates in a demonstrator near the city center, setting the stage for a scalable model that underscores multi-modality and sustainable transport methods. In the upcoming phases of the DISCOPROXI measure, Helsinki's Living Lab will undertake a series of steps to establish a network of urban micro-hubs by also considering the suggestions from the Urban Planning department. The initial phase will involve identifying and cataloguing underused urban spaces that are suitable for conversion into micro-hubs. The suitability of these spaces for integration into the city's logistics network will be evaluated, with a focus on understanding the infrastructure needs and estimating local logistics demand. The DISCOPROXI application will be utilized to test various locations for the micro-hubs, aiming to find the most strategic placements. Following this, the installation of containers and lockers at these selected sites will lay the groundwork for the micro-hubs' physical infrastructure. Once the infrastructure is in place, ROLAN will take on the management of the micro-hubs, initiating their operation. Data integration will be a key component, with operational data, including routing information from existing apps, being fed into the Urban Freight Data Space. The operation of the micro-hubs will be monitored and assessed to ensure they meet the needs of logistics operators and the community. In parallel, a demand-to-supply matching service will be developed, incorporating algorithms to efficiently connect logistics services with user needs. The user experience with the green routing app will be evaluated, and feedback will be used to improve the service. Finally, the business operations and fulfilment capabilities of the micro-hubs will be analyzed to ensure they align with the objectives of the DISCOPROXI measure. The ultimate goal is to demonstrate an effective, flexible urban logistics system that can be scaled up and adapted to future needs.

The suggested process of implementing the DISCOPROXI measure in Helsinki's Living Lab, with its methodical and progressive steps towards establishing a network of urban micro-hubs, is depicted in the left part of the figure below.

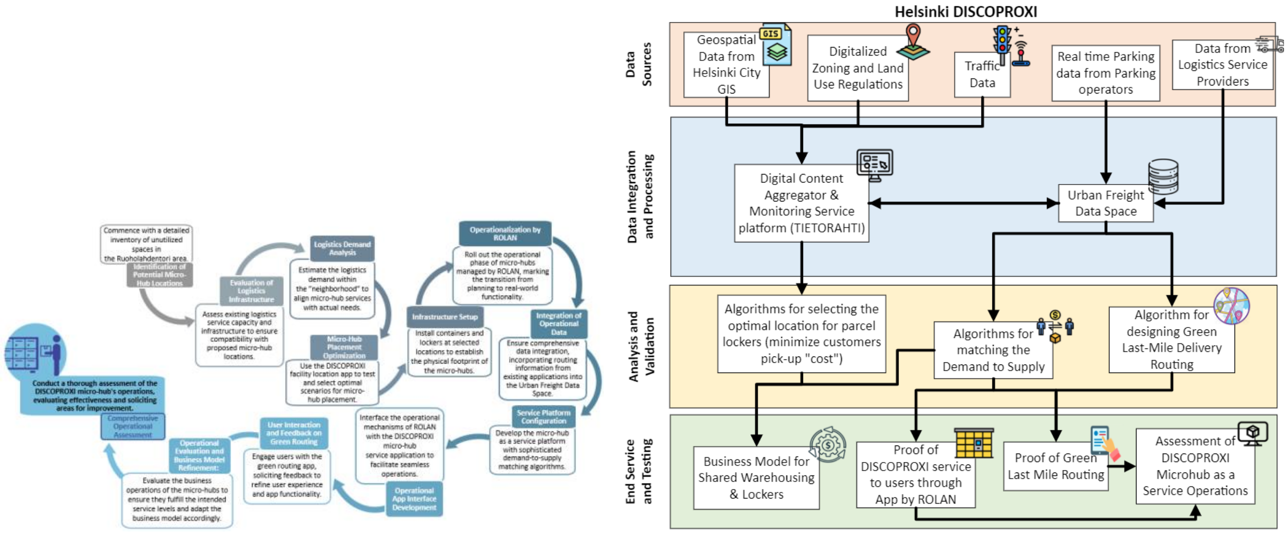


Figure 16: The suggested implementation process (left) and the suggested PI Operational Paradigm (right) for Helsinki to achieve the DISCOPROXI measure

The right part of the Figure 16, presents the suggested PI Operational Paradigm for Helsinki to achieve the implementation of DISCOPROXI. The provides a data-centric approach to enhancing urban logistics. It integrates geospatial, regulatory, traffic, parking, and logistics service provider data into a centralized platform, TIETORAHTI, and an Urban Freight Data Space for analysis. Algorithms are developed for optimizing parcel locker locations to reduce pick-up costs and for efficient demand-supply matching, alongside green routing for last-mile deliveries. The implementation phase includes a shared warehousing and locker business model, user service proof via the ROLAN app, and a demonstration of sustainable routing practices. The project concludes with an operational assessment of the DISCOPROXI microhub service, emphasizing the practicality and environmental focus of the logistics solutions.

4.4. Thessaloniki Starring Living Lab

4.4.1. Thessaloniki's THESS_01_DISCOPROXI

The DISCOPROXI measure in Thessaloniki was described as such:

> To demonstrate innovative business models and services for free space use, by adopting smart contracts. The city community aims to enrich with blockchain the WareM&O (Warehouse as a Service) community platform solution which already integrates a fair pricing algorithm for facilitating business agreements in WaaS. The resulting flexible and improved space management will better serve e-commerce needs, resulting in a mitigation of the negative effects on quality of life and operations. It will be done by a) identifying strategically positioned proximity areas as off-road places dedicated to L/U nearby destinations to reduce vehicle trips; and b) adopting innovative business models and services for free space utilisation with smart contracts.

Thessaloniki's DISCOPROXI measure essentially consists of two cases. The first case focuses on the meticulous development of the city's Logistics Real Estate Database. This involves a detailed assessment and enrichment process to identify, and catalogue underused, freely available, and privately owned spaces suitable for micro-hubs and smart locker systems. The city plans to conduct a comprehensive demand analysis for city logistics within two critical neighbourhoods, the historical center, and the Rotonda Low Emission Zone (LEZ), to test various facility location setups under a shared micro-hub operational model.

Case 1: Enrichment of Thessaloniki's Logistics Real Estate Database
In the future, Thessaloniki will focus on expanding its Logistics Real Estate Database. This enrichment will involve identifying and cataloguing underused, free, and privately owned spaces suitable for logistics purposes, along with locations for smart lockers and micro-fulfilment centers. This effort will create a comprehensive database that effectively captures potential logistics hubs and smart locker sites, facilitating strategic planning for urban logistics networks and micro-fulfilment operations across the city.

Case 2: Microhubs as a Service & Last Mile Operational Verification in DISCOPROXI
Thessaloniki will also demonstrate the concept of 'Microhubs as a Service.' This initiative will include the deployment of shared smart lockers at the TIF-HELEXPO premises, a strategic move to test their usage by multiple last-mile operators. This demonstration will not only validate the effectiveness of smart lockers in enhancing last-mile delivery efficiencies but also contribute to the city's overall logistics optimization within its high-traffic areas. Additionally, Thessaloniki plans to advance the integration of microhubs within the Rotonda Low Emission Zone. This will involve HIT conducting demand analysis in the area to determine the most effective number and locations for locker

installations, ensuring that they meet the actual logistical demands of the city. Moreover, a key aspect of this case will be the development of a regulatory framework that permits the placement of lockers in public spaces, a crucial step in harmonizing innovative logistics solutions with urban policy and planning. As Thessaloniki forges ahead with the DISCOPROXI measure, the implementation path depicted in the figure below marks the city's progression towards a smarter logistics framework.

The implementation journey will continue with the installation of micro-hubs and lockers within the Thessaloniki International Fair (TIF) premises, complemented by the municipal incentives and the critical role of data provision for demand and services. The second use case expands on the operational verification of Microhubs as a Service and Last Mile as a Service within the DISCOPROXI framework. Thessaloniki aims to enhance the existing Warehouse as a Service platform, ensuring seamless and secure contract information exchange, and tailoring it for the integration of micro-mobility hubs and lockers.

Additionally, the city seeks to incorporate last-mile service applications like DELINET and taxi apps, to support the business verification of the warehouse as a service app operation. This will include establishing a clear vocabulary and definitions for micro-hubs, ensuring the data collected is consistent and valuable. Finally, business collaboration and operational protocols for Microhubs as a Service, alongside the standardization of city logistics spaces and capacity descriptions, will be crucial. This concerted effort will provide a robust foundation for feeding the DISCOPROXI apps operation and contributing to the Urban Freight Data space, marking a significant stride towards a smarter and more sustainable urban logistics system in Thessaloniki.

This procedure is depicted to the left part of Figure 17 which shows the suggested implementation process of Thessaloniki to achieve the DISCOPROXI measure.

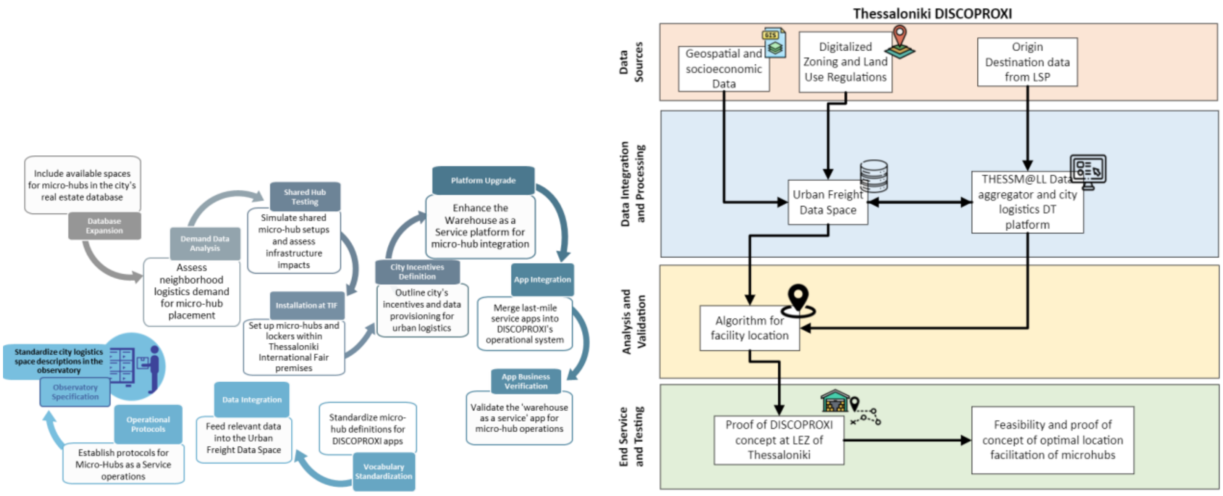


Figure 17: The suggested implementation process (left) and the suggested PI Operational Paradigm (right) for Thessaloniki to achieve the DISCOPROXI measure

The DISCOPROXI measure of Thessaloniki which aims the optimization of urban logistics infrastructure can be seen also in the suggested PI operational paradigm in (right part of Figure 17). The project harnesses geospatial and socioeconomic data, along with digitized zoning and land use regulations, and origin-destination data from logistics service providers (LSP). This data is consolidated within an Urban Freight Data Space and further processed by a logistics and city aggregator platform, THESSM@LL. The core analytical component is an algorithm tailored for facility location optimization. The execution phase of the project is manifested through a proof of concept at the LEZ of Thessaloniki, which validates the DISCOPROXI concept. Lastly, the framework explores the feasibility and provides a proof of concept for the optimal location and facilitation of microhubs, integral to the project's goal of enhancing the efficiency of urban freight systems.

4.4.2. Thessaloniki's THESS_02_DISCOESTATE

The DISCOESTATE measure in Thessaloniki was described as such:

> To demonstrate temporary/multipurpose and optimal use of strategically positioned buildings at the TIF HELEXPO Exhibition Centre as a logistics hub (when events aren't taking place) to operate with shared transport and logistics facilities (e.g., freight hotels) and their optimization through smart solutions and tools and green last mile solutions.

Thessaloniki's DISCOESTATE measure is about the utilization of the strategically located buildings within the TIF HELEXPO Exhibition area, transforming them into dynamic logistics hubs during non-event periods. The operational 'marriage' of this effort will be between the LSP partner of Thessaloniki's Living Lab, ACS, and the infrastructure provider of the Living Lab, TIF HELEXPO. This innovative approach aims to facilitate temporary, multipurpose utilization of these spaces, combining them with shared transport and logistics facilities like freight hotels. The focus will be on optimizing these hubs through smart solutions and tools, coupled with green last-mile delivery options. The key aspects of this transformation include:

Case 1: Multi-tenant Hub Infrastructure Preparation
This aspect of the DISCOESTATE measure involves the enhancement of the digital Buildings/Logistics Real Estate Inventory, vital for the identification and utilization of space. It also covers the need for connectivity between Warehouse Management Systems (WMS), Real Estate Management Systems, and Operators' Transport Management Systems (TMS), which currently lacks development. The city is in the process of procuring and installing operational protocol sensors, such as those enabling building accessibility and capacity availability.

Case 2: Multi-tenant Hub Operational Verification

This aspect assesses the operational readiness and use of multi-tenant hubs, considering the existing Storage Demand & Supply publishing service, which is set for further improvement. Price models for warehouse and service use are already in place, yet the framework for certification, liabilities transfer, and rules for warehouse sharing requires development. Furthermore, regulations for the operational and legislative model in case of non-logistics infrastructure use are not yet established, although time window and pricing regulations are already operational.

Thessaloniki is advancing its DISCOESTATE measure with a twofold approach aimed at transforming the Thessaloniki International Fair Buildings into a versatile urban logistics hub. The first case involves enhancing the Building Management System to align with the city's standardized Logistics Real Estate database. This integration will support the digitalization of building layouts, pricing models, and availability. Additionally, sensor installation will monitor logistics operations, providing real-time data to the WareM&O app engine for demand and capacity matching. The development of a business model will facilitate the adoption of these multi-tenant and multi-purpose hubs by companies, while also generalizing requirements and providing dynamic information on operations.

In the second case, Thessaloniki will conduct a practical demonstration with a single tenant to validate the hub's functionality. Agreements with external logistics service providers will explore the potential for shared use, assessing the feasibility with third-party collaborators. This will extend to connecting these companies with the Warehouse Management System (WMS) for real-time hub capacity information. The culmination of these efforts will be an evaluation of the dynamic use of these innovative hubs in the city, paving the way for a new era of urban logistics.

The left part figure below illustrates the stepwise suggested implementation process for implementing the DISCOESTATE measure in Thessaloniki, encompassing the integration of IT infrastructure, operational adaptation, business model formulation, and collaborative feasibility evaluations.

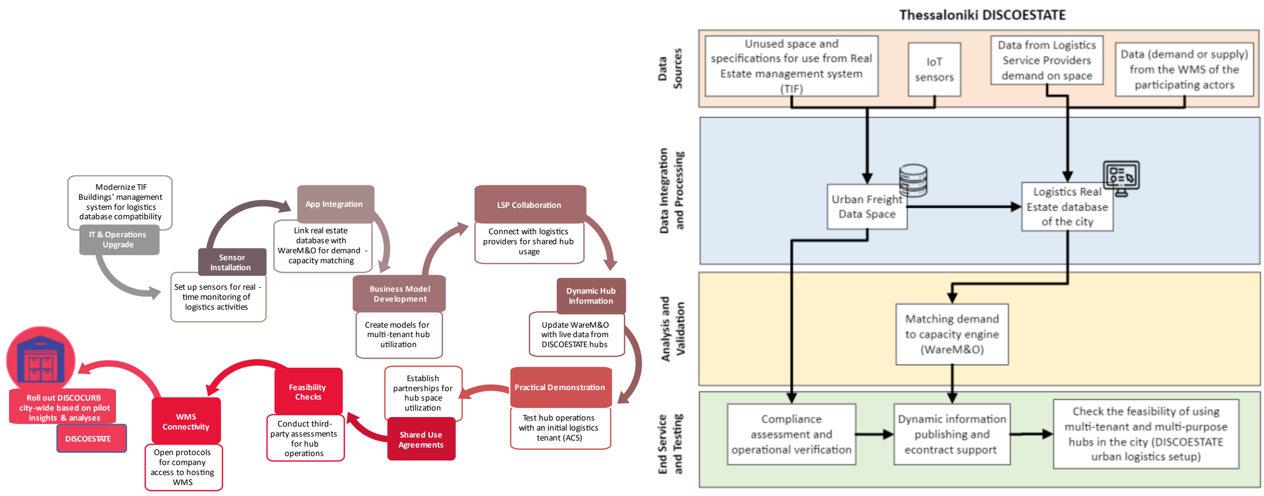


Figure 18: The suggested implementation process (left) and the suggested PI Operational Paradigm (right) for Thessaloniki to achieve the DISCOESTATE measure

The suggested PI operational paradigm for the DISCOPROXI of Thessaloniki (Figure 18 - right part) illustrates an urban logistics management system. The data collection phase includes sourcing space specifications from a Real Estate management system, IoT sensor data, logistics demand data from service providers, and supply data from the WMS (Warehouse Management System) of participating actors. This data feeds into two main repositories: an Urban Freight Data Space and a Logistics Real Estate database of the city, indicating a blend of physical space and digital data management. The analysis and validation phase centers on a Matching demand to capacity engine (WareM&O), which presumably optimizes logistics operations by aligning available space and resources with logistics needs. The final service end phase includes a compliance assessment and operational verification, dynamic information publishing and contract support, and a feasibility check for multi-tenant and multi-purpose hubs in the city, known as DISCOSTATE. This suggests a comprehensive approach to managing urban logistics infrastructure, considering legal compliance, operational viability, and the flexible use of urban spaces for logistics purposes.

4.4.3. Thessaloniki's THESS_03_DISCOBAY

The DISCOESTATE measure in Thessaloniki was described as such:

> To map underused infrastructure to be used as freight hotels and enrich the WaaS data space with other unexploited areas and land available and managed by the municipality to create an integrated space availability observatory for Thessaloniki.

For Thessaloniki's DISCOBAY measure, the strategic objective is to leverage underutilized infrastructure for the establishment of freight hotels and to augment the city's Warehouse as a Service (WaaS) database with other untapped municipal areas. This will contribute to an integrated observatory of space availability, optimizing the city's logistics landscape.

Thessaloniki is embarking on a thorough feasibility assessment of its urban terminals, such as the port and rail stations, to evaluate their suitability as last-mile delivery hubs for e-trucks. This measure is strategically focused on the spaces between the vibrant city center and the industrial area, which is a key demand generator on the outer western side of the urban core. The city intends to enrich its Logistics Real Estate database, identifying vacant areas at these terminals and other potential intermodal locations. Thessaloniki will use simulation techniques to validate the feasibility of these locations, demonstrating their effective use as multimodal nodes to enhance sustainable freight transport and optimize the city's logistics network.

The implementation path for Thessaloniki's DISCOBAY measure illustrates the city's strategic steps toward enhancing its urban terminals as innovative hubs for e-truck last-mile deliveries. The following figure succinctly depicts each phase, from augmenting the logistics database to validating the operational concept, marking Thessaloniki's journey towards sustainable urban freight logistics.

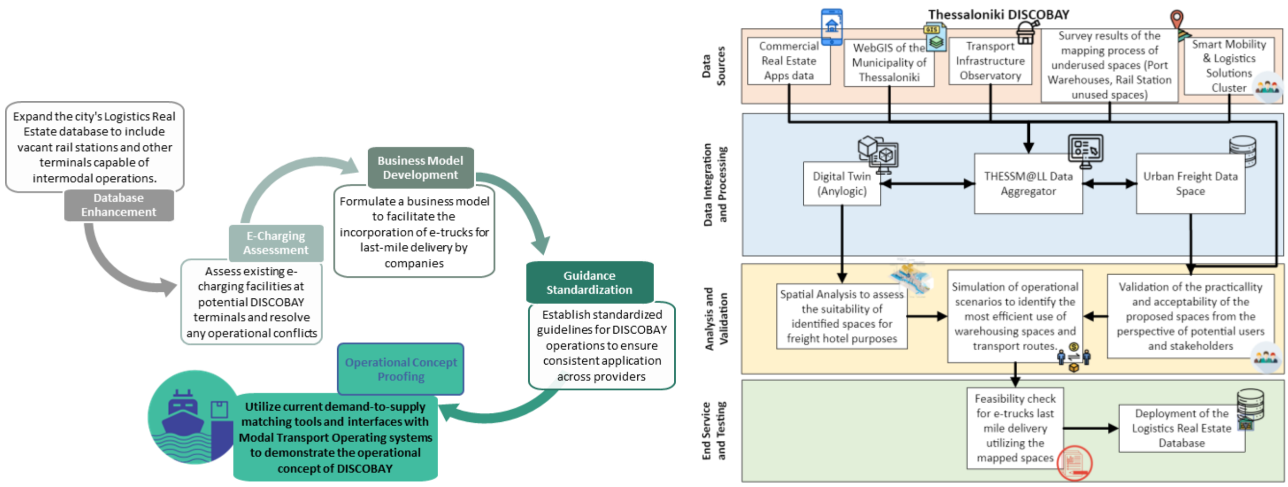


Figure 19: The suggested implementation process (left) and the suggested PI Operational Paradigm (right) for Thessaloniki to achieve the DISCOBAY measure

The right part of Figure 19 (suggested PI operational paradigm) for the DISCOBAY in Thessaloniki outlines a scheme for the city towards multi-layered urban logistics analysis and optimization. It commences with data collection from commercial real estate apps, the WebGIS of the Municipality of Thessaloniki, transport infrastructure observatory, and survey results of unutilized spaces (from port warehouses, rail stations, and unused spaces), supported by the Smart Mobility & Logistics Solutions Cluster. Data integration is managed through a Digital Twin and a data aggregator (THESSM@LL), which synthesize the collected information into an Urban Freight Data Space (UFDS). The analysis phase employs spatial analysis to assess the suitability of identified spaces for freight hotel purposes and conducts simulations of operational scenarios to identify the most efficient use of warehousing spaces and transport routes. The final phase includes validating the practicality and acceptability of the proposed spaces from the perspective of potential users and stakeholders, a feasibility checks for e-trucks' last mile delivery utilizing the identified spaces, and the deployment of the Logistics Real Estate Database. This comprehensive approach aims to enhance the efficiency and utility of urban spaces for logistics purposes, leveraging digital modelling and stakeholder feedback.

4.5. Copenhagen Starring Living Lab

4.5.1. Copenhagen's COPE_01_DISCOCURB

The DISCOCURB measure in Copenhagen was described as such:

> To demonstrate an innovative dynamic space management and urban planning tool as a small-scale use case for effective and flexible curb side use.

Copenhagen's DISCOCURB measure focuses on establishing an innovative dynamic space management tool to facilitate effective and flexible curbside use. With the impending removal of half the parking lots in the Inner City by 2024, there is a pressing need to redefine curb side delivery and parking space sharing strategies. The Copenhagen Living Lab is proactively engaging with stakeholders to explore new delivery opportunities that align with the Sustainable Urban Logistics Plan.

As part of its SULP shaping process, the Living Lab is collecting comprehensive logistics demand data from its Group Partners. This data will be instrumental in simulating various curb management scenarios within a Digital Twin of the city, aiding in the strategic decision-making process. The anticipated reduction of parking spaces in the medieval are of the city is subject to advisors' recommendations in the coming months and subsequent political approval. The outcome of these discussions and workshops with the Partner Group and Advisory Board will inform the placement of new loading zones, ensuring that Copenhagen's curb side management remains responsive to the evolving urban landscape.

In Copenhagen's Living Lab, the DISCOCURB implementation path unfolds with an evaluation of dynamic curb management in response to a significant parking space reduction, leveraging rich data ecosystems and stakeholder collaboration. Culminating in the demonstration of a tool (Digital Twin), DISCOCURB's implementation will exemplify adaptive, efficient curbside usage in Copenhagen's historic core.

The forthcoming figure outlines a strategic implementation path for the implementation of Copenhagen's DISCOCURB measure, charting the city's course as it prepares to navigate the challenges of a 50% reduction in parking spaces within its medieval inner city. The transition will commence with an assessment of the impact this reduction will have on city logistics, utilizing data from existing parking apps and insights from freight partnerships. A data collection strategy will then be established to feed into Copenhagen's digital twin, essential for urban planning.

Simultaneously, the city will analyze the effects of parking lot reductions on logistics operations, including demand, cost, time, congestion, and CO_2 emissions, to understand the broader impact on economic activities and the level of service for last-mile deliveries. Alternative solutions for these last-mile operations will be simulated in the Digital Twin, exploring various configurations of loading zones within the inner city.

As the process unfolds, the effectiveness of dynamic curb management systems will be estimated to determine their ability to fulfil the requirements of the city logistics operators. Locations for dynamic curb management will be co-selected with stakeholders, guided by advice from city advisors and political decisions.

Following this, sensors will be installed to commence the proof of concept for dynamic curb management, ensuring data feeds into the Data Space. A visualization application will be developed to utilize this data, integrating with existing parking apps to facilitate user access. The operation of DISCOCURB will then be assessed, analyzing data and user feedback to gauge the system's performance.

To further this initiative, collaborative models will be proposed to leverage the DISCOCURB innovation, encouraging its widespread adoption among all relevant actors. The culmination of these efforts will be demonstrated through an innovative dynamic space management tool (which is expected to be developed in the DISCO project, envisioned as a small-scale use case to exhibit effective and flexible curbside use. This demonstration will draw upon research from FIT, the city of Copenhagen, and inputs from workshops with the Partner Group and Advisory Board, setting a precedent for digital urban planning tools in the future.

All this knowledge was used to build suggested implementation process that city of Copenhagen could follow to successfully implement the DISCOCURB measure.

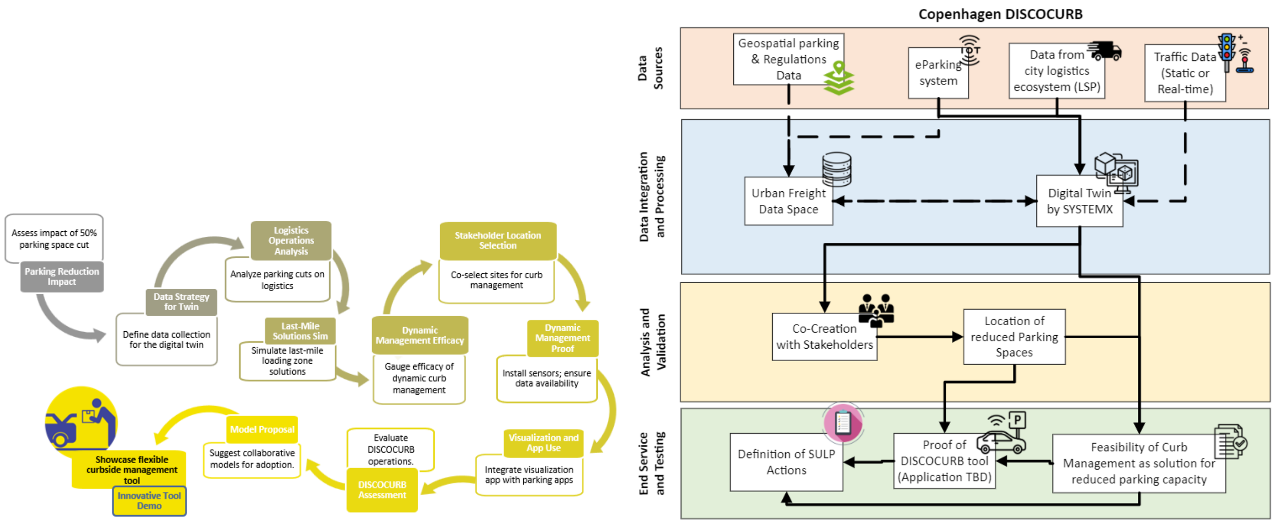


Figure 20: The suggested implementation process (left) and the suggested PI Operational Paradigm (right) for Copenhagen to achieve the DISCOCURB measure

The suggested PI operational paradigm which is presented in the right part of Figure 20 focuses on guiding cities how to achieve a PI-led urban parking and traffic management. The project initiates data collection, involving geospatial parking and regulations data, an eParking system, logistics service provider data, and traffic data that could be static or real-time. This data should potentially be integrated into an Urban Freight Data Space and also aggregated and analysed using a Digital Twin by SYSTEMX. The analysis and validation stage features co-creation with stakeholders to foster collaborative solutions and identifies locations for reduced parking spaces, suggesting an effort to streamline parking utilization in the city. The final service end phase involves defining Sustainable Urban Logistics Plans (SULP) actions, providing a proof of concept for the Dynamic Curb Management tool (with the application to be determined), and assessing the feasibility of curb management as a solution for reduced parking capacity, indicating a focus on practical, implementable strategies for urban space optimization.

4.5.2. Copenhagen's COPE_03_DISCOPROXI

The DISCOPROXI measure in Copenhagen was described as such:

> To develop a new sustainable business model for an open consolidation hub in the city thanks to the use of shared transport facilities for goods through smart solutions e.g., to attract more couriers to the existing urban micro-hub Køleskabet.

Copenhagen's DISCOPROXI measure, is focused on creating a sustainable business model for an urban consolidation hub, leveraging smart solutions to facilitate shared transport facilities for goods. With a clear understanding that public spaces cannot be utilized for micro-hubs, the city is shifting its attention to enhancing Køleskabet and other micro-hubs throughout the urban landscape. By integrating big data analytics and a digital twin currently in development, Copenhagen's Living Lab aims to determine, in the coming months, the most advantageous locations for these hubs, thereby improving last-mile green delivery services. Although significant steps have been made in the workshops that the Living Lab organized with their Logistics Operators/ Partners, there remains a need to develop essential tools and interfaces, such as a Transportation Management System and Service Platforms for hub operators, to fully realize the potential of these hubs. Moreover, the city is navigating the regulatory landscape, ensuring that planning regulations like zoning and land use are conducive to the transformation of freight transfer within low emission zones, while seeking solutions to allow micro-hub installations in the suitable private spaces that will come as a result of the Green Mile Project.

Copenhagen's DISCOPROXI measure is set to embark on a strategic and detailed stepwise approach, aiming to augment urban logistics with a network of accessible micro-hubs. Starting with a comprehensive inventory of e-commerce facilities and potential hub locations, the city plans to systematically retrofit privately owned spaces into versatile logistics centers. Through the Living Lab's collaborative efforts with industry stakeholders, a shared vision for an open consolidation hub will be brought to life, with 'Køleskabet' serving as a model for future hubs. Data collection and analysis will play a crucial role in shaping the operational and business framework of these hubs, ensuring they cater to the e-commerce demand surge and contribute to greener last-mile solutions. Each phase, from feasibility studies to the co-creation of business models and policy actions, will guide Copenhagen towards a more integrated and sustainable urban logistics system. This stepwise approach, leading to the implementation of Copenhagen's DISCOPROXI measure, is illustrated in the figure below.

This implementation path will be informed by lessons from the Green Mile Project, ideas generated in workshops with stakeholders, and simulations within the Living Lab's Digital Twin to ascertain the most optimal locations for micro-hubs. The outcome will be a model that integrates micro-hubs into Copenhagen's urban fabric, enhancing logistics efficiency and supporting new urban development areas.

This whole procedure was integrated and is depicted in the left part of Figure 21, which makes a suggestion to Copenhagen by building a suggested implementation process for DISCOPROXI.

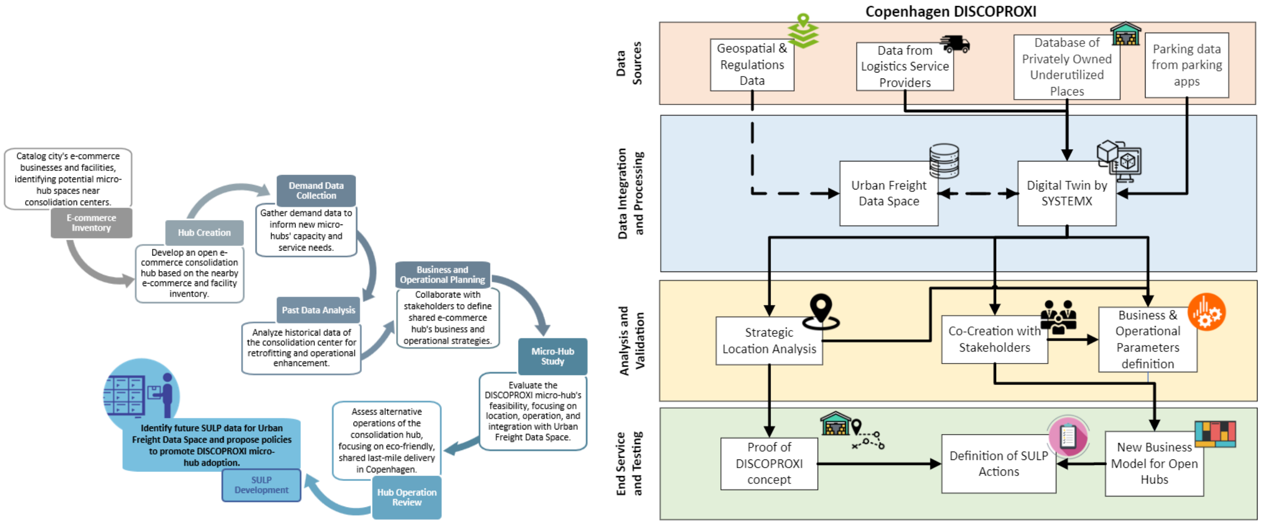


Figure 21: The suggested implementation process (left) and the suggested PI Operational Paradigm (right) for Copenhagen to achieve the DISCOPROXI measure

The right part of Figure 21 presents the PI operational paradigm for DISCOPROXI measure in Copenhagen which aims to optimize urban logistics and space utilization following a PI-led approach. Data sources include geospatial and regulatory data, logistics service provider data, a database of privately owned underutilized places, and parking data from apps. This is potentially compiled within an Urban Freight Data Space and also connected and modelled with a Digital Twin by SYSTEMX. The project then moves into an analysis phase where strategic location analysis is conducted, accompanied by co-creation sessions with stakeholders and the setting of business and operational parameters for the proposed solutions. The final service stage is multi-faceted, offering a proof of concept for the DISCOPROXI concept, defining Sustainable Urban Logistics Plans (SULP) actions, and creating a new business model for Open Hubs, which likely serve as shared, flexible spaces for various logistics activities. This represents a holistic approach to rethinking urban spaces in response to logistics needs.

4.5.3. Copenhagen's COPE_02_DISCOBAY

The DISCOBAY measure in Copenhagen was described as such:

> To retrofit the Høje Taastrup terminal as a peri-urban and neighbourhood multimodal hub for reloading, adopting zero-emission vehicles.

Copenhagen's DISCOBAY initiative leverages the strategic use of the Høje-Taastrup Transport Center as a peripheral, multimodal hub aimed at boosting low-carbon city logistics. Situated approximately 20 kilometers from the city's populous center, this hub is pivotal in dispatching electric vehicles for urban core supplies, particularly for B2C and B2B fresh food products from cold storage facilities. By retrofitting this transport center and utilizing zero-emission vehicles, Copenhagen aims to substantially reduce peri-urban emissions and alleviate road congestion. Integrating rigorous data collection from diverse logistics operators over a fortnight, this approach marks a shift towards dynamic, data-informed logistics planning. The outcome is expected to yield an enriched understanding of delivery patterns, paving the way for the development of a new Sustainable Urban Logistics Plan. This transformation hinges on close collaboration with stakeholders, a thorough assessment of hub capacities, and meticulous spatial planning to establish a functional, future-proof urban logistics model.

Copenhagen's path toward implementing the DISCOBAY measure for green last-mile services will commence with the collection of traffic and demand data from freight companies. This essential data will enrich the Digital Twin of the Copenhagen Region, providing a sophisticated platform for strategic planning and operational simulations.

The Høje-Taastrup Transport Center is set to be assessed for its capability to function as a peri-urban logistics hub as it is located in a municipality further outside the Copenhagen's urban core, with particular attention to warehouse capacity and the infrastructure required for a fleet of green vehicles, including necessary charging stations.

The next phase will focus on establishing the physical infrastructure, specifically designating unloading zones for heavy vehicles and setting up efficient dispatch systems for a fleet of electric vans. These vans will form the backbone of the BAY's last-mile delivery services. Close collaboration with logistics service providers, city officials, and the local community will ensure that the operations not only meet but exceed Copenhagen's stringent emission standards.

Copenhagen will also leverage its newly developed Digital Twin to simulate a variety of logistical scenarios. This virtual modelling will be pivotal in optimizing the flow and efficiency of goods through the DISCOBAY. To further streamline the operation, a common Transport Management System or similar system needs to be developed, aligning cargo matching with the most effective routing strategies.

The measure will undergo an iterative improvement process, with the proof of concept for the BAY being refined through successive trials to identify and rectify any operational issues. Following the demonstration phase, Copenhagen Living Lab will need to methodically adjust the workflows, recalibrate the fleet size, and enhance the necessary infrastructure based on the outcomes and insights gained.

This adaptive approach, as presented in the left part of figure below (Figure 22), ensures that the final implementation of the DISCOBAY measure is well-tuned to the city's logistics ecosystem, ultimately paving the way for a sustainable and congestion-free urban core.

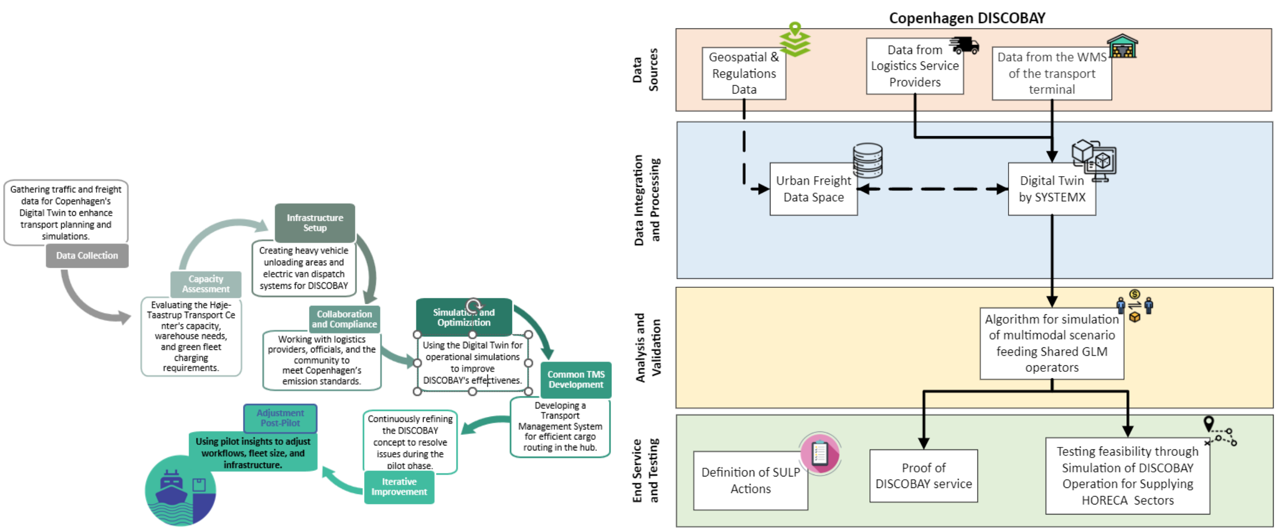


Figure 22: The suggested implementation process (left) and the suggested PI Operational Paradigm (right) for Copenhagen to achieve the DISCOBAY measure

The suggested PI operational paradigm for the DISCOBAY in Copenhagen is presented at the right part of Figure 22 which aims to adjust workflows, fleet size and infrastructure. First, it collects geospatial and regulations data, logistics service provider data, and data from the Warehouse Management System (WMS) of the transport terminal. This data is centralized and further modeled in a Digital Twin by SYSTEMX (potentially, Urban Freight Data Space could be used as a node for centralization). The project employs an algorithm for the simulation of multimodal scenario feeding Shared green last mile operators, indicating an analytical approach to optimizing logistics across different transport modes. The final stage of the project involves defining Sustainable Urban Logistics Plans (SULP) actions, presenting a proof of service for DISCOBAY, and testing the feasibility of the DISCOBAY operation for supplying the HORECA (Hotel/Restaurant/Café) sectors through simulations. This suggests a focus on practical, real-world applications of the project's findings, particularly within the service industry's supply chain.

4.6. Conclusions & Way forward

The comprehensive analysis of urban ecosystems across various cities has illuminated a critical insight: despite sharing numerous commonalities, cities exhibit distinct variations in their ecosystem structures. This diversity often necessitates unique approaches to handling similar use cases. This finding underscores the importance of having a dedicated dataspace aligned to the specific needs of each city. Delving into more detail, the key reasons identified for this necessity are as follows:

- Cities encounter a multitude of **data types**, sourced from varied platforms, each with its unique format. This diversity is rooted in the specific use cases defined by the five DISCO-X categories. A significant observation is the presence of data aggregator platforms in cities, which amalgamate and integrate these diverse data streams. This highlights the necessity for a specialized tool or add-on within the dataspace, capable of performing the role of a data aggregation platform.
- For the effective implementation of urban use cases, both in planning and operation stages, cities require the development, deployment, or adoption of various **tools**. The existence of a component in the dataspace that encompasses these tools and facilitates interoperability is crucial.
- The introduction of innovative solutions in urban settings demands the use of advanced tools like Digital Twins for data preprocessing. To foster these innovations, cities must support and enhance **engagement among stakeholders**, encouraging them to contribute, co-create, and co-design these essential tools.
- The chapter underscores the need for cities to establish a consolidated dataspace. This space should house all available data, thereby enabling cities to make informed, **data-driven decisions**, particularly in the realm of freight management.

The following chapter present the concept of Urbane Freight Data Space and the requirements needed for this to be developed.

5. The Urban Freight Data Space Requirements

5.1. Requirements for supporting Urban freight planning

Any transportation planning process requires knowledge of i) the size and the characteristics of the transport demand and ii) the typology, the capacity, and the operational conditions of the offering of the supply (cost, time, access, regulation etc.). For passenger mobility these data are collected though surveys involving citizens and operators and methods/models are available for quantifying current and estimating future transport demand. Thus, the passenger's mobility planning process in urban areas is sufficiently data and facts driven. The Intelligent Transport Systems (ITS) which were largely adopted for monitoring and optimizing passengers' transport supply operations provide important historical and real time digital content allowing for facts driven decision making and dynamic and AI based innovative solutions for greening and optimizing the passenger mobility operations.

In the case of urban freight, the above mentioned "good" and open and "trusty" sharing of information for passenger's mobility planning and operation does not exist. Methods and modeling techniques have been developed for the UF demand calculation, but no verification data exists for making these estimations accountable for planning in cities. Fragmentation in data sharing due to extremely competitive conditions in city logistics environment, creates constraints both for efficient planning and for data driven & dynamic optimization of operations.

However, the environmental concerns and the requirement for sustainable urban mobility & UF transport achievement, create the opportunity for reverse this situation. Cities are now urged to design and apply regulations to preserve urban space and environment while securing economic growth of their urban activities. In this context DISCO dedication to support physical internet paradigm shift in UF, presuppose: i) the definition of data needed for planning and PI operations in city logistics, ii) the provision of guidance on how these data can be made available, and iii) design & make available the UFDS infrastructure that will enable the data offering for DISCO-X innovations.

In this chapter the general requirements for the UFDS are provided based on DISCO-X innovation use cases defined at cities and the use cases envisaged by the partners who promote the individual DISCO-X. Additional considerations related to the UFDS role in stimulating fact & data driven planning are also provided.

5.2. Defining the UF Data Space for PI-led City logistics transition

5.2.1. UFDS is not storing data is showing where you can find the data you need for UF planning & operations.

The Urban Freight Data Space (UFDS), as conceptualized within the DISCO, represents an innovative approach to managing and exchanging data related to urban freight logistics. This model operates as a decentralized, trustworthy 'market' environment, focusing not on storing data but on facilitating its exchange among various stakeholders. Participants in the UFDS, including both data providers and consumers (e.g. municipalities, city planners, etc.), engage within this space based on mutually agreed principles, maintaining the sovereignty and security of their data.

Key to the UFDS is that it only stores metadata, not the data itself. This approach ensures a secure and efficient mechanism for participants to search, access, and exchange relevant information without compromising the integrity or ownership of the actual data. The UFDS supports applications developed externally, leveraging the data space for enhanced functionality. Within the broader context of the DISCO Meta Model Suite, the UFDS serves as a critical component. to revolutionize urban freight logistics through the PI led strategies supported by DISCO-X innovations.

5.2.2. The UFDS should support the operation of a data Sharing partnership that should be invoked/ created by the city

Since cities are facing compliance with EU regulations, they will become more and more obliged to apply rigorous data centric planning and monitoring processes and for doing so there is a need to create city led data partnerships for UF & mobility. Data sharing partnerships are created by the industry for:

- collaborating with their partners in Data related projects
- building confidence in data sharing with data governance capacity
- developing data sharing methodologies and tools for fast & easy to use data integration, provenance tracking data exploration and risk assessment and
- influencing and advocating policies and regulations on data sharing and reuse.

The cities should take the initiative and create incentives for building such a Data Sharing Partnership for UFT following industrial practices that are easier to be taken up by the logistics industry. In this context UFDS should integrate capabilities to support such partnership operation.

From the municipality side regulation/incentives implementation and promotion/trust-building activities are to be undertaken for making the industrial partners to join the city data sharing partnership and to use the infrastructure and functionality to be offered by UFDS in this regard. In a generalized UFT partnership the city should support the implementation of a use case through the UFDS by:

- <u>Providing access to the data related to smart city systems operating in the city and the regulations applied with or without technological support</u>: geospatial data, georeferenced regulations applied, traffic or other ITS transport system operation and surveyance data that that municipalities or public authorities are acquiring following smart city paradigm in EU.
- <u>Supporting the "collection" of sample data the commercial actors and the partners of the city logistics sector (external to the municipality)</u> may provide to municipalities on voluntary basis or in order to comply with city incentives/regulations. The municipalities are providing the license for the operation of most of the shops and for commercial activities in their territory (i.e., the generators of the urban freight transport demand). They could for example

relate such a licensing process with the obligation for regular provisioning by the stakeholders of sample data on UF transport operations related to the commercial activities to which the city granted the license. Such as regular provisioning of data (number & magnitude of deliveries performed, stops duration, modes involved in delivery, slots, and peaks etc.) from industrial parties to the Municipal authority. Such an incentive or regulations implementation would be stimulated by the offering of an operational, in accordance with SoA organized & trusted UFTDS. The requirement is for a UFDS architecture to guarantee secured access, entry & data provisioning process management.

- Securing Data Discovery inside the Municipalities and Public Organizations for UFT data. Cities should make available through the UFDS, economic activities statistic data (number of shops, space, typology etc.), data collected as part of UFT surveys, and results of simulation tools, projects & studies which should be accessible through the UFDS. Provide the ability to the municipalities to find relevant data to satisfy particular analytic problems. Without the ease of access, the challenges for efficient Data discovery would severely limit the success.
- Securing access to Logistics Supply data. Knowledge of city logistics Infrastructure in a Municipal functional area is an important requirement for optimizing infrastructures development & Operations management. In the cities there are Land Use development plans and legal/administrative decisions for positioning hubs terminal etc. This infrastructure view needs to be consolidated (with standardized descriptive and georeferenced position and coverage information) and enriched to have a full view of urban space occupation & availability for UFT activities, in order to be used for planning and decision making.
- Recognizing and interfacing with data from city service platforms, community platforms and Digital repositories. In each city there are already recognized Data bases and service platforms acting as Data repositories to fulfil city or actors' operational interests. With these recognized and priority data repositories the UFDS should secure permeant interfaces for achieving access to their Data, since usually these initiatives are based on a real case and benefit from strong actor's trust and cooperation's agreements.
- Providing minimum data visualization services. In a full UFDS operation it is expected that the availability of multiple static and dynamic data will stimulate the development and implementation of more innovative PI lead services for UF. In this context if UFDS offers data visualization functionalities that will support the comprehensive understanding of the value of the offered data sets, by potential data consumers, in fulfilling the needs of new or extended existing DISCO or others PI led solutions.

5.3. The UFDS Requirements for enabling DISCO-X PI operations

5.3.1. Organization and Intelligent adaptation of data for DISCO-X use.

For each DISCO-X, specific tools will be developed to enable the operation of the DISCO-X solutions to each city. The Urban Freight Data Space will facilitate the tools deployment by providing the good organization of the data needed for the implementation of each DISCO-X in the cities and utilize the meta data flows of the UFSD to obtain information sufficiently covering their needs. DISCO-X are seen as data consumers of the UFDS. Good organization of the data (and related metadata) needed for feeding tools for each DISCO-X implementation in the cities is a priority. The existing tools and data for each LL are available in Annex 5 while the typology of data involved in each DISCO-X implementation is in summary presented in following paragraph.

Checking available data sets it is concluded that the same type of dataset that needs to be used for the same DISCO application in different cities may be available in different data formats and representations. In this context the possibility to provide common and intelligent adaptations of these data to standardized structures for facilitating data use is an important parameter of UFDS success to support PI led solutions. DISCOLLECTION is specified as an efficient answer to this "data alignment" requirement. "Global" DISCOLLECTION use cases enabling intelligent adaptation of data possibly covering more than one DISCO-X and/or more than one city application of the same DISCO-X will be further analyzed during the DISCOLLECTION specification process.

Towards this direction of a "global" DISCOLLECTION, it is crucial to consider using established international standards to enable the integration of the data from the different cities. It is advisable to thoroughly examine existing standards set by authoritative bodies such as the United Nations (UN), International Organization for Standardization (ISO), and the National Institute of Standards and Technology (NIST), particularly those related to transport, freight, and location data. This step is essential to ensure that the technologies implemented at the foundational levels are in compliance with globally recognized standards. Non-adherence to these standards can exacerbate the challenges of data sharing and integration, leading to a "Tower of Babel" scenario where incompatible data formats and protocols hinder effective communication and operational efficiency. This approach not only enhances the effectiveness of the DISCO-X implementations but also contributes to a more cohesive and universally compatible urban data ecosystem.

5.3.2. Linking Data and Data sources for full implementation & expansion of DISCO-Xs.

As described in chapters 3 & 4 the implementation of DISCO-Xs in cities envisages the data provisioning from different organizations, platforms and management tools. The resources, processes, and capabilities of the involved Public & private UF related actors in data management and analytics are not on the same level (i.e., municipalities vs warehouse operators, real-estate actor vs small transport operator, etc.). As DISCO-Xs will prove their value, more actors will join DISCO-X implementations and additional data sources will be considered for new DISCO-X use cases or new PI led operations. With several data sources the ability to support data linkage and data provenance/lineage (monitor data evolution and trace errors back to the data sources when necessary) becomes indispensable. This is especially important for UFDS since loose data resources might be brought together from different applications and organizations for creating the DISCO-X operational basis.

5.3.3. Generalized DISCOESTATE use case as consumer of UFDS & agility considerations

The generalized implementation of DISCO-Xs involve users (data consumers), business parties, data owners, the DISCO-X tools or service platforms operators and of course the cities in an operational context for PI led implementation. In this paragraph the role of these "virtual" actors is presented for DISCOESTATE in an attempt to define common roles and the operation of UFDS.

Table 2: The DISCOLLECTION actors and their role in relation to the UFDS

Actor	Operation to be supported
User A requesting warehouse or last mile service (demand partner)	A city logistics industrial stakeholder is interested to find empty space &/or last mile service, for serving extraordinary demand for a time period. The user enters: 1. To the DISCOESTATE platform defining its request based on the standardised User Interface offered by the tool or DISCOESTATE service platform and proceeds in accordance to the platform offered functionality OR 2. Enters to UFDS of the city is interested to and retrieves information on the supply of logistics infrastructures and actors in the city for contacting negotiations & agreements making OR 3. Enters to UFDS and retrieves a library of service platforms to choose for digitally achieving optimum answer to his problem of demand and supply matching for warehouse as a service operation of for last mile delivery operations (shared or green or other). The user make choice based on information related to the service typology and data used and can invoke running of the DISCOESTATE through UFDS.
User B logistics or real-estate actor offering warehouse or last mile service (supply partner/data owner)	A city logistics industrial stakeholder is interested to offer empty space &/or last mile service, for serving needs of other operators for a time. The user enters: 1. The DISCOESTATE service platform and in accordance with the platform specifications enters its capacity availability OR 2. The UFDS and is guided to provide metadata for the data set of available warehouse & last mile service intends to offer and receives specification on how to build a standardised data set for making it available for multiple DISCOESTATE applications served by the UFDS and additionally: a. Comply with data quality specs of the UFDS, b. Receives specifications for developing interface for dynamic exchange of data with DISCOESTATE service platform

Actor	Operation to be supported
DISCOESTATE tool or service platform Offering	DISCOESTATE tool and service platform is matching demand and supply many offers from different logistics services providers based on operational rules and business criteria already consider by the data analytics and matching algorithm. In the future these services platforms might be more than one with different strengths and weaknesses each. However, the provisioning of the necessary data for the multiple DISCOESTATE service operators through the same UFDS should be envisaged.
DISCOESTATE tools or service platform as a consumer of UFDS	1. DISCOESTATE tool/service platform request regularly not real time to UFDS the availability of empty spaces and when demand is presented the DISCOESTATE platform applies criteria business rules and return result to the user advising for contract & agreement process. 2. DISCOESTATE tool/platform request real time information for space availability and last mile delivery availability. UFDS is prompting available data sets and upon user choice or based on UFDS suggestion (data sources validation) is establishing the connectivity needed with data sources for the data to be used by the DISCOESTATE tool. DISCOESTATE platform applies criteria business rules and return result to the user advising for contract & agreement process
UFDS operation to support DISCOESTATE	1. Logistics service providers of Warehouse operators or Real Estate actors who have already joined the UF Data Partnership maintain available datasets fulfilling DISCOESTATE tool Specification. 2. The offering of data from different data sources (i.e. WMS of different actors) in real time or regularly updated is prompted in UFDS and the Data system & meta data catalogue of UFDS orchestrates the metadata flows related to DISCOSESTATE operation. 3. UFDS secure data sources connectivity for providing the data to DISCOESTATE app. 4. After actor's agreement data synchronization process to depict the new status of available capacities is invoked. 5. Statistics on DISCOESTATE operation results may be stored to the UFDS. 6. The UFDS keeps logbooks on data usage and apply methods for data value capturing and measurement

Actor	Operation to be supported
Logistic operator’s data connectivity & update	The actors entering to the UF Data Partnership will maintain available and update in accordance with their DISCOESTATE service level agreement the data set for the DISCOESTATE operation.

In the evolving landscape of DISCO-X, the roles of data providers encompass a diverse array of systems, service platforms, databases, and industrial actors, each equipped with their own management tools. This diversity is exemplified in the DISCOESTATE model discussed here. In an operational Physical Internet (PI) context, it is essential to consider the dynamics of city logistics, including the ebb and flow of partners within the UF data partnership. The potential impact of PI on operations and the economies of scale strategy of sector actors must be carefully evaluated. The readiness of DISCO cities' ecosystems to adopt innovative solutions, along with their capacity and strength for PI implementation (as detailed in Chapter 6), underscores the necessity of making PI innovations operational in real business environments. This entails not only maintaining the operation but also ensuring the continuity and relevance of the PI value proposition.

At this point, it is vital to consider the minimal, yet crucial data required for effective PI operations, as documented in D1.1 (URBANE framework for optimised green last mile operations) of the URBANE project. This data, essential for planning routes, scheduling vehicles, and more, includes basic shipment information such as weight, sender and recipient addresses, package size, shipment ID, and barcodes is pivotal for efficient logistics delivery operations. Moreover, the URBANE document highlights the importance of additional data for maximizing PI's potential. This includes real-time information on traffic conditions, handling times at nodes, and capacity constraints, crucial for decision-making in logistics operations. Notably, the use of blockchain technology is proposed for ensuring non-repudiation and legal robustness in data handling and dispute resolution. Effective communication between PI nodes is another critical aspect. This involves sharing not just shipment details but also handling requirements, node capacity states, and real-time updates on shipment status. Such communication is key for smooth and efficient operations across the PI network.

In this context the importance of Agility and of Value creation from Data to the UF actors is dominant for the PI led city logistics development. UFDS should enable agile deployment of Data Driven (DISCO) solutions within the IT landscapes and the business processes of the specific urban freight ecosystem.

UFDS is supposed to offer access to data which however could be provided on a cost basis. Since DISCO-X are designed to become exploitable PI services it is wise to consider in Urban Freight Data partnership and in UFDS design support to Data Value capture and measurement. We do not have all the answer to quantify the value of Data, monetize solutions and measure return on investment and for all the DISCO-X but a user centric value metrics for data might be an option to guide the collaboration of stakeholders over UFDS creation and operation.

5.3.4. Data typology and available Data at Living Labs

The cities have provided detailed information about their available data and respective sources in response to the document they received, which outlined the DISCO-X description and requirements. This data was thoroughly analyzed to determine the essential components required for each DISCO-X. This crucial information will be supplied to the Urban Freight Data Space, playing a pivotal role in defining its architecture.

For **DISCOCURB**, the UFDS integrates diverse data from public and private sources, emphasizing curbside information in the city. It includes near-real-time geospatial data, updated semi-annually or less frequently, detailing the city's parking areas, zones, and associated regulations. This data is sourced through spreadsheets or direct connections with the city's official GIS system. Additionally, static traffic data, serving as a historical record to analyse traffic patterns and seasonality, will be fed through spreadsheets or retrieved from city online services at designated intervals. The UFDS will also feature real-time data on parking occupancy and Logistics Service Providers (LSP) demand, sourced from online city services and private companies, respectively.

In **DISCOPROXI**, the UFDS encompasses data on city on urban space allocation & use, LSP operations data (routes, demand description & operational requirements, etc), and infrastructure availability. It links with the Logistics Real Estate database for each city, providing real-time updates on underused or vacant spaces. The platform includes static geospatial data on land use and regulations, updated monthly or annually via the city's GIS systems or spreadsheets. It also manages static and real-time traffic data, inputted on-demand or through online city services. Essential to this module is data from LSPs, including demand, vehicle information, and operational KPIs like load factors.

DISCOESTATE focuses on the storage capacity of available spaces. The UFDS maintains a live connection with infrastructure databases, offering real-time details on capacity, regulations, and accessibility. It also includes tracking and shipping data for matching supply and demand in logistics operations.

Lastly, **DISCOBAY** concerns the capacity offering data of available spaces. The UFDS houses real-time information about different spaces' (warehouses, hubs, stations, ROCs etc.) capacity, services, and duration availability, linked with space management systems to update space availability. The UFDS will have data about digitalized zoning & land use regulations that needs to be monitored on a daily basis in order to be always up to date.

5.4. Minimum UFDS structure to enable DISCO-X innovation implementation

The DISCO Urban Freight Data Space serves as a comprehensive ecosystem where data providers contribute predefined datasets, which are processed under confidentiality agreements. Also, it deploys online tools and services to utilize this data, and the results of these analyses are stored within the system and users can access these stored results to view and assess the findings. Moreover, the UFDS offers flexibility by either connecting to online sources for real-time data or accepting data on demand from users. In summary, DISCO plays a crucial role in enhancing urban freight management by providing valuable insights and facilitating informed decision-making. The UFDS platform will be consisted of three main components as shown in the figure below (Figure 23).

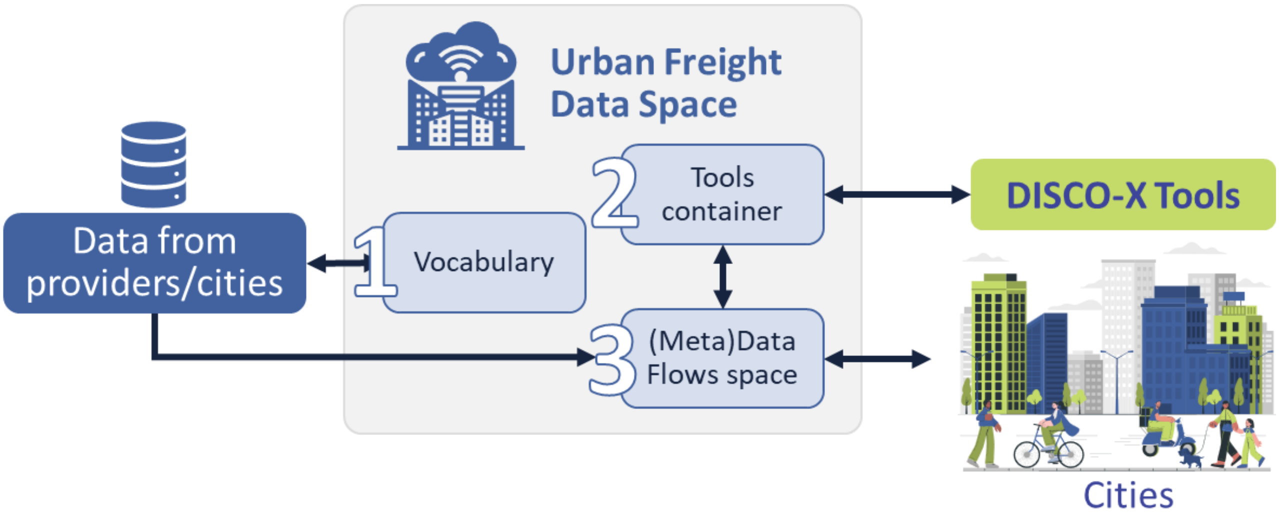


Figure 23: The UFDS minimum components

- the **Vocabulary** which serves as the foundational element for communication and data exchange within the ecosystem. It provides a standardized "common language" that ensures consistency and clarity in the description of meta data, services, and processes (DCAT or other) for exporting meta data & intelligent Data value creation. This standardization is crucial for interoperability, allowing different systems and stakeholders to understand and utilize the data effectively. By adhering to a common set of terms and definitions, the Vocabulary reduces ambiguity and facilitates smoother interactions across the platform. This vocabulary component will consider the necessary data of each DISCO-X tool and will be developed based on the available data that cities have and the way they can transferred.
- the **Available Tools Container** which functions as a marketplace for applications offering a connection with tools developed in DISCO, that are designed to enhance the efficiency of logistics operations. These applications can access and utilize data from the UFDS, employing algorithms and analytics to provide insights, suggestions, and optimizations for freight and courier operations. It is not only facilitating the discovery and deployment of these logistics

tools but also ensures that they are compatible and compliant with the standards and protocols of the UFDS, promoting a cohesive and integrated system. For its functioning, the available tools of the UFDS will be connected through online connectors (e.g., API).

- the **Data & Metadata Flow Space** serves as a pivotal component in managing and facilitating the flow of metadata across the platform. In a broader sense, it acts as an intermediary that collects, organizes, and disseminates metadata given from cities. This metadata can encompass a wide range of meta data such as performance metrics. The primary functionality of the data component is to provide a centralized, accessible repository where this diverse metadata is aggregated and standardized. This centralization is critical for ensuring data consistency and integrity, which in turn enhances the quality and reliability of data-driven decisions made through the UFDS. As a result, it will help cities to collect data and assess the operation of the Innovative solutions in the city. This component is going to be fed with data from city and private stakeholders (e.g., LSPs) without maintaining this data; it will only store the outcomes of the services.

6. Maturity of the cities in transitioning to PI-led city logistics & the role of planning

6.1. Introduction

This chapter reports the results provided by the cities on their current level of maturity related to the urban logistics and planning PI-led Digital Transition. Towards this goal, a three steps methodological approach was followed:

- **Innovation Readiness assessment:** Although, cities want to achieve the transition to innovative solutions, the experience have shown than often, they are not yet fully equipped to embrace and implement such innovations, often lacking necessary synergies, infrastructure, policies, and data. This fact often leads to the forced stop of the innovation after the end of the project. In this context, the first step of the methodology deploys a general assessment for the cities to understand how ready cities are to adopt innovative urban mobility and logistics solutions. This assessment was developed in the context of H2020 SPROUT and through an extensive qualitative survey, it evaluates the readiness level of the different Innovative urban mobility and logistics ecosystem elements.
- **SUMP/SULP assessment:** Apart from the innovation readiness of cities, the significance of strategic planning cannot be neglected. Effective planning can reshape city land-uses, practices, and regulations to support the successful deployment not only of city logistics solutions but especially of the innovative, PI-driven ones. Therefore, the second step involved reviewing cities' past SUMP/SULP implementations to identify enabling factors and past failures.
- **SWOT assessment:** Finally, considering that Physical Internet concept in a new approach in city logistics and the adoption is affected of different city characteristics, an assessment of the city's strengths and weaknesses was conducted towards the principles of Physical Internet facilitation. The results of the SWOT analysis were validated by the Impact Creation Board for Transformation (ICBT). This validation process from the ICBT was considered as a pseudo-DELPHI which will set the baseline and it will be further extended with internal and external Physical Internet experts.

These three steps set the ground on guiding cities to accelerate DISCO-X innovation adoption and they will provide a picture for the Twinning Living Labs to replicate and adapt to their local context the implementation of the Starring living labs. However, considering the Physical Internet novelty and the lack of expertise and experience in cities towards PI, it was not possible to create Physical Internet scenarios customized to each city that should be taken into consideration changing their planning process. Thus, with the aim to create PI scenarios for cities, as next step, the project will follow a DELPHI approach (Thangaratinam & Redman, 2005) with the contribution of DISCO internal partners and external experts with global experience on Physical Internet. Through this DELPHI methodology, the important parameters of Physical Internet-led innovation will be addressed and the Innovation Readiness tool of H2020 SPROUT will be enriched to capture the maturity of the cities towards Physical Internet Readiness. This Physical Internet readiness assessment will be delivered in D2.3 and the validation of SWOT analysis from the ICBT will be considered as the pseudo-DELPHI.

6.2. Innovation Readiness of cities

This section includes the results of the Innovation Readiness tool which describe the maturity of the city to adopt innovative urban mobility and logistics solutions. Although all the cities were asked to fill in the innovation readiness tool, responses were gathered for the six of the DISCO cities (Starring and Twinning). The assessment was conducted through the SPROUT Urban Policy Model website[2] and their results can be displayed on the tool's dashboard. For each city participating in the Innovation Readiness Assessment, the outcomes are displayed using a radar plot. This plot visualizes various facets of an Innovative Urban Mobility Ecosystem, such as Data Availability and City Capacity. In each plot, a green line indicates the city's score. Additionally, blue and red lines depict the upper and lower thresholds, respectively. These benchmarks are dynamic and set automatically from the tool by using the data from cities recorded in the Innovation Readiness Tool's database. In cases where the green line is over the blue, the aspect is considered as strong compared to the database's cities, while in cases where green line is under the red, these aspects are considered as weak compared to the rest of the cities. The questionnaire used for this process is available in Annex 4, and the outcomes of the Innovation Readiness assessment to the cities are presented in the subsequent sections.

6.2.1. The city of Ghent

The city of **Ghent**, Belgium, provided information regarding its urban development strategies and logistics planning. Ghent has a Strategic Urban Mobility Plan (SUMP) well-established in 2018 or earlier, emphasizing its proactive approach to sustainable urban transportation. Additionally, the more recent development of the SULP in 2023 underscores the city's commitment to optimizing freight movements within its borders. However, alignment between the SUMP and SULP remains uncertain. Notably, Ghent has made progress towards environmental sustainability, drawing a plan for achieving net-zero carbon emissions in 2020. In terms of city logistics data collection, Ghent gathers detailed information on freight vehicle volumes and locations of logistics infrastructure. Moreover, the city monitors the operational details of freight vehicles within its boundaries, including vehicle types and frequency, categorized by zones. Ghent has implemented several regulatory measures, encompassing time zones, circulation plans, pedestrian areas, and low

[2] https://urbanpolicymodel.imet.gr/innovation-readiness.html

emission zones, showcasing its dedication to creating a more efficient, environmentally conscious urban landscape.

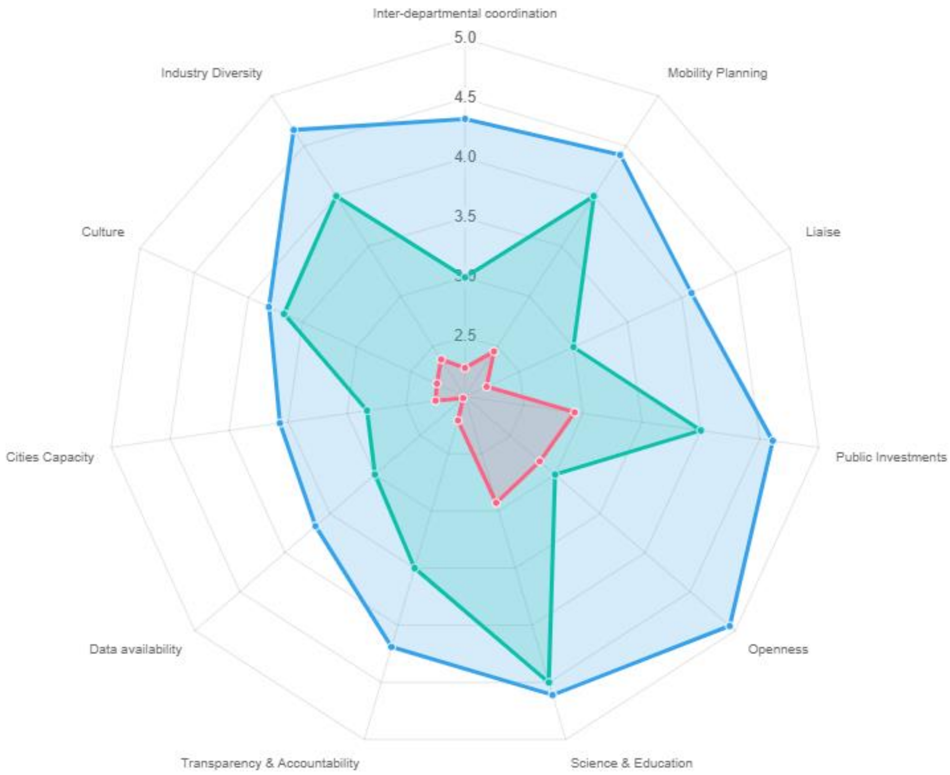


Figure 24: The results Innovation Readiness tool in Ghent

Based on the results from the Innovation Readiness tool, every aspect of **Ghent's** ecosystem surpasses the minimum threshold, determined by the tool's database responses. Ghent excels in mobility planning, evident from its low emission zone in the city center. The city also has strong industry diversity, with numerous leading innovators and a robust science and education sector, highlighted by its many universities and research institutions. Additionally, Ghent's experience in innovative logistics solutions, like micro-hubs, contributes to its high culture score. However, the city faces challenges in its capacity element, particularly in skilled workforce availability for innovative logistics, affecting its data-driven policy-making. This shortfall is likely why data-driven freight transport policy-making is limited, due to insufficient freight data.

Overall, Ghent has a strong ecosystem with major innovating companies and an educated population experienced in implementing innovative logistics solutions. Yet, despite strong city planning and measures for city logistics, the shortage of freight data and expertise in freight policy tackles data-driven urban logistics planning. Therefore, enhancing ecosystem engagement to gather more data is crucial.

6.2.2. The city of Helsinki

The city of **Helsinki**, doesn't currently have a Strategic Urban Mobility Plan (SUMP) or a Strategic Urban Logistics Plan (SULP), indicating a different strategy in managing urban mobility and logistics. However, despite the absence of these specific plans, Helsinki has a dedicated focus on environmental sustainability, as evidenced by its plan to achieve net-zero carbon emissions established in 2020. Interestingly, their data collection primarily revolves around identifying the locations of both public and private city logistics infrastructure. There isn't detailed information available regarding the operation of freight vehicles within Helsinki's borders, and the city doesn't currently have specific regulations governing access hours, area restrictions, or vehicle types in certain zones, highlighting a different approach to urban planning and management.

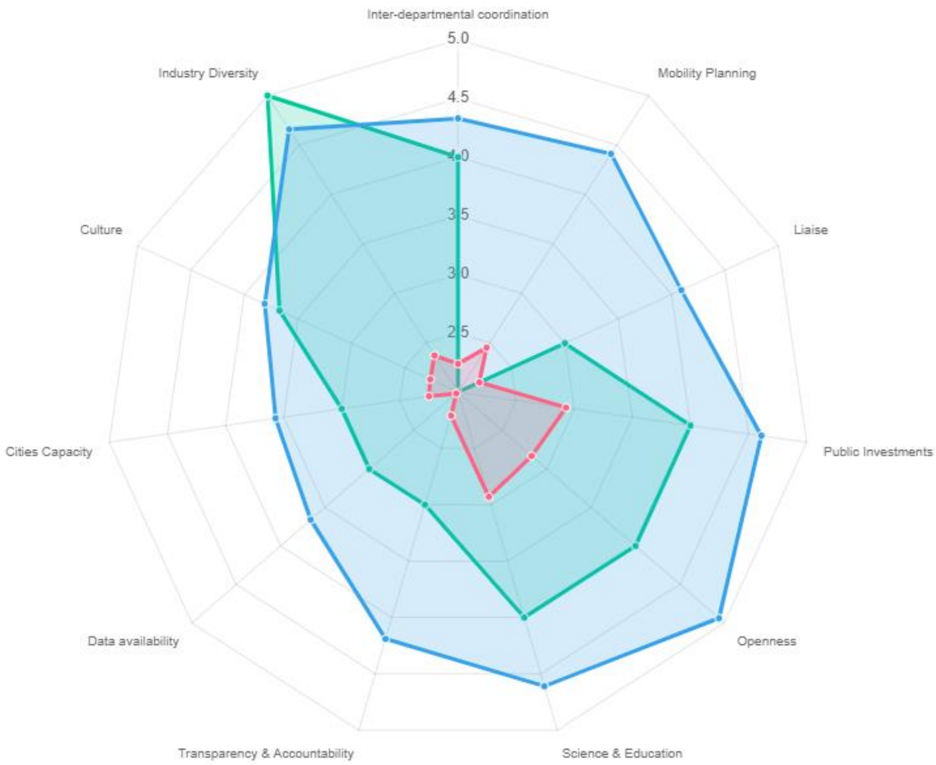


Figure 25: The results Innovation Readiness tool in Helsinki

The Innovation Readiness assessment for **Helsinki** showed that most of the city's areas fell within the normal range. However, mobility planning scored below the benchmark, while Industry Diversity exceeded the high benchmark. Helsinki's status as a major tech hub is evident in its high Industry Diversity score and the significant number of educated individuals. This is reflected in the variety of passenger and freight innovative mobility solutions tested or currently operational in the city, contributing to a high Culture score. On the other hand, Helsinki struggles with mobility and logistics planning, as indicated by the low score in the Mobility Planning area. Additionally, the city has an intermediate score in data availability and the capacity for data-driven and expert-driven freight planning. Furthermore, Helsinki is not particularly advanced in engagement practices for co-creating and co-designing innovative solutions.

Overall, while Helsinki benefits from the strong ecosystem of actors, including citizens and companies which are experienced in using innovative solutions, the city shows a weakness in collecting freight data and conducting efficient data-driven planning.

6.2.3. The city of Copenhagen

Copenhagen confirmed the presence of both Strategic Urban Mobility and Logistics Plans, established before 2018, signifying a long-standing dedication to these areas. However, it was noted that these plans aren't entirely aligned, suggesting potential areas for further integration. The city has also adopted a comprehensive strategy for achieving net-zero carbon emissions, demonstrating an early proactive approach to environmental concerns. In terms of logistics planning, Copenhagen primarily collects data on freight vehicle volumes and flows but lacks detailed information on the number of vehicles operating within its borders. Despite this, the city does enforce regulations, such as time slots on pedestrian streets, reflecting efforts to manage access and vehicle usage in specific zones, showcasing a balance between mobility and urban space management.

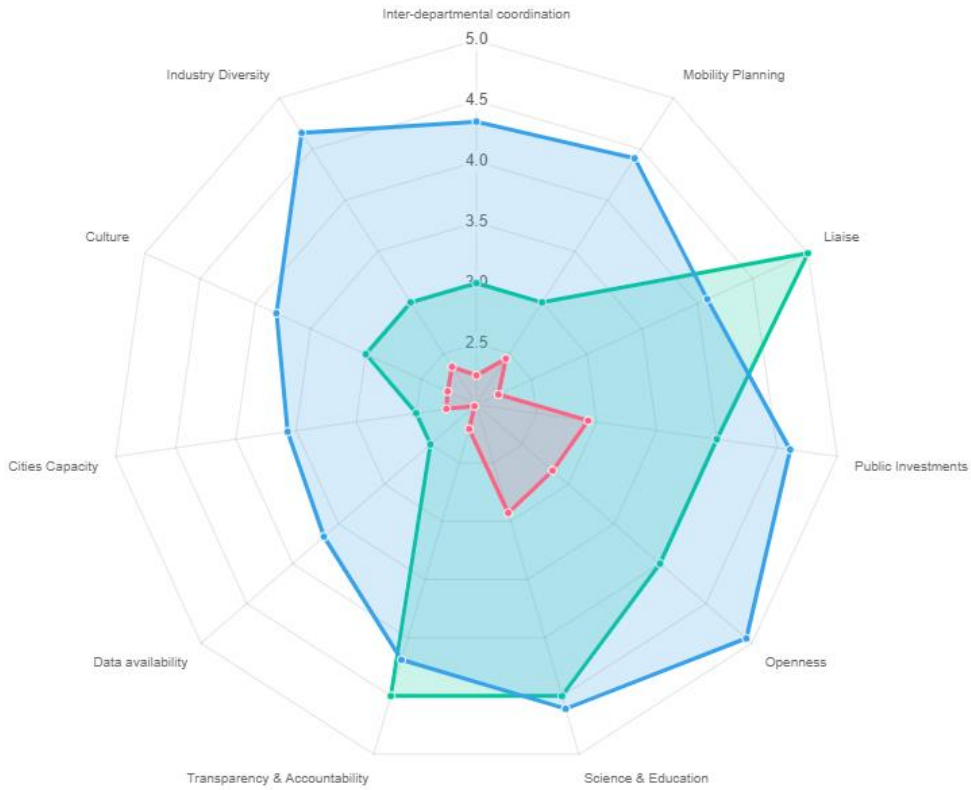


Figure 26: The results Innovation Readiness tool in Copenhagen

The innovation readiness assessment for **Copenhagen** highlighted that the city did not score below the minimum threshold, and two areas of the ecosystem exceeded the upper threshold of the tool. Specifically, Copenhagen excels in the smartness and transparency of government processes, fostering strong engagement among various stakeholders. The presence of universities and research institutions contributes to the high level of education among its citizens. However, Copenhagen faces challenges in mobility planning. Although it has a Sustainable Urban Mobility Plan (SUMP), it is outdated, and there's no Sustainable Urban Logistics Plan (SULP), which impacts its mobility planning score. Additionally, the city struggles in data availability, particularly for freight, and lacks smart infrastructure to collect dedicated data. Despite high levels of transparency and accountability indicating data availability, there's a deficiency in open data for freight operations. This data scarcity likely leads to lower scores in the city's capacity, affecting data-driven passenger and freight planning.

Overall, while Copenhagen engages effectively in co-creation and co-design of mobility solutions and exhibits smart governmental processes, there's a gap in dedicated logistics planning through SUMP/SULP documents. The lack of freight data hampers policy planning for innovative freight solutions.

6.2.4. The city of Thessaloniki

Finally, **Thessaloniki** was reported to have active Sustainable Urban Planning process based on data evidence. The city reported having a Strategic Urban Mobility Plan (SUMP) in place, drafted in 2020, but lacked a corresponding Strategic Urban Logistics Plan (SULP). Thessaloniki expressed an ongoing commitment to developing a plan for achieving net-zero carbon emissions. In terms of data collection for city logistics planning, Thessaloniki gathers information on volumes of cargo, typology of products, volumes/flows of freight vehicles, and the location of private or public city logistics infrastructure. However, the city does not currently collect data on the number of freight vehicles operating within its borders. Despite this, Thessaloniki has regulations in place, such as time windows, a smart parking system, and access restrictions for specific weight vehicles, indicating a proactive approach to urban logistics management.

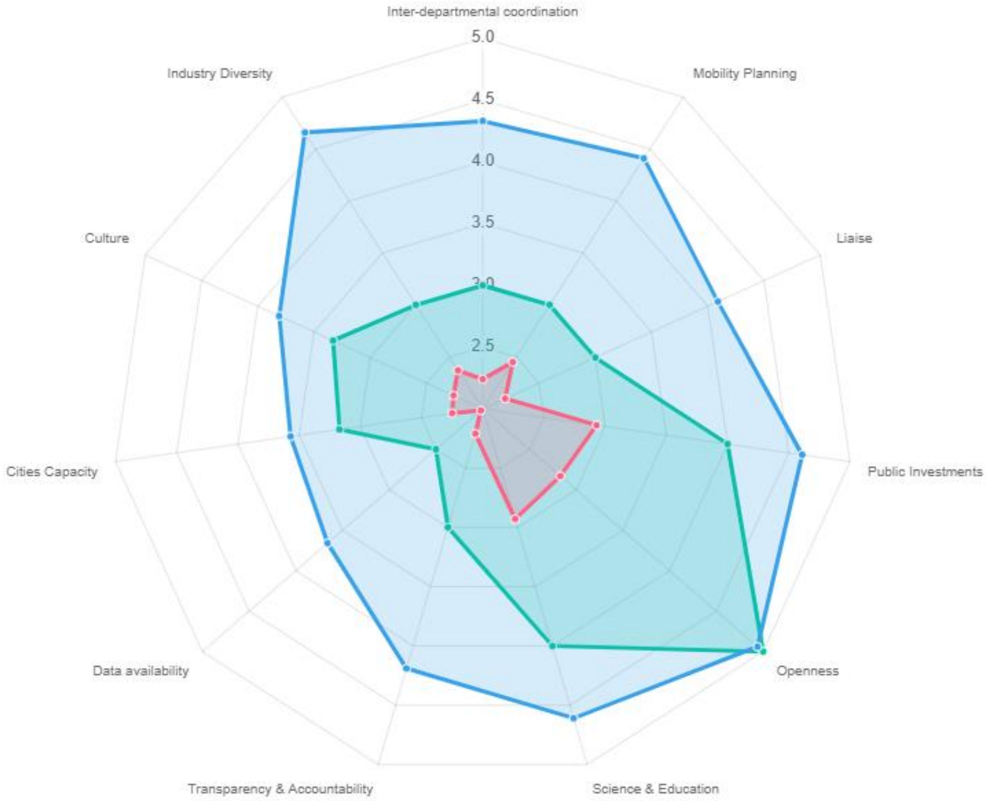


Figure 27: The results Innovation Readiness tool in Thessaloniki

The innovation readiness tool showed for **Thessaloniki** that none of the areas scored below the tool's minimum threshold, while one area exceeded the upper threshold. Thessaloniki demonstrates a high level of synergy with neutral partners and organizations. As a university city with numerous universities and institutions, it has an educated population that supports the city's culture in implementing and testing innovative logistics solutions. The presence of Thessaloniki's Living Lab facilitates data-driven mobility and logistics policymaking. However, while the city has an active Sustainable Urban Mobility Plan (SUMP), it lacks a Sustainable Urban Logistics Plan (SULP) which is also delayed by the insufficient interdepartmental coordination and stakeholder engagement practices. Additionally, although there is available open mobility data, there is a notable lack of accessible freight data.

Overall, Thessaloniki is conducive to synergies and, with its high number of universities and institutions, represents an ideal location for implementing and testing new mobility solutions. However, the available freight data, while utilized by the city for data-driven solutions, is not open to the public. This, coupled with the lack of interdepartmental coordination and engagement practices for co-creation and co-design of mobility solutions, hinders the development of a dedicated logistics planning document (SULP).

6.2.5. The city of Zaragoza

Zaragoza boasts both a Strategic Urban Mobility Plan (SUMP) and a Strategic Urban Logistics Plan (SULP), both developed in 2019 and thoughtfully aligned with each other. Impressively, the city is decisive in its commitment to environmental sustainability, recently unveiling a plan to achieve net-zero carbon emissions in 2023, demonstrating a proactive stance toward combating climate change. In terms of logistics planning, Zaragoza focuses on collecting data related to product typology and the locations of both public and private logistics infrastructure. Additionally, the city actively monitors freight vehicle operations within its borders. Zaragoza distinguishes itself further by implementing regulations concerning access hours, area restrictions, and specific vehicle types permitted in certain zones, showcasing a robust and multifaceted approach to urban development and management.

6.2.6. The city of Valencia

When it comes to **Valencia**, there is a Strategic Urban Mobility Plan (SUMP) implemented in 2018 or earlier, reflecting the city's longstanding commitment to enhancing urban mobility. However, Valencia currently lacks a Strategic Urban Logistics Plan (SULP). Despite this, Valencia has forged ahead with a plan to achieve net-zero carbon emissions, solidifying its dedication to sustainability, established in 2021. In terms of logistics data collection, Valencia focuses on pinpointing the locations of both public and private city logistics infrastructure, underscoring its emphasis on efficient urban logistics. Additionally, the city enforces traffic restrictions, particularly concerning heavy goods vehicles with a maximum authorized mass of over 12 tonnes within specific delineated areas from 7:00 a.m. to 10:00 p.m. These regulations, illustrate Valencia's proactive approach to managing traffic flow and accessibility within defined zones, showcasing a commitment to effective urban planning and congestion management. Valencia's involvement in multiple European projects through Las Naves highlights its active engagement in innovation and collaborative initiatives aimed at shaping the city's future.

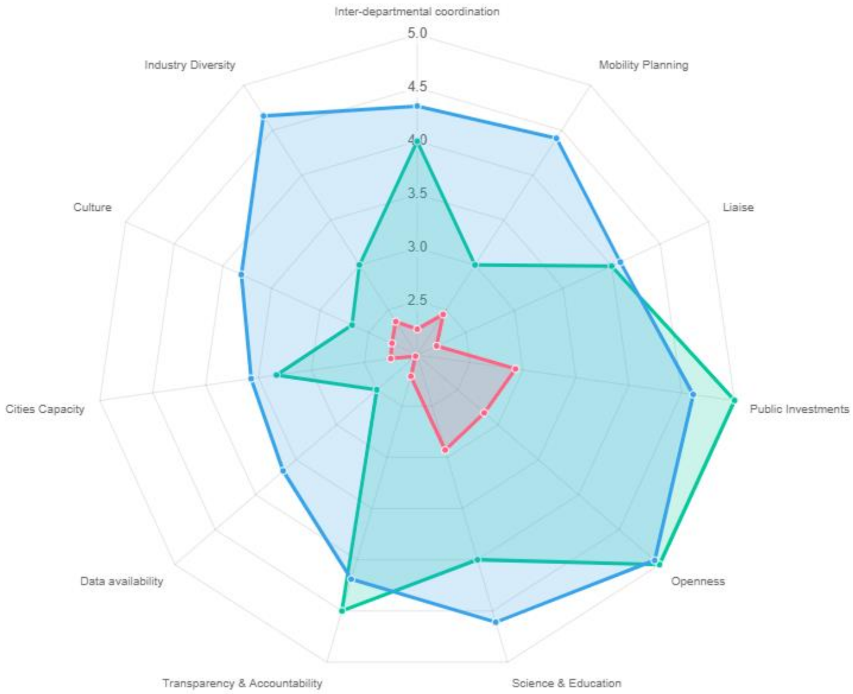


Figure 28: The results Innovation Readiness tool in Valencia

Valencia showed no area of its ecosystem falling below the minimum threshold. Impressively, three elements scored above the upper threshold. The analysis revealed that Valencia excels in fostering synergies with neutral partners and other cities. The city's high number of universities and research institutions significantly contributes to its strong performance in science and education. Furthermore, Valencia is proactive in promoting public investments for innovation, and its governmental processes are noted for their smartness and transparency.

However, despite scoring well in interdepartmental coordination, Valencia lacks an advanced Sustainable Urban Mobility Plan (SUMP) and does not have a Sustainable Urban Logistics Plan (SULP). In terms of data management, the city shows weaknesses in data collection processes, which affects the efficiency of its freight and mobility data-driven policies, resulting in an intermediate score in these areas. Additionally, while Valencia is open to synergies, it lacks experience in testing innovative urban logistics solutions.

6.2.7. The city of Barcelona

Barcelona has made significant strides in urban mobility and logistics planning, evident through the recent development of a Strategic Urban Mobility Plan (SUMP) in 2022 and a Strategic Urban Logistics Plan (SULP) in 2023. However, the alignment between these plans remains uncertain, highlighting a potential area for further exploration. Interestingly, the existence of a plan to achieve net-zero carbon emissions is unknown, indicating a potential gap in information. Regarding logistics data collection, Barcelona focuses on gathering information on volumes and flows of freight vehicles, showcasing a commitment to understanding and optimizing urban logistics. The city actively collects data on the operation of freight vehicles within its borders; however, specific details regarding the depth or granularity of this information remain unclear. Barcelona implements regulations governing access hours and area restrictions, such as Low Emission Zones (LEZ), allocating special parking areas for distribution vehicles from Monday to Friday. Additionally, there seem to be specific operational timeframes for larger vehicles, allowing operation only between 23:00 and 5:00, showcasing efforts to manage traffic and emissions during peak hours. While Barcelona's approach to urban planning demonstrates a concerted effort toward sustainable mobility and logistics, there might be areas where further information or alignment between different plans could enhance the city's strategies for a more efficient and environmentally conscious urban landscape.

6.2.8. The city of Padua

Padua reported having a Strategic Urban Mobility Plan (SUMP) developed in 2020 and expressed a commitment to achieving net-zero carbon emissions, with a plan in place from 2022. However, Padua does not currently have a Strategic Urban Logistics Plan (SULP). In terms of data collection for city logistics planning, Padua focuses on gathering information on volumes and flows of freight vehicles. Interestingly, the city actively collects detailed data on the number of freight vehicles operating within its borders, including hourly data and categorization by vehicle type (e.g., multi-axel, van, etc.). Padua also has regulations in place, such as an LTZ (Limited Traffic Zone) in the city center, indicating a strategic approach to urban logistics management with specific restrictions on hours of access and types of vehicles allowed in certain zones.

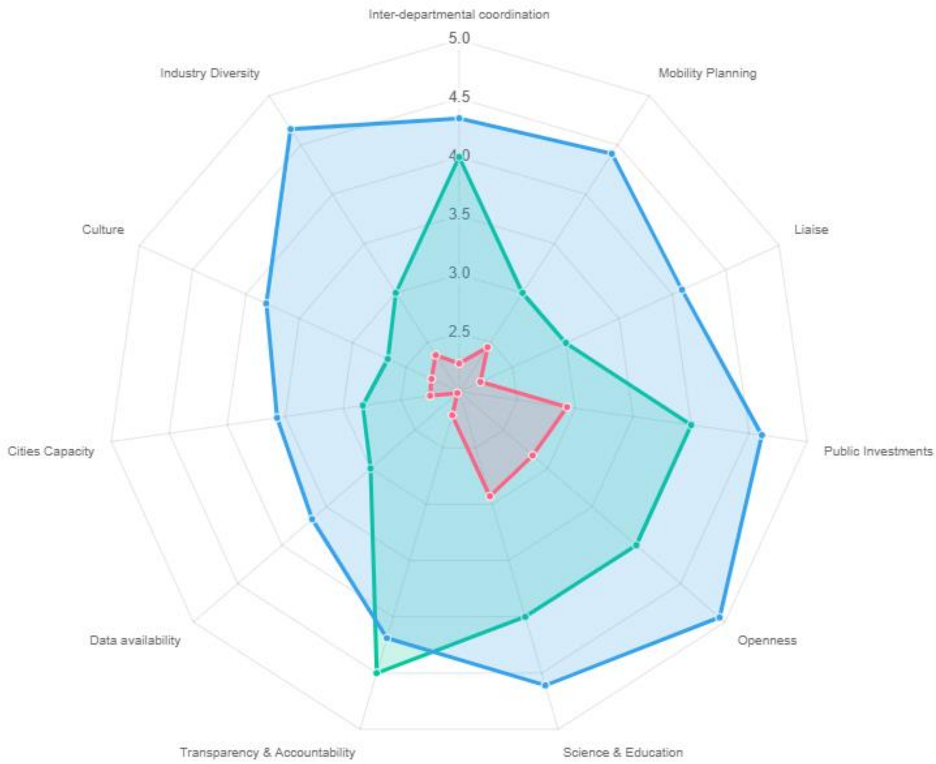


Figure 29: The results Innovation Readiness tool in Padua

Padua had none of its ecosystem areas falling below the tool's threshold, and one area performing above the upper threshold. The city is characterized by its smart and transparent governmental processes, ensuring safe and open data sharing. Padua also shows strength in building synergies with other cities and institutions, and it actively invests in innovative mobility and logistics solutions.

However, despite the city government's high level of interdepartmental coordination, Padua lacks an advanced planning procedure. This shortfall is partly attributed to the low level of stakeholder engagement, indicating an area where the city could potentially focus its efforts to improve its overall innovation readiness.

6.2.9. Conclusions

In summary, the Innovation Readiness self-assessment reveals that while all DISCO cities demonstrate a maturity level of 65% to 70% in adopting innovative mobility solutions, they face challenges in aligning with the principles of the Physical Internet (PI) in freight mobility. The concept of data sharing in PI represents a significant paradigm shift, advocating for a logistics infrastructure that is more collaborative, transparent, and interconnected. However, most DISCO cities currently lack the necessary smart infrastructure & incentives or regulation to effectively collect and manage data related to freight operations. This deficiency in comprehensive freight data impedes the cities' ability to develop Strategic Urban Logistics Plans (SULP) and implement data-driven, evidence-based policy making in freight transport.

Additionally, these cities appear to fall short in employing robust engagement strategies essential for co-designing and co-creating innovative mobility and logistics solutions. Such engagement is a core principle of the PI, emphasizing the importance of collaboration in creating an efficient urban logistics environment. Therefore, for these cities to fully embrace and benefit from the principles of the Physical Internet, there is a pressing need to improve their data collection frameworks, foster stronger stakeholder engagement, and advance towards more integrated and informed urban logistics planning. Developing and maintaining. An **Urban Freight Data Space (UFDS)** proves itself as necessity as a priority requirement of cities for enabling: i) transition to PI lead innovation and ii) dynamic and shared management of city logistics infrastructure, assets, and services.

6.3. SUMP/SULP assessment

For the SUMP/SULP assessment, a survey was conducted, and the cities highlighted the different enablers, barriers and delays for the different city logistics measures implemented in each city. The analysis showed that key measures include the establishment of low emission zones, timed access restrictions to alleviate peak-hour traffic, the implementation of 'School Streets' for safer pedestrian zones during specific times, and the development of advanced underground logistics systems to streamline goods distribution beneath city streets. Other notable measures comprise traffic ordinances to reduce freight congestion in historical city centers, smart load/unload bay management to optimize parking turnover, and the strategic placement of logistic microhubs to facilitate last-mile delivery. The questionnaire used for this process is available in Annex 3, and the outcomes of the SUMP/SULP assessment to the cities are presented in the subsequent paragraphs.

The successful implementation of these measures within DISCO cities is often enabled by several critical factors, as indicated by the current research. Strong political leadership provides the necessary momentum and authority to advance these complex initiatives. Sufficient funding and resources are paramount for implementation and operation, underscoring the importance of sound financial planning in urban logistics. Clear objectives and the availability of technological infrastructure are also essential, allowing for effective execution and measurable outcomes. Additionally, national legislation and proactive mobility promotion during crises, such as the COVID-19 pandemic, have expedited the adoption of certain measures.

However, the research identifies several factors contributing to the failure of some initiatives. A significant barrier is the outright refusal of private sector stakeholders to invest in necessary infrastructure modifications, leading to the underuse of potentially beneficial systems like underground distribution tunnels. Economic disparities also play a role, with measures sometimes disproportionately affecting lower-income communities or small businesses. Moreover, the unwillingness of private operators to adapt their business models to new measures has been a recurrent issue, signaling a gap between policy objectives and operational realities.

Delays in the implementation of these logistics' measures are attributed to a spectrum of factors. Budgetary limitations and human resource deficits often challenge the timely execution of projects, reflecting larger economic and administrative constraints within municipal structures. Lengthy procurement processes and shifts in political leadership can introduce delays, underscoring the vulnerability of these measures to political cycles and bureaucratic inertia. Furthermore, a lack of political interest, inadequate enforcement of new traffic regulations, and a deficiency in rigorous monitoring and control mechanisms have been observed to slow the momentum of logistics innovations in DISCO cities. These findings highlight the necessity for ongoing stakeholder engagement, adaptive planning approaches, and resilient financing models to maintain the continuity and efficacy of urban logistics improvements.

The Physical Internet (PI) concept is based on a few basic yet powerful principles: collaboration, trust building, and asset sharing, aimed at enhancing logistics efficiency and minimizing social and environmental impacts. The PI envisions an integrated "network of networks," where all parties participate collaboratively. In contrast to this, it has been observed in many cities that over 60% of last mile deliveries in the city center were conducted by major logistics players. This evidence underscores the dominance of these key players in urban logistics and highlights the potential for PI to revolutionize urban freight systems by fostering more inclusive and sustainable practices. However, COVID-19 pandemic underscored the critical role of local logistics service providers in facilitating last-mile deliveries, a segment often overlooked yet vital in maintaining supply chain continuity during crises. This context sets the stage for the strategic value proposition of the DISCO initiative. The implementation of DISCO-X, and its subsequent impact assessment, will provide evidence showcasing the efficacy and benefits of this approach. This data will be instrumental in engaging major logistics service providers during workshops organized by each participating city. These workshops are designed to foster collaboration and integration of local and major logistics entities. Additionally, the role of city governance is pivotal in this ecosystem, adopting a bottom-up approach. Through targeted regulation and incentive schemes, cities can catalyze change and force larger logistics service providers to adapt and align with more efficient, inclusive, and sustainable delivery models.

In conclusion, while the ambition and scope of logistics measures in DISCO cities are indicative of a concerted effort to address urban logistics challenges, the success of these initiatives is contingent upon overcoming financial, commercial, political, and social obstacles. The evidence underscores the need for a holistic approach that encompasses strong governance, stakeholder collaboration, and resilient planning to ensure that such measures yield the intended benefits and contribute to the sustainable development of urban spaces.

6.4. SWOT analysis

At this point, the results of the system diagnosis, along with the outcomes of the Sustainable Urban Mobility Plan/ Logistics Plan assessment and the cities' input on their Strengths, Weaknesses, Opportunities, and Threats towards Physical Internet-led city logistics, were used to construct a SWOT analysis for each Use Case of each Living Lab. The SWOT analysis is a fundamental tool in strategic planning, offering a clear framework for organizations to assess their current position and plan for the future (Helms, & Nixon, 2010). At a final step, the results of the SWOT analysis were sent for validation to the ICBT, and their feedback was incorporated into the deliverable. The questionnaire used for this process is available in Annex 2, and the outcomes of each SWOT analysis are presented in the subsequent sections.

6.4.1. The city of Ghent

Ghent demonstrates a commitment to integrating technology and logistics, with strengths in defined shared logistics areas and potential for last-mile partnership development. However, the city faces a slow transition from ambition to action, and a lack of detailed long-term goals hinders the formation of an actionable plan. Opportunities lie in leveraging its robust tech ecosystem and political support, but the city's role in the collaborative approach needs to be clarified to maintain support from market players. The following figure presents the results of the SWOT analysis:

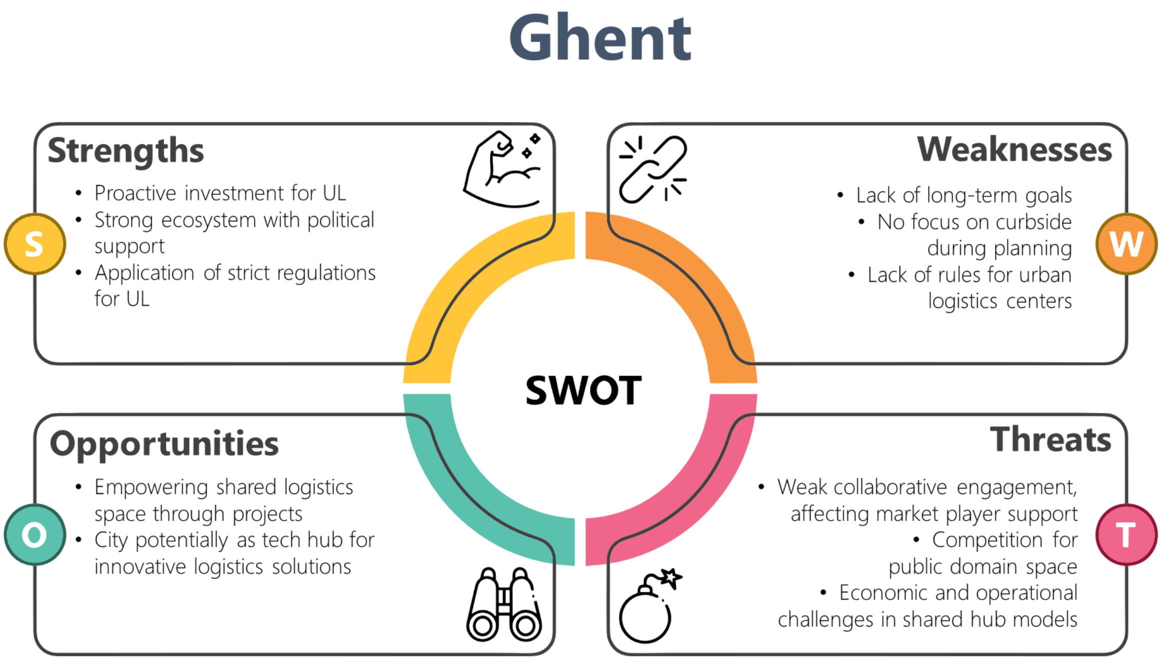


Figure 30: SWOT analysis of Ghent

Strengths:

- Proactive definition of investment areas (shared logistics and last-mile partners).
- Strong ecosystem with political support and potential to be a tech hub.
- Experience in applying strict regulations (e.g. access rules) for urban logistics.

Weaknesses:

- Lack of city's detailed long-term goals which causes slow transition from ambition to reality.
- Inadequate focus on delivery and pickup in street redevelopment.
- Challenges in defining rules for urban logistics centers.

Opportunities:

- Potential to define new rules and concepts for on-street loading bays.
- Opportunities for empowering shared logistics space through projects.
- Possibility to leverage its status as a potential tech hub for innovative logistics solutions.

Threats:

- Uncertainty in the city's role in the collaborative approach, affecting market player support.
- Competition for public domain space, leading to insufficient attention to logistics needs.
- Economic and operational challenges in shared hub models.

6.4.2. The city of Helsinki

Helsinki recognizes the importance of urban consolidation centers for efficient city logistics and supports innovative solutions, as evidenced by the Jätkäsaari area pilot. The city's main challenge is its limited capability to provide spaces for such centers and a somewhat passive role in their development. However, the active local logistics ecosystem and the city's support for micro consolidation hubs present significant opportunities. The major threat lies in finding suitable locations that meet the needs of logistics operators. The following figure presents the results of the SWOT analysis:

Helsinki

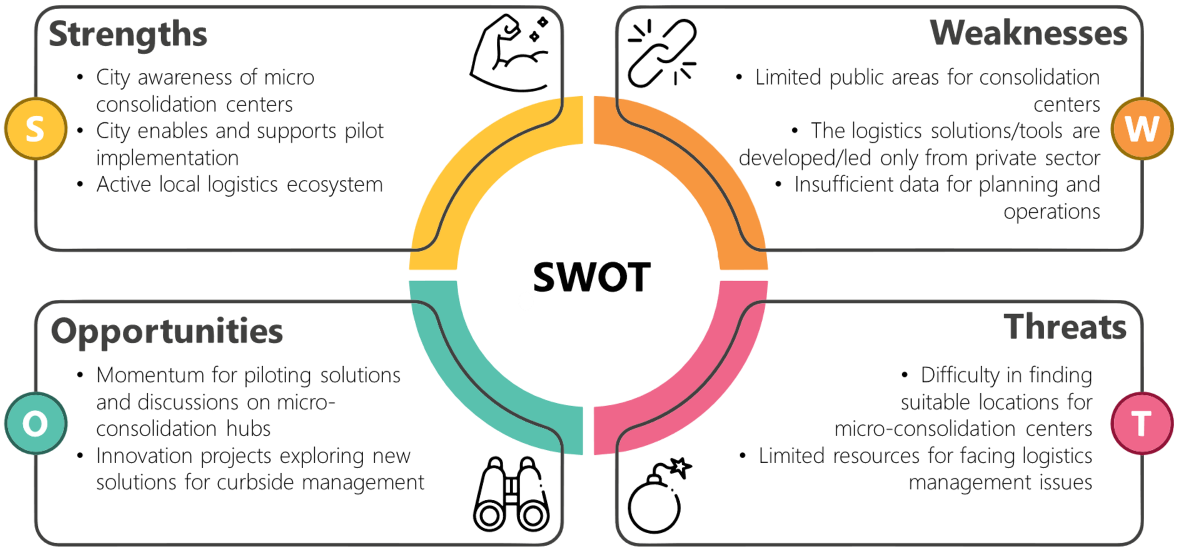


Figure 31: SWOT analysis of Helsinki

Strengths:

- City awareness of micro consolidation centers.
- City enables and supports pilot implementation.
- Active local logistics ecosystem.

Weaknesses:

- Limited capabilities in offering public areas for consolidation centers.
- The logistics solutions/tools are developed/led only from private sector.
- Insufficient data for planning dynamic management of parking spaces.

Opportunities:

- Momentum for piloting solutions and discussions on micro-consolidation hubs.
- Innovation projects exploring new solutions for street space and data utilization.

Threats:

- Difficulty in finding suitable locations for micro-consolidation centers.
- Limited resources for tackling logistics management issues.

6.4.3. The city of Copenhagen

Copenhagen has strengths in its established freight partnerships, but it faces challenges due to a lack of freight data. The city has opportunities to gain new insights through its new partnership agreements, which could enhance its logistics strategies. The primary threat is the limited data availability from companies, which could impede effective logistics planning. The following figure presents the results of the SWOT analysis:

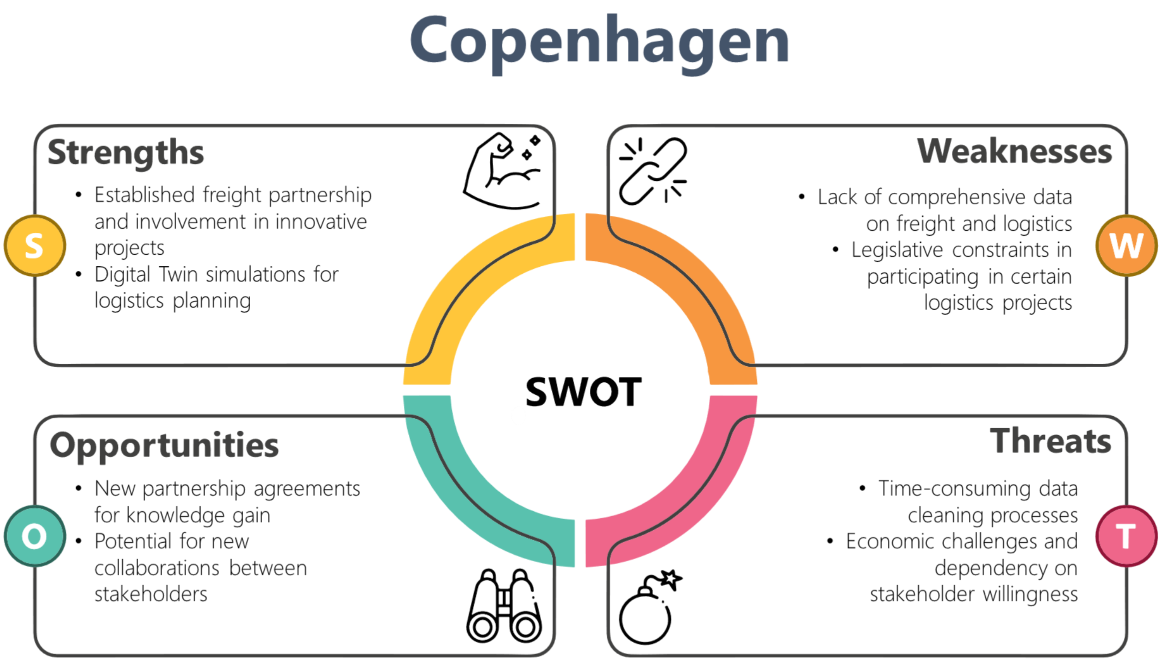


Figure 32: SWOT analysis of Copenhagen

Strengths:

- Established freight net partnership and involvement in innovative projects.
- Digital Twin simulations for logistics planning.

Weaknesses:

- Lack of comprehensive data on freight and logistics.
- Legislative constraints in participating in certain logistics projects.

Opportunities:

- New partnership agreements offering opportunities for knowledge gain.
- Potential for new collaborations between stakeholders in logistics.

Threats:

- Time-consuming data cleaning processes.
- Economic challenges and dependency on stakeholder willingness.

6.4.4. The city of Thessaloniki

Thessaloniki, with its unused public buildings and strong government support, has a solid foundation for developing innovative mobility solutions, further bolstered by its high research capacity and sufficient EU funding. However, the city grapples with bureaucratic delays, infrastructural constraints, limited public transport options, and challenges in stakeholder collaboration, which impede the integration of new mobility solutions. Opportunities arise from significant investments by major companies, the promising THESSINTEC project, and the growth of e-commerce, all of which can drive innovation in logistics and mobility. However, these advancements face potential setbacks from public and entrepreneurial resistance, and the strain on the road network due to ongoing infrastructure projects, highlighting the need for balanced and strategic planning to navigate these challenges and capitalize on the opportunities. The following figure presents the results of the SWOT analysis:

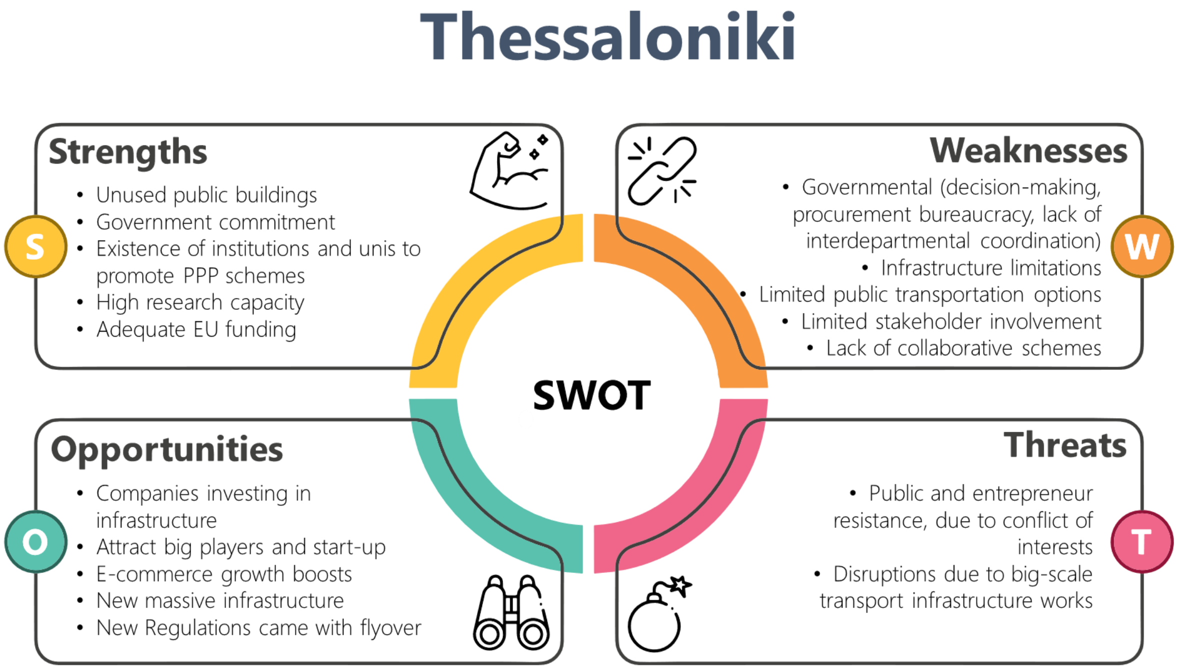


Figure 33: SWOT analysis of Thessaloniki

Strengths:

- Unused public buildings offer potential for innovative mobility solutions.
- Government commitment can facilitate new initiatives.
- Existence of institutions and universities that promote PPP schemes.
- City has a high research capacity.
- Adequate EU funding supports innovative mobility projects.

Weaknesses:

- Governmental issues such as decision-making and procurement delays for mobility solutions, long bureaucratic procedures and lack of interdepartmental coordination.
- Infrastructure limitations tackle and delay the integration of new mobility solutions.
- Limited public transportation options and unregulated parking affects the regular operation of city.

* Limited stakeholder involvement and limited collaborative schemes towards planning of innovative logistics solutions.

Opportunities:

* Major companies investing in infrastructure to foster collaboration.
* Attract big players and start-up companies through the construction of THESSINTEC[3] (logistics competence center and smart mobility mega project).
* E-commerce growth boosts prospects for innovative logistics and mobility solutions.
* New massive infrastructure (metro) is going to be finished by the next year.
* Regulations came with flyover construction kick-off (e.g., strict parking regulations) will potentially help city's operation.

Threats:

* Public and entrepreneur resistance, due to conflict of interests, challenges mobility adoption.
* Big scale transport infrastructure works that fatigues the rest road network.

6.4.5. The city of Zaragoza

Zaragoza has the potential to be an effective enabler in establishing a collaborative framework for urban logistics, already participating in strategic initiatives. However, challenges in inter-departmental coordination could hinder progress. The city has opportunities to repurpose facilities like public markets for logistics purposes, but there's a risk of stakeholder disengagement if the project scopes aren't aligned. The following figure presents the results of the SWOT analysis:

[3] https://www.thessintec.eu/

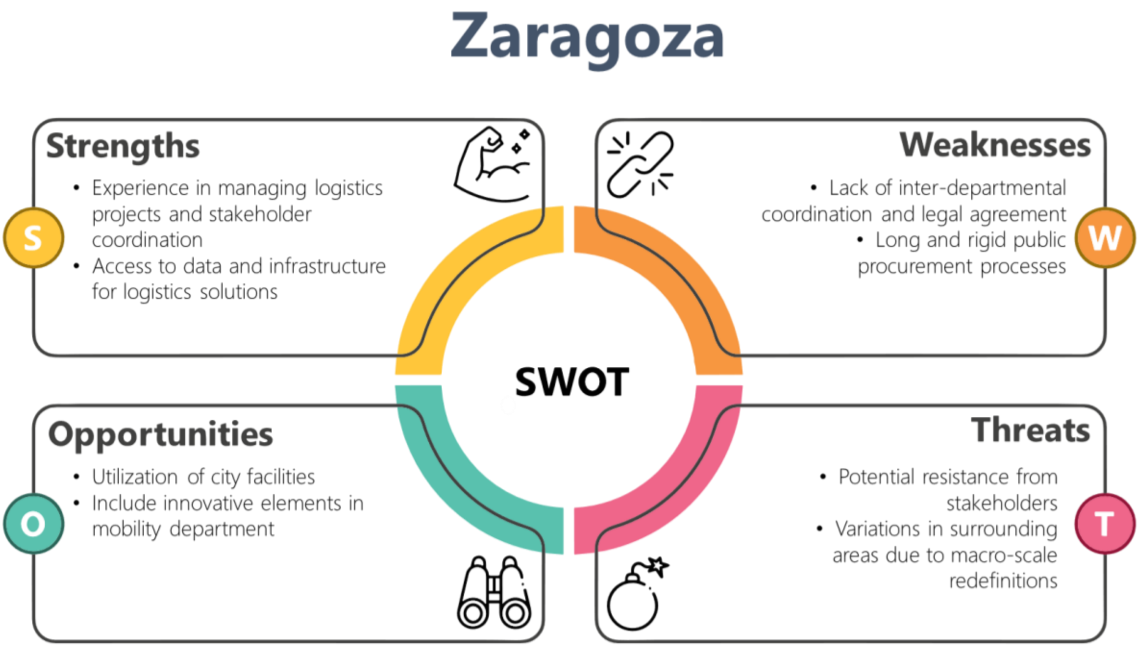


Figure 34: SWOT analysis of Zaragoza

Strengths:

- Experience in managing logistics projects and stakeholder coordination.
- Access to data and infrastructure for implementing logistics solutions.

Weaknesses:

- Challenges in inter-departmental coordination and legal agreement formalization.
- Long and rigid public procurement processes.

Opportunities:

- Utilization of city facilities like public markets for logistics activities.
- Opportunity to include innovative elements in mobility department projects.

Threats:

- Potential resistance from stakeholders not included in project initiatives.
- Variations in surrounding areas due to macro-scale redefinitions.

6.4.6. The city of Valencia

Valencia's strengths lie in its collaborative approach and commitment to sustainable mobility, with significant initiatives underway like the Open Mobility Table and Low Emissions Zone. The lack of an Urban Freight Plan and connectivity issues with the metropolitan area are notable weaknesses. Opportunities exist in leveraging technology for solving complex urban problems, but challenges in communication and adapting to technological changes could pose threats. The following figure presents the results of the SWOT analysis:

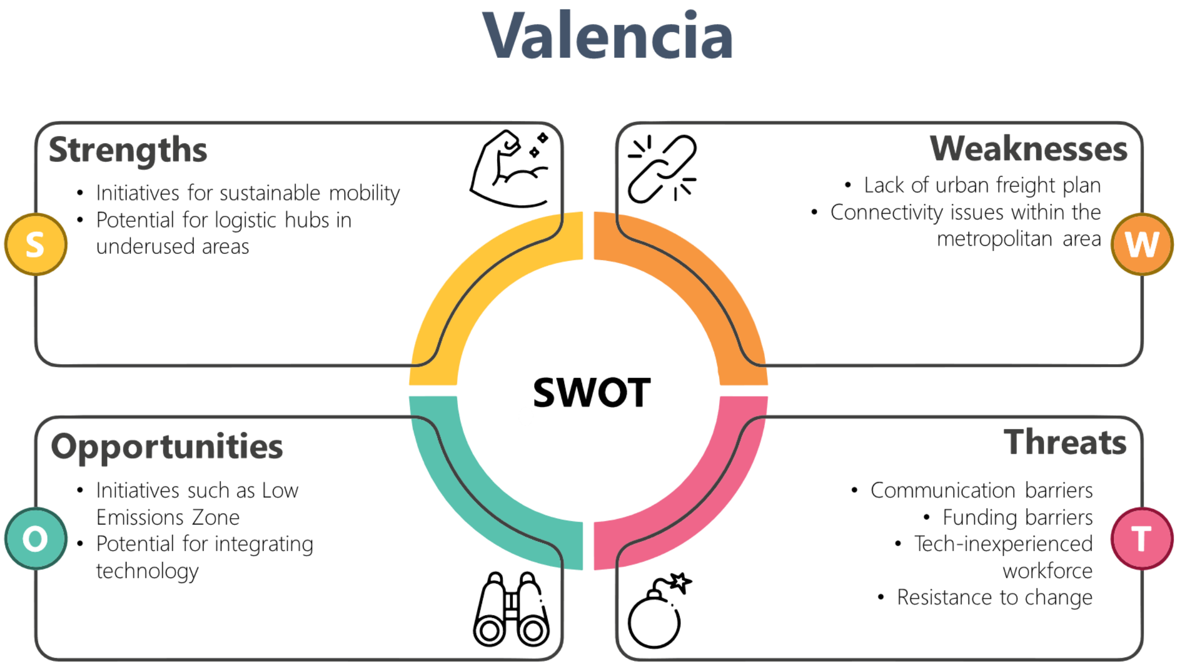


Figure 35: SWOT analysis of Valencia

Strengths:

- Initiatives for sustainable mobility
- Potential for logistic hubs in underused areas

Weaknesses:

- Lack of urban freight plan
- Connectivity issues within the metropolitan area

Opportunities:

- Initiatives like Low Emissions Zone
- Potential for integrating technology

Threats:

- Communication barriers
- Technological challenges
- Resistance to change.

6.4.7. The city of Barcelona

Barcelona has a solid foundation with established urban mobility and logistics plans and is advancing in digitalizing parking access. Adapting to a changing city model and political shifts are the main weaknesses. The city's recent transformation offers opportunities to enhance its logistics plan, but political changes and insufficient funding could disrupt progress. The following figure presents the results of the SWOT analysis:

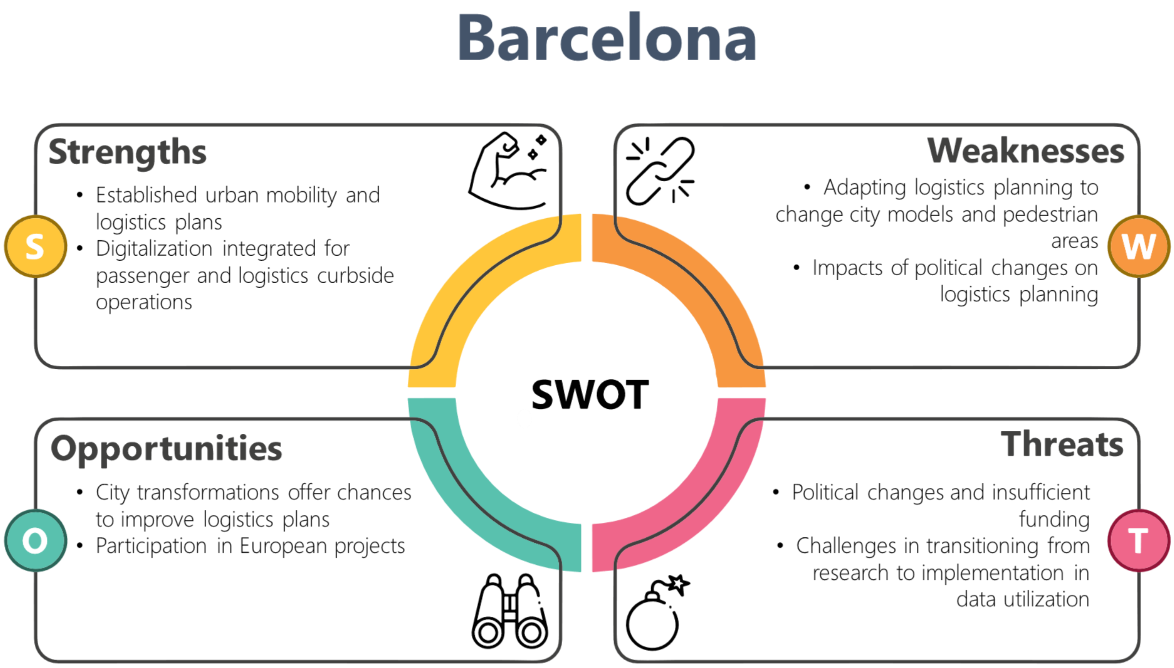


Figure 36: SWOT analysis of Barcelona

Strengths:

- Established urban mobility and logistics plans.
- Digitalization of access to parking and loading areas.

Weaknesses:

- Adapting logistics planning to change city models and pedestrian areas.
- Potential impacts of political changes on logistics planning.

Opportunities:

- Recent city transformations offering chances to improve logistics plans.
- Participation in European projects for logistics innovation.

Threats:

- Political changes and insufficient funding for logistics transformations.
- Challenges in transitioning from research to implementation in data utilization.

6.4.8. The city of Padua

Padua shows strong municipal commitment and successful last-mile delivery operations through Cityporto. The city's challenge is in engaging more operators and dealing with limited space. Opportunities exist in further developing CityPorto's activities, but the lack of cooperation from key stakeholders and rigid IT systems of large carriers pose threats to logistics improvements. The following figure presents the results of the SWOT analysis:

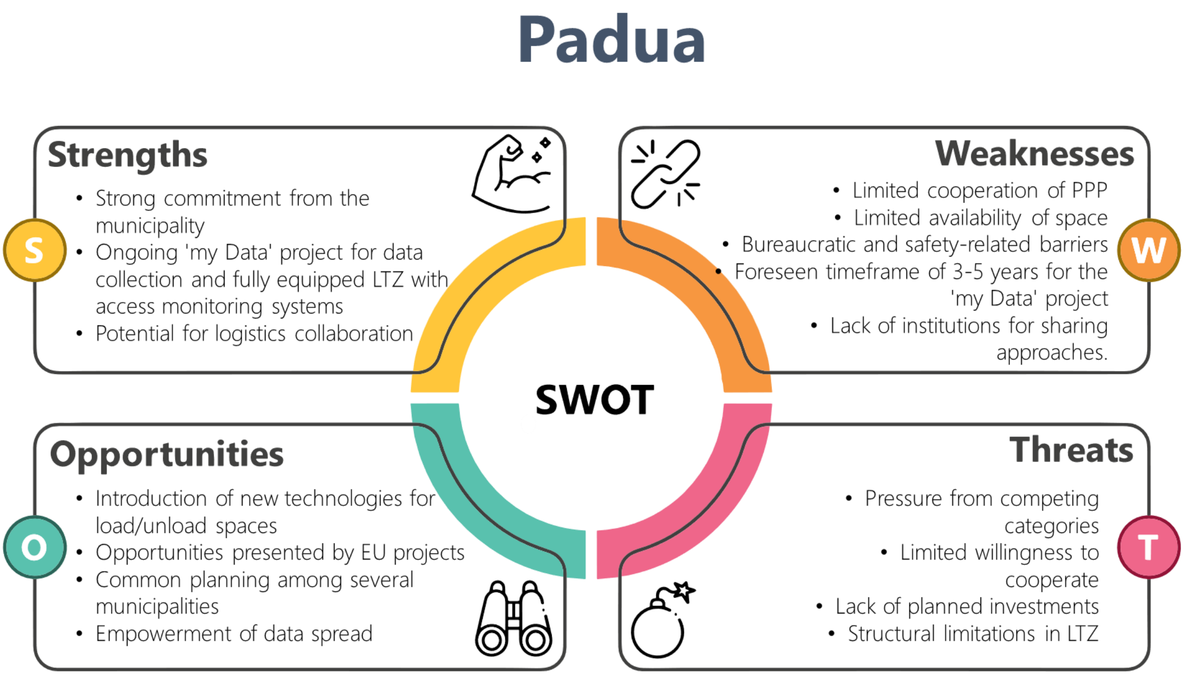


Figure 37: SWOT analysis of Padua

Strengths:

- Strong commitment from the municipality towards urban logistics improvements.
- Activity of the last-mile delivery operator and a well-defined ordinance for managing space in LTZ (Limited Traffic Zones).
- Ongoing 'my Data' project for data collection and fully equipped LTZ with access monitoring systems.
- Municipality's stake in the Fair, offering potential for logistics collaboration.

Weaknesses:

- Limited cooperation with major stakeholders and almost half of the operators not collaborating with each other.
- Limited availability of space, especially in the Padua Fair and the historic center.
- Bureaucratic and safety-related barriers in collaboration, and unsuitable characteristics of LTZ and historic center for logistics operations.

- Foreseen timeframe of 3-5 years for the 'my Data' project and lack of institutions for sharing approaches.

Opportunities:

- Further enhancement of LSP's activities and introduction of new technologies for load/unload spaces.
- Opportunities presented by EU projects (e.g., DISCO, SPROUT, etc.) for exploring new logistics solutions.
- Common planning among several municipalities in the region for logistics improvements.
- Empowerment of data spread to all potentially interested subjects for better logistics planning.

Threats:

- Pressure from competing categories like residents, cutting down parking space offer.
- Limited willingness to cooperate from major stakeholders in delivery operations.
- Lack of planned investments in maintaining technological infrastructure.
- Structural limitations in LTZ and historic center impacting logistics operations.

6.4.9. Conclusions from SWOT analysis

The SWOT analysis of the 8 cities was further analyzed to detect potential commonalities, and differences. The analysis resulted in six (6) variables as Strengths, six (6) variables as Weaknesses, four (4) variables as Opportunities and four (4) variables as Threats.

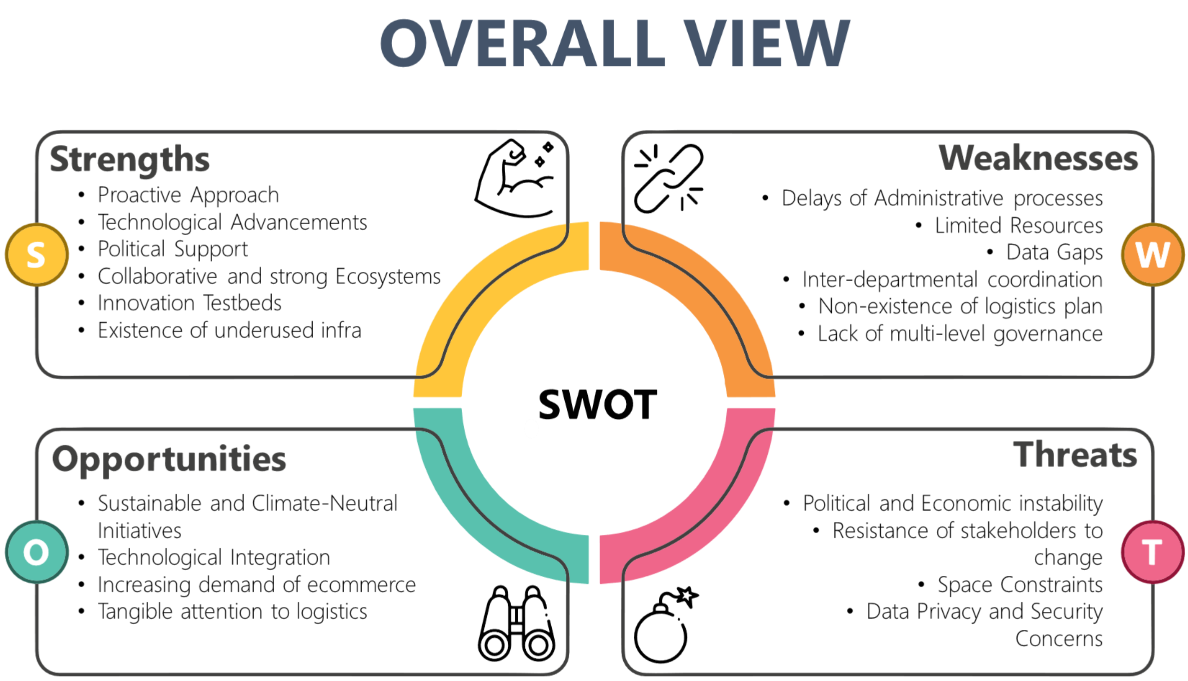


Figure 38: The overall conclusions of the SWOT analysis

Strengths: Cities are increasingly adopting a proactive approach toward sustainable mobility and logistics planning, as evidenced by initiatives in places like Ghent and Zaragoza. The integration of technological advancements, such as in Copenhagen and Padua, is revolutionizing urban logistics through digital solutions and data-driven strategies. This progress is often supported by political backing, creating strong ecosystems that involve collaboration among academia, industry, and government, as seen in Ghent. Cities like Thessaloniki and Barcelona are emerging as innovation testbeds, experimenting with new mobility solutions. Additionally, there's potential to repurpose existing infrastructure, which could further enhance these initiatives.

Weaknesses: On the flip side, cities face significant challenges, including delays in administrative processes, as observed in Thessaloniki and Padua, which hinder the swift implementation of projects. Financial and logistical constraints, like those in Valencia and Padua, limit the advancement of urban mobility initiatives. Incomplete data collection, as in Copenhagen, affects strategic planning, and the challenge of aligning various city departments and stakeholders for cohesive action is evident in cities like Ghent and Thessaloniki. Moreover, the absence of a comprehensive logistics plan in some cities, such as Valencia, impedes effective urban logistics management.

Opportunities: However, there are numerous opportunities for growth and improvement. The growing emphasis on environmental sustainability, as seen in Ghent and Helsinki, provides a strong impetus for green projects. The integration of advanced technologies, including AI and IoT, offers exciting prospects for enhancing urban logistics, as could be explored in Valencia and Barcelona. Furthermore, the rise in e-commerce, exemplified by Thessaloniki, is creating new demands and possibilities for urban logistics solutions.

Threats: Yet, there are also threats that need to be addressed. Political and economic instability, as might occur in Barcelona or due to economic downturns in shared hub models like in Ghent, can disrupt urban mobility plans. The resistance of stakeholders to adapt to new systems and practices, as seen in Thessaloniki and Zaragoza, presents a significant challenge. Additionally, space constraints in densely populated urban areas, such as Ghent's public domain or Padua's historic center, pose challenges for the development of new infrastructure or logistics hubs. Finally, data privacy and security concerns, which are increasingly pertinent in data-reliant cities like Padua and Copenhagen, necessitate careful handling and protection of sensitive information.

7. First cut-view of the Meta Model Suite

This part describes the planned structure and the functionality of the Meta Model Suite. The Meta Model Suite is a set of tools and frameworks that synchronizes spatial and multimodal freight transport logistics planning tools, facilitating the analysis and assessment of urban policies, disruptive technologies, and data-driven urban logistics services. The goal behind the Meta Model Suite is for it to collect the knowledge, the data and the tools from the work will be done in WP2 and WP3 of the DISCO project in order to guide and support cities that want to make the transition to green and Physical Internet-led city logistics.

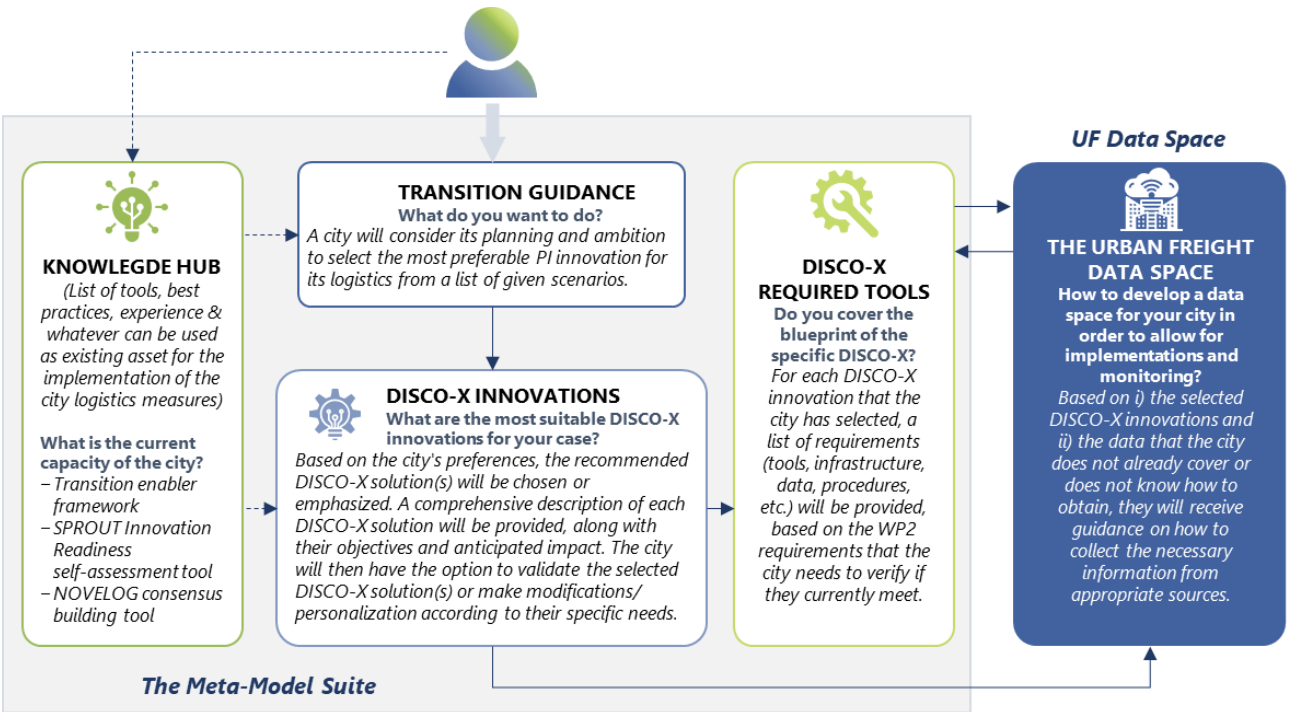


Figure 39: The structure and the five levels of the Meta Model Suite

As presented in Figure 39, the Meta Model Suite will be structured in five levels:

- Component Zero, termed the **Knowledge Hub**, functions as a comprehensive repository offering an array of tools, exemplary practices, and empirical insights from the project. This resource aids cities in gaining profound insights into various facets of urban mobility and innovation.
- Moving to Component One, named **Transition Guidance**, its primary objective is to assist cities in delineating their vision and objectives concerning urban mobility. It facilitates the process of selecting the most suitable solution from evaluating different scenarios utilizing the Transition Enabling Framework.

- Progressing to Component Two, denoted as **DISCO-X Innovations**, the focus shifts towards aiding cities in the discernment and selection of the most fitting DISCO-X innovation(s) aligned with their favorable scenario.
- Advancing to Component Three, termed **DISCO-X Required Tools**, this phase is instrumental in enabling cities to connect with the AppStore of the Urban Freight Data Space in order to deploy suitable tools to support for the implementation and the operation of their chosen DISCO-X solution(s).
- Finally, Component Four, **The Urban Freight Data Space**, plays a pivotal role in supporting cities in the establishment of a dedicated data space tailored to their urban landscape. This space is crucial for the successful implementation and ongoing monitoring of the DISCO-X solutions.

7.1. The Knowledge Hub

In recent years, an increment of tools dedicated to urban mobility and logistics has emerged, often accessible online, yet cities and governments frequently remain unaware of their existence. The Knowledge Hub emerges as a critical repository within the DISCO Meta Model Suite, aimed at bridging this gap by curating a comprehensive list of online tools stemming from DISCO and various other projects, both within and outside the EU. This Knowledge Hub will be embedded in the ALICE platform with a direct link on the DISCO Meta Model Suite.

This repository serves as a centralized resource hub, housing an extensive catalog of tools along with detailed explanations and functionalities, best practices and insights from the project. By consolidating these resources, the Knowledge Hub empowers users, offering them a panoramic view of the diverse array of tools available for optimizing urban mobility and logistics.

Within this section, municipalities, urban planners, and stakeholders gain access to a collection of tools sourced from DISCO and other projects, fostering exploration and enabling informed decision-making. Each tool is accompanied by dedicated explanations, highlighting its specific functionalities, intended applications, and potential benefits. This comprehensive listing not only exposes users to novel tools but also provides insights into their suitability for various urban contexts. Users are thereby equipped to explore and select tools that align most closely with their unique urban challenges, objectives, and aspirations.

By housing these resources in a centralized repository, the Knowledge Hub acts as a catalyst for knowledge dissemination and innovation adoption. It enables cities and governments to expand their repertoire of available tools, fostering a culture of informed decision-making and facilitating the adoption of cutting-edge solutions. Ultimately, the Knowledge Hub serves as a springboard for cities, empowering them to navigate the ever-evolving landscape of urban mobility and logistics with confidence and foresight.

7.2. The Transition Enabling Framework

Transition Guidance emerges as the next crucial phase within the Meta Model Suite, poised to assist cities in defining their vision and setting objectives that are aligned with their urban mobility aspirations and will be supported by the **Transition Enabling Framework** which will be developed in collaboration with T2.2. This stage acts as a guiding beacon, illuminating the path toward a transformative urban landscape. Through a structured approach, Transition Guidance empowers cities to navigate the complexities of selecting optimal solutions from a spectrum of diverse scenarios. It facilitates a strategic alignment between city objectives and potential solutions, fostering a cohesive vision that encapsulates the desired outcomes. By leveraging this guidance, cities can articulate their aspirations and chart a course toward sustainable, efficient, and people-centric urban mobility systems.

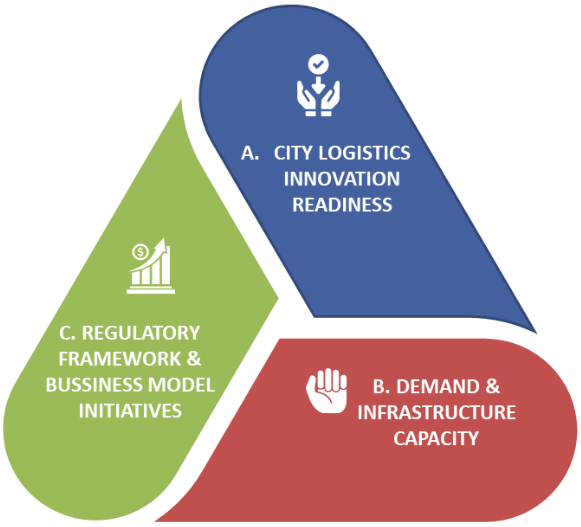


Figure 40: The three layers of the transition enabling framework

As cities progress through the Meta Model Suite, they encounter a pivotal phase that encompasses a comprehensive assessment tool designed to evaluate their readiness and capabilities for the seamless integration of DISCO-X solutions namely **Transition Enabling Framework**. This tool comprises three distinct layers, each serving as a critical component in assessing and enhancing a city's preparedness for embracing innovative logistics solutions.

The first layer, the **City Logistics Innovation Readiness tool**, is a collaborative endeavour developed in partnership with KLU (T2.2), designed to methodically evaluate a city's readiness in adopting Physical Internet-led logistics solutions. This layer serves as the initial test, probing into the city's capacity and willingness to embrace innovative logistic strategies driven by key performance indicators. It offers insights into the city's adaptive potential and willingness to leverage cutting-edge solutions, laying the foundation for the successful implementation of DISCO-X innovations.

Moving to the second layer, the **Demand & Infrastructure/Capacity** assessment, this component examines the city's ability to meet the diverse requirements posed by DISCO-X solutions. It delves into the intricacies of the city's logistical landscape, evaluating its infrastructure's capacity to accommodate and sustain logistical demands. This layer scrutinizes the city's logistical volume, assessing its capability to efficiently handle the inflow and outflow of goods. It offers a comprehensive overview of the city's infrastructure readiness, shedding light on its capacity to manage and support innovative logistics solutions effectively.

Finally, the third layer, **Regulatory Framework & Business Model Initiatives**, intricately examines the legal and regulatory framework governing urban logistics within the city. This layer offers a detailed portrayal of existing regulations, elucidating the legal landscape and emphasizing business model initiatives that streamline logistics operations while ensuring compliance with regulatory measures. It provides insights into the city's initiatives aimed at fostering a conducive environment for innovative logistics, outlining regulatory frameworks and incentivized business models that facilitate the seamless integration of DISCO-X solutions.

Together, these three layers form a robust assessment framework that offers a holistic understanding of a city's logistics landscape. From evaluating innovation readiness and infrastructure capacity to elucidating regulatory frameworks and business models, this comprehensive tool equips cities with invaluable insights to fortify their readiness and pave the way for the successful implementation of DISCO-X solutions within their urban fabric.

7.3. The DISCO-X Innovations

The Meta-Model Suite is underpinned by and based on the DISCO-X innovations, which are instrumental in shaping the implementation paths that guide cities from current practices to future, more efficient logistics systems.

Integral to the Meta-Model Suite's architecture are the generalized implementation paths for the key DISCO project measures: DISCOCURB, DISCOPROXI, DISCOESTATE, and DISCOBAY. These paths extract the essence of DISCO-X innovations into pragmatic roadmaps, offering cities a structured framework to enhance their urban logistics. As such, the Meta-Model Suite transcends its initial remit with the participant cities, extending its reach to assist new cities in embracing these sophisticated urban logistics solutions.

7.4. The DISCO-X Required Tools

This pillar will be connected to the App Store component of Urban Freight Data Space (UFDS). This component will include tools related to the DISCO-X that the cities could potentially use to support the operation of the innovation.

8. Conclusions

This deliverable provides a comprehensive understanding of the current state of urban logistics in various cities, identifying strengths, weaknesses, opportunities, and threats in the context of urban logistics. The document outlines a structured methodology for evaluating the urban logistics ecosystem, defining DISCO-X innovations, and creating city-specific Physical Internet operational schemes. It emphasizes the importance of data availability, supportive policies, and regulations for the successful adoption of urban logistics innovations. Additionally, the introduction of the DISCO Urban Freight Data Space and the Meta Model Suite aims to guide cities in selecting appropriate DISCO-X solutions based on their capacities and requirements. The major conclusions drawn from this deliverable are the following:

- **Stakeholder Collaboration and Evidence-Based Planning Deficiencies:** The SWOT analysis underscored significant gaps in collaboration among key stakeholders, alongside a notable shortfall in freight evidence-based planning. This lack of synergy and data-driven decision-making is a critical concern.
- **Planning Objectives and DELPHI Approach:** It was identified that effective planning requires clear objectives. Many cities exhibit a nascent understanding of Physical Internet (PI)-led initiatives, often with ambiguous goals. To address this, a pseudo-DELPHI method was utilized, leveraging the expertise of ICBT experts. This serves as a foundational step for a comprehensive DELPHI study, aiming to elucidate key parameters driving PI-led innovation.
- **Requirements for the Urban Freight Data Space:** Cities are confronted with a vast array of data types, originating from various platforms and in different formats. This heterogeneity, stemming from the unique requirements of the five DISCO-X categories, underscores the need for a specialized data aggregation tool or add-on within the urban dataspace. This tool should integrate disparate data streams, facilitating interoperability and supporting effective urban planning and operational management. The proposed Urban Freight Data Space (UFDS) emerges as an essential component, enabling the transition to PI-led innovation and dynamic, shared management of city logistics. The UFDS will contain static data to cover the planning processes that is needed for the implementation of specific DISCO-X while also live data that will enable the operational implementation and the impact assessment of the DISCO-Xs.
- **Early drop of DISCO-X Implementation and PI-Operational Paradigm:** The report delineates the initial phase of DISCO-X implementation in urban areas. Alongside this, a PI-operational paradigm was proposed, offering guidance for cities in implementing DISCO-X strategies effectively.
- **Meta Model Suite Development:** A preliminary version of the Meta Model Suite was introduced. This tool is envisioned as a comprehensive resource for cities embarking on the journey towards PI-enabled infrastructure management, offering a unified framework for the effective implementation of PI principles in urban logistics and infrastructure planning.

Bibliography

Abel, S., et al. (2021). Dynamic Curbside Management: Keeping Pace with New and Emerging Mobility and Technology in the Public Right-of-Way. The National Academies Press.

ALICE. (2020). Roadmap to Physical Internet 2030-2040. Alliance for Logistics Innovation through Collaboration in Europe. Retrieved from https://www.etp-logistics.eu/about-alice/documents-publications/

Ambra, T., Caris, A., & Macharis, C. (2019). Towards freight transport system unification: reviewing and combining the advancements in the physical internet and synchromodal transport research. *International Journal of Production Research, 57*(6), 1606-1623. https://doi.org/10.1080/00207543.2018.1494392

Thangaratinam, S. and Redman, C.W. (2005), The Delphi technique. The Obstetrician & Gynaecologist, 7: 120-125. https://doi.org/10.1576/toag.7.2.120.27071

Capka, J. R. (2008). The Importance of Understanding Freight. In Freight Demand Modeling: Tools for Public-Sector Decision Making (pp. 17-18). The National Academies Press. https://doi.org/10.17226/23090

Chase, K. M., Anater, P., & Phelan, T. (2013). Research Approach. In Freight Demand Modeling and Data Improvement (Chapter 2). The National Academies Press. https://doi.org/10.17226/22734

Crainic, T. G., & Montreuil, B. (2016). Physical internet enabled hyperconnected city logistics. *Transportation Research Procedia. 12*. 383-398. 10.1016/j.trpro.2016.02.074.

Deloitte. (2017). Improving Last-Mile Logistics with the Future of Mobility. Retrieved from https://www.deloitte.com/

Demir, E., Syntetos, A., & van Woensel, T. (2022). Last mile logistics: Research trends and needs. IMA Journal of Management Mathematics, 33(4), 549–561. https://doi.org/10.1093/imaman/dpac006

Dong, C., & Franklin, R. (2020). From the digital Internet to the physical Internet: a conceptual framework with a stylized network model. *Journal of Business Logistics, 42*(1), 108–119. https://doi.org/10.1111/jbl.12253

Eisele, W. (2014). The impact of tailpipe emissions from frequent acceleration, deceleration, and idling while searching for parking. In Dynamic Curbside Management: Keeping Pace with New and Emerging Mobility and Technology in the Public Right-of-Way. The National Academies Press.

Giuffrida, N., Fajardo-Calderin, J., Masegosa, A.D., Werner, F., Steudter, M., & Pilla, F. (2022). Optimization and Machine Learning Applied to Last-Mile Logistics: A Review. Sustainability, 14, 5329. https://doi.org/10.3390/su14095329

Helms, M.M., & Nixon, J. (2010). Exploring SWOT analysis – where are we now? A review of academic research from the last decade. Journal of Strategy and Management, 3(3), 215-251. https://doi.org/10.1108/17554251011064837

Holguin-Veras, J., Ramirez-Rios, D., Ng, J., Wojtowicz, J., Haake, D., Lawson, C. T., Calderón, O., et al. (2021). Freight-efficient land uses: Methodology, strategies, and tools. Sustainability, 13(6), 3059. MDPI AG. http://dx.doi.org/10.3390/su13063059

Hossain, M. A., Islam, M. A., & Rahman, M. S. (2021). A model for the selection of transportation modes in the context of sustainable freight transportation. Sustainability, 13(4), 2183.

Jha, S. K., Mandal, S. K., & Mukherjee, S. K. (2021). Evaluating sustainability initiatives in warehouse for measuring sustainability performance: An emerging economy perspective. Journal of Cleaner Production, 279, 123698.

Karim, D.M. (2017). Creating an Innovative Mobility Ecosystem for Urban Planning Areas. In: Meyer, G., Shaheen, S. (eds) Disrupting Mobility. Lecture Notes in Mobility. Springer, Cham. https://doi.org/10.1007/978-3-319-51602-8_2

Lyons, T., & McDonald, N. C. (2023). Last-Mile Strategies for Urban Freight Delivery: A Systematic Review. Transportation Research Record, 2677(1), 1141-1156. https://doi.org/10.1177/03611981221103596

McCahill, C., Weinberger, R., & Shoup, D. (2016). The negative externalities of free or underpriced curbside parking. In Dynamic Curbside Management: Keeping Pace with New and Emerging Mobility and Technology in the Public Right-of-Way. The National Academies Press.

McKinnon, A. C., Cullinane, S., Browne, M., & Whiteing, A. (2010). Green logistics: improving the environmental sustainability of logistics. In *Kogan Page eBooks*. https://ci.nii.ac.jp/ncid/BB11672690

Montreuil, B., Meller, R.D., & Ballot, E. (2012). Physical Internet Foundations. Service Orientation in Holonic and Multi Agent Manufacturing and Robotics

Montreuil, B., Meller, R. D., & Ballot, É. (2013). Physical internet foundations. In *Studies in computational intelligence* (pp. 151–166). https://doi.org/10.1007/978-3-642-35852-4_10

Moradi, N., Sadati, İ., & Çatay, B. (2023). Last mile delivery routing problem using autonomous electric vehicles. Computers & Industrial Engineering, 184, 109552. https://doi.org/10.1016/j.cie.2023.109552

Özarık, S. S., Veelenturf, L. P., Van Woensel, T., & Laporte, G. (2021). Optimizing e-commerce last-mile vehicle routing and scheduling under uncertain customer presence. Transportation Research Part E: Logistics and Transportation Review, 148, 102263. https://doi.org/10.1016/j.tre.2021.102263

Pacrez, B. O., Lipscomb, D., Ayuk, D., Stokes, C., & Patterson, E. (2020). Innovative Curbside Management in the Nation's Capital. In State of Transportation Planning 2020: Moving People Over Cars (pp. 158-169). American Planning Association: Transportation Planning Division.

Rosenblatt, L. (2020). With extra barriers and even more simulation, self-driving cars gear up to start testing again. Pittsburgh Post-Gazette.

San Francisco Municipal Transportation Agency. (2014). SFpark: Putting Theory Into Practice.

Schachenhofer, L., Kummer, Y., & Hirsch, P. (2023). An analysis of underused urban infrastructures: Usage opportunities and implementation barriers for sustainable logistics. Applied Sciences, 13(13), 7557. MDPI AG. http://dx.doi.org/10.3390/app13137557

Sert, E., Hedayatifar, L., Rigg, R. A., Akhavan, A., Buchel, O., Saadi, D. E., Kar, A. A., Morales, A. J., & Bar-Yam, Y. (2020). Freight Time and Cost Optimization in Complex Logistics Networks. Complexity, 2020, Article ID 2189275, 11 pages. https://doi.org/10.1155/2020/2189275

Sharma, V., Raut, R. D., Govindarajan, U. H., & Narkhede, B. E. (2021). Advancements in urban logistics toward smart, sustainable reforms in developing enabling technologies and markets. *Kybernetes, 51*(3), 1038–1061. https://doi.org/10.1108/k-01-2021-0026

Tiwari, K. V., & Sharma, S. K. (2023). An optimization model for vehicle routing problem in last-mile delivery. Expert Systems with Applications, 222, 119789. https://doi.org/10.1016/j.eswa.2023.119

Wang, Y. (2019). Research on supply and demand matching model of transportation modes in logistics network based on sustainable development. Journal of Physics: Conference Series, 1986(1), 012051.

Zhang, Y., Li, Y., & Liu, Y. (2021). A literature review of smart warehouse operations management. International Journal of Production Research, 59(5), 1387-1403.

APPENDICES

Annex 1
Final version of the DISCO-X requirements templates to the DISCO-X players

Annex 2
Qualitative Assessment of Sustainable Urban Mobility Plans/ Sustainable Urban Logistics Plans measures' state of implementation

Urban logistics related measures	Reasons that led to **delays** in the implementation of the measure	Main factors that **enabled** the successful implementation of the measure	Main factors that contributed to the **failure** of the measure's implementation
Low emission zone	-	Regional legal framework Strong political leadership Business case (investment <> income)	-
Time windows	-	Strong political will and leadership, Adequate funding and resource allocation, Clear and achievable objectives, Robust technological support and infrastructure.	-
"School Streets" (time windows 8-830 am)	-	Around 15 school apply this.	On voluntary basis (school takes the lead). Depends on volunteering.
Covenant on avoiding construction traffic in school zones at peak hour	The "chart" is not know, implemented, cannot be controlled.	-	Political leadership considers it will not work without strict rules like: weight restrictions + time zones
Zero Emission City Logistics	Currently the city of Ghent has expressed the ambition to implement a zero emission zone by 2030. It is awaiting a regional legal framework du mid 2024.	-	-

Urban logistics related measures	Reasons that led to **delays** in the implementation of the measure	Main factors that **enabled** the successful implementation of the measure	Main factors that contributed to the **failure** of the measure's implementation
Pedestrian and low traffic zone	-	Strong political will and leadership, Adequate funding and resource allocation, Clear and achievable objectives, Robust technological support and infrastructure.	-
Ordinance of LTZ	Changes in political leadership or priorities, Resistance or opposition from stakeholders or interest groups.	Strong political will and leadership Effective communication and awareness campaign	-
Ordinance: 'Limited access for freight vehicles' into historical centre	Insufficient respect of road signage	Strong political will and leadership Effective communication and awareness campaign	-
Creation of a low emission zone	No delays in the implementation, in fact it came from a national legislation (every city with at least 50k)	National legislation that forced its implementation Political commitment to increase air quality in city Political commitment EU missions	Inequal delimitation of the area, not based on the purchase power of neighbourhoods (the current area involves low-income tenders with old vans)

Urban logistics related measures	Reasons that led to **delays** in the implementation of the measure	Main factors that **enabled** the successful implementation of the measure	Main factors that contributed to the **failure** of the measure's implementation
Pacification of streets (30km/h) extending the bike network	No delays in implementation, in fact, Zaragoza was the first big city in Spain implementing the axis in 2010	Covid19 forced an active mobility	Not all bikers are confident enough to use pacified streets instead of secure bike lanes (for instance, postal couriers are often reluctant to ride a cargo bike on pacified streets)
Mapping of logistic microhubs/lockers (H2020 Senator project)	So far the lack of funding Lack of political interest	The funded opportunity of a H2020 project (SENATOR)	Full commitment/Lack of experience
Load/Unload bays smart parking (H2020 Senator project)	Long procurement process	The funded opportunity of a H2020 project (SENATOR) Renewal of the current concession is ongoing	Long and rigid procurement process
Optimal location of Load/Unload bays modelling for a better quality of service (H2020 Senator project)	So far the lack of funding Lack of political interest	The funded opportunity of a H2020 project (SENATOR)	The study needs to be validated beyond measure 4 - which will help validating the measure -
Developing Underground Distribution	The underground tunnel has been built by the City to serve the logistics of downtown buildings. The tunnel is finished, but only few buildings have invested to build an elevator to connect the building to the tunnel.	The City was active and has invested to build the tunnel and the tunnel is finished.	The investment to connect a building to the tunnel network is left to the private actors owning the buildings. Only few buildings have invested to build an elevator to connect the building to the tunnel, which has led

Urban logistics related measures	Reasons that led to **delays** in the implementation of the measure	Main factors that **enabled** the successful implementation of the measure	Main factors that contributed to the **failure** of the measure's implementation
			to a situation where the tunnel is heavily underutilized.
Implementation of Distribution Traffic Parking Permit	No delays in the process	The work to implement the traffic parking permit is currently a work in process. The City has been active to coordinate the process, but it is still in the early phase of planning.	-
Development of a Loading and Unloading Area Improvement Plan for Distribution Traffic, including both the formulation and short-term implementation	Partially implemented, partly not assessable (places have been added, but it is not known when). There were no quantitative targets for adding places.	-	-
Coordinating Land Use and Distribution Traffic Planning	No delays in the process	Strong will to cooperate internally with the city planning division	
Establishment of the City Logistics Collaboration/Development Working Group and Monitoring the Impacts of Measures	This working group has not been established. However, there is a unofficial group discussing city	Active stakeholders both from the City as from the private sector have formed an unofficial working group.	No information from the City on the reasons why official working group has not been established.

Urban logistics related measures	Reasons that led to **delays** in the implementation of the measure	Main factors that **enabled** the successful implementation of the measure	Main factors that contributed to the **failure** of the measure's implementation
	logistics on a monthly basis.		
Development of KPI's for monitoring the achievement of city logistics goals.	Budgetary constraints and lack of human resources	-	Budgetary constraints and lack of human resources
Implementation of an Interactive Campaign	Budgetary constraints and lack of human resources	-	Budgetary constraints and lack of human resources
Analysis of City Logistics Survey Results	Fully implemented	Active stakeholders both from the City as from the private sector	
Improving Collaboration Among Goods Receivers, Advancing Logistics, and Developing Block-Specific Logistics Plans	Not implemented or not assessable (no new shopping centers have been built in the city center).	-	Budgetary constraints and lack of human resources
Promoting Local Distribution Stations and Light Distribution Solutions on Sites	Fully implemented	Active stakeholders both from the City as from the private sector, mainly pushed forward by different innovation projects conducted by FVH and other entities.	-
Advancing Logistics in Shopping Centers	The completion of this measure is designated to private shopping malls. Some shopping malls have completed the measure, others have not. The City acts as an enabler and	-	The completion of this measure is designated to private shopping malls. Some shopping malls have completed the measure, others have not. The City acts as an enabler and

Urban logistics related measures	Reasons that led to **delays** in the implementation of the measure	Main factors that **enabled** the successful implementation of the measure	Main factors that contributed to the **failure** of the measure's implementation
	provides assistance if needed.		provides assistance if needed.
Enhancing the Efficiency of Downtown Service Tunnel Utilization and Increasing Underground Distribution	After 2020, there has not been any new downtown buildings that have built a connection to the downtown service tunnel. The investments are decided by private real estate owners.	-	After 2020, there has not been any new downtown buildings that have built a connection to the downtown service tunnel. The investments are decided by private real estate owners, which are not willing to invest in the connections.
Promoting Environmentally Friendly Distribution Solutions	Technical and financial reasons hinders the completion of the measure. However, plenty of new pilots have been ongoing since 2020.	Active stakeholders both from the City as from the private sector, mainly pushed forward by different innovation projects conducted by FVH and other entities.	-
Developing Opportunities for Expanding Nighttime Distribution in Distribution Transport	The completion of this measure is designated to private operators and therefore the completion depends on the operation models of private operators	-	The completion of this measure is designated to private operators and therefore the completion depends on the operation models of private operators. For now, it seems that private operators are not willing to modify their

Urban logistics related measures	Reasons that led to **delays** in the implementation of the measure	Main factors that **enabled** the successful implementation of the measure	Main factors that contributed to the **failure** of the measure's implementation
			delivery schedules especially due to the opening hours of retailers and other parcel receivers.
Improving the Accessibility of the Downtown Service Tunnel	After 2020, there has not been any new downtown buildings that have built a connection to the downtown service tunnel. The investments are decided by private real estate owners.	-	The completion of this measure is designated to private real estate owners. Some owners have completed the measure, others have not. The City acts as an enabler and provides assistance if needed.
Improving the Sizing of Loading Docks	The completion of this measure is designated to private operators and therefore the completion depends on the private operators	-	According to the City, this measure has not been monitored and therefore answering is difficult.
Development of Logistics Collaboration on Construction Sites	The completion of this measure is designated to private operators and therefore the completion depends on the private operators	-	According to the City, this measure has not been monitored and therefore answering is difficult.
Feasibility Assessment of Helsinki City Logistics Information System and Drafting an Implementation	The completion of this measure is designated to private operators and therefore the	-	According to the City, this measure has not been monitored and

Urban logistics related measures	Reasons that led to **delays** in the implementation of the measure	Main factors that **enabled** the successful implementation of the measure	Main factors that contributed to the **failure** of the measure's implementation
Plan, including System Implementation	completion depends on the private operators		therefore answering is difficult.

Annex 3
SWOT Analysis Online Questionnaire to the Starring and Following Living Labs

Annex 4
Innovation Readiness Tool

Annex 5
Descriptions of available datasets and tools at the Starring Living Labs

Ghent			
Type	**Source (Owner/ Provider)**	**Description**	**Additional info**
GIS/ Geospatial data	GIPOD (Digitaal. Vlaanderen)	This data provides comprehensive information on infrastructure works, public events, traffic disruptions, permits, work coordination, safety measures, environmental impacts, and public notifications that could be used for routing purposes in Ghent.	Near real-time GIS Open Data, can connect with their API (Access: https://www.vlaanderen.be/en)
Digitized Zoning & Land Use Regulations	Location Manager (BeMobile)	Provides detailed digital mapping of zoning and land use regulations in Ghent that will feed the UAC with the Access Rules information.	Data are retrieved by GIPOD. SULP/SUMP data are also going to be added manually from the City of Ghent. (Access: https://www.vlaanderen.be/en)
Traffic Data	TomTom Traffic Index	Live traffic data for Ghent, including travel times, speeds, congestion levels, cost, emissions, and alternative transport modes.	Real-time updated (Access: https://www.tomtom.com/traffic-index/ghent-traffic/)
Parking Occupancy	-	-	-
LSP Origin - Destination Data	Ghent Living Lab	Continuous data input. Bill of Loading includes information about the Origin and Destination of the freight vehicles.	Private data. It is under negotiation if the companies are going to share a sample dataset for the needs of the UFDS.
LSP Demand Data	Ghent Living Lab	Continuous data input. Bill of Loading.	Private data. It is under negotiation if the companies are going to share a sample dataset for the needs of the UFDS.
Underused/ Empty Spaces	not available data	not available data	not available data
LSP Order Tracking and Shipping Data	Ghent Living Lab	SETO Horizon Europe project will create a data management platform for using and controlling inland barging, combined with track & trace of goods. Partners OHB and VIL are in both projects,	-

	and the data from this project will be relevant to the DISCO project.	

Helsinki			
Type	**Source (Owner/ Provider)**	**Description**	**Additional info**
GIS/ Geospatial data	Helsinki City open GIS data & Finnish Transport Infrastructure Agency (City of Helsinki)	• The Helsinki Service Map provides internal and external datasets as map layers - city planning, public services, environmental areas. Could be used to feed with the relevant spatial information a Digital Twin. • From the Finnish Transport Infrastructure Agency's open data API, you can access comprehensive transport network data, including information on roads, railways, and waterways.	Near real-time GIS, can connect with their API (Access: https://www.hel.fi/en/decision-making/information-on-helsinki/city-maps-and-gis), (https://vayla.fi/en/transport-network/data/open-data/api)
Digitized Zoning & Land Use Regulations	Helsinki City open GIS data (City of Helsinki)	It includes datasets as map layers - zoning information, detailed land use plans and regulations, which are essential for urban development and planning. This information is useful for understanding the permitted uses of different areas, restrictions, and the future development plans of the city. Could be used to feed with the relevant spatial information a Digital Twin.	Near real-time GIS, can connect with their API (Access: https://kartta.hel.fi/paikkatietohakemisto/pth/?id=2)
Traffic Data	Digitraffic	Real-time road traffic data including weather conditions, traffic measurements, and forecasts for efficient traffic management in Finland.	Real-time updated, accessible via API. (Access: https://www.digitraffic.fi/en/road-traffic/#restjson--apis)
Parking Occupancy	Helsinki Region Infoshare (City of Helsinki)	A real-time REST interface that provides information on the parking situation in Helsinki. The interface provides the number of parking spaces currently in operation in the area concerned. The interface gathers information from parking ticket machines and all private mobile payment operators operating in Helsinki.	Data frequently updated and available via API. (Access: https://hri.fi/data/en_GB/dataset/rajapinta-helsingin-pysakointipaikkojen-kaytosta)
LSP Origin - Destination Data	A2B, DB (Helsinki	A2B's and DB Schenker's data that includes parcel pick-up locations, hub arrival and departure times, and journey timelines.	Private data. The companies are going to share a sample dataset.

	Living Lab)		
LSP Demand Data	Helsinki Living Lab	A2B's and DB Schenker's data that covers shipment weight, quantity of goods, vehicle types used, emissions data, and delivery success rates.	Private data. The companies are going to share a sample dataset.
Underused/ Empty Spaces	Not relevant to the LL's cases	Not relevant to the LL's cases	Not relevant to the LL's cases
LSP Order Tracking and Shipping Data	Not relevant to the LL's cases	Not relevant to the LL's cases	Not relevant to the LL's cases

Thessaloniki			
Type	**Source (Owner/ Provider)**	**Description**	**Additional info**
GIS/ Geospatial data	Sustainable Urban Development Observatory of Thessaloniki (Region of Central Macedonia)	The Region of Central Macedonia in Thessaloniki provides spatial data regarding demographics (age groups, income etc), population density	Open Static Data (CSV, KML, Zip, GeoJSON, GeoTIFF) which are updated in different frequencies. (Access: https://urbanlab.pkm.gov.gr/portal/apps/sites/#/home)
Digitized Zoning & Land Use Regulations	Open Data Thessaloniki (Municipality of Thessaloniki)	The WebGIS online platform provides geospatial data on zones in the Urban Agglomeration of Thessaloniki, including land use details and related restrictions.	Static data available in usual GIS formats updated regularly by the Municipality of Thessaloniki (Access: https://maps.thessaloniki.gr/public/)
Traffic Data	Thessaloniki Smart Mobility Living Lab (Hellenic Institute of Transport/ CERTH)	Data and services including real-time traffic information for cars and trains, short-term traffic condition predictions, mobility and activity pattern analyses, and extensive IoT equipment.	Provides real-time traffic information in Thessaloniki, Greece. It offers features such as live traffic updates, historical data export in CSV format, email alerts for slow traffic, and a map view. (Access: https://trafficthess.imet.gr/)
Occupancy Data	Not relevant to the LL's cases	Not relevant to the LL's cases	Not relevant to the LL's cases
LSP Origin-Destination Data	ACS (Thessaloniki Living Lab)	This type of data includes information about the store, the courier assigned for delivery, estimated timings for the start and end of the delivery route, receipt identification, the sequence of deliveries, estimated times of arrival and departure at destinations, the actual time of execution, designated ETA zones, delivery zones with specified start and end boundaries.	Near real-time private data

LSP Demand Data	ACS (Thessaloniki Living Lab)	This type of data includes the types of products being moved, the nature of the movement, reasons for any non-deliveries, and the actual sequence of operations.	Near real-time private data
Underused/ Empty Spaces	not available data yet	not available data yet	Near real-time private data
Order Tracking and Shipping Data			

Copenhagen			
Type	**Source (Owner/ Provider)**	**Description**	**Additional info**
GIS/ Geospatial data	Open Data DK (Copenhagen Municipality)	The City of Copenhagen's open data portal provides datasets, including CO2, traffic speeds, excavation permits, parking regulations.	Available in formats like GeoJSON, CSV, SHP, and PDF, with frequent updates. (Access: https://www.opendata.dk/city-of-copenhagen)
Digitized Zoning & Land Use Regulations	Open Data DK (Copenhagen Municipality)	The City of Copenhagen's open data portal provides datasets, including CO2, traffic speeds, excavation permits, parking regulations.	Data in GeoJSON, CSV, SHP, and PDF formats with frequent updates. (Access: https://www.opendata.dk/city-of-copenhagen)
Traffic Data	INRIX (Copenhagen Municipality)	Traffic data aiding Copenhagen's carbon neutrality efforts through ECO Driving, Traffic Signal Optimization, and the MobiMaestro traffic management system.	Real-time data provision (under contract with the Municipality of Copenhagen) (Access: https://inrix.com/case-studies/copenhagen-case-study/)
Parking Occupancy	Open Data DK (Bydata)	Datasets for parking counts, areas, zones, and garages relevant to parking occupancy and city logistics. Includes data on parking availability, regulations, and usage for effective urban planning. 6 Parking Apps are also available in the city that could be used to record occupancy rates.	Data in GeoJSON, csv, and shp formats. Frequent updates, available for API integration. (Access: https://www.opendata.dk/city-of-copenhagen)
LSP Origin-Destination Data	Copenhagen Living Lab	Continuous data input for the Origin and Destination of the freight vehicles	Private data. The companies are not going to share data. The data comes from internal agreements within the Living Lab.
LSP Demand Data	Copenhagen Living Lab	Data includes routes, travel times, transshipment points (with addresses/coordinates); package details (product category and volume); vehicle types used; and	Private data. The companies are not going to share data. The data comes from internal agreements within the Living Lab.

		distinctions between B2B/B2C deliveries.	
Underused/ Empty Spaces	Copenhagen Living Lab	Suggestions from the Green Mile Project as to where micro hubs can be placed in private spaces.	Report from Green Mile Project financed by the European Investment Bank
Order Tracking and Shipping Data	Copenhagen Living Lab	Data includes routes, travel times, transshipment points (with addresses/coordinates); package details (product category and volume); vehicle types used; and distinctions between B2B/B2C deliveries.	Private data. The companies are not going to share data. The data comes from internal agreements within the Living Lab.

Tools at Living Labs	
System/ Tool name	**Description**
The UAC System	The UAC System is the key component of Ghent's DISCO-X measures (DISCOPROXI, DISCOBAY), serving as the central operational node for these measures. **Core Components of the UAC system** The system consists of four main components: **Location Manager:** Operated by Be-Mobile, this is where the Sustainable Urban Mobility Plan (SUMP) and Sustainable Urban Logistics Plan (SULP) access rules are inputted on a 2D map. This tool will receive data manually from city administrators or automatically pull data from external sources like GIPOD, which lists temporary city obstructions such as construction works. **Transport Management System (TMS):** A Logistics Service Provider's TMS interfaces with the UAC, retrieving translated access rules and exchanging bills of loading (BoL), which contain detailed information about freight origins and destinations. **Route Planner:** Operated by Be-Mobile, this component, equipped with a traveling salesman plugin, uses OpenStreetMap (OSM) data to calculate the optimal delivery routes considering multiple drop-off points, access rules, and real-time obstructions. **Urban Access Control:** Central to the architecture of the system, the UAC receives and synthesizes the data from the Location Manager and TMS to enforce the city's access rules, ensuring that the planned freight movement aligns with the urban logistics policies and the infrastructure capacities of the City of Ghent. **The process that is followed now** The city's Access rules are pushed to the UAC and pulled by the TMS of the Logistics Service Provider. The TMS pushes the Bill of Loading (BoL) information to the UAC. The BoL is confirmed, ensuring that the proposed route is viable. The Route Planner receives these rules and calculates optimal routes. Final routes are provided back to the TMS of the LSP through the UAC for execution. **Data Utilization** **Real-Time Obstructions:** The UAC integrates data from GIPOD to account for real-time urban obstructions, adjusting routes to avoid construction sites or temporary blockages. **Access Rules:** SUMP and SULP data, which include regulations on urban freight access, are factored into route planning to ensure compliance with city policies such as low-emission zones and delivery time windows. **BoL Information:** Logistics information from the TMS, such as cargo details and specific delivery requirements, are incorporated into the route planning process.

	Optimal Route Calculation: With inputs from the TMS and Location Manager, the Route Planner devises efficient routes, maximizing delivery efficiency and minimizing disruptions. **Additional Features in the context of DISCO and UFDS integration** **Data Ingestion**: SULP data from City X and Ghent is ingested into the UFDS. This includes access rules and other regulatory information that governs freight movement within the urban space. **Smart Data Platform (Data translation):** Imec is involved in translating data to ensure compatibility with the UAC, enabling seamless integration of access rules and freight information into the system. **Green-Last Mile Service Offerings and Integration:** A dedicated website allows GLM providers to input their services, which can then be factored into the UAC for eco-friendly delivery options. Data regarding eco-friendly delivery options is inputted into the UFDS. **Routing and Analysis:** The UAC retrieves SULP data and alternatives from the UFDS to inform its route planning. Impact analysis is conducted within the UFDS, assessing the implications of routing decisions on urban traffic and logistics operations. **Route Planning:** The Be-Mobile route planner, in communication with the UAC, uses this data along with real-time traffic information and OSM data to calculate optimal routes. Delivery orders and preferences for Green-Last Mile (GLM) services are factored into the routing. **Execution and Feedback:** The LSP will receive emails with optimized planning, routing, and personalized GLM propositions (CO2-savings, cost-savings etc), either by using a GL Operator (DISCOPROXI) or a combination of waterway logistics and green modes (DISCOBAY). Data on delivery outcomes and route efficiency is fed back into the UFDS for ongoing analysis and optimization.
VFC of WareM&O	The Virtual Freight Center (VFC) system in Thessaloniki is set to be a central pillar in the city's DISCO-X measures (DISCOBAY, DISCOPROXI). **Core Components of the VFC system** The VFC system consists of three (plus one) key layers: **Presentation Layer/UI Layer:** This web-accessible layer is where users engage with the platform to offer or request storage space. Users can access and manage platform entities related to warehouses (including specific features, compartments, and availability), manage reservations, and utilize support tools like maps and reports. **Business Logic Layer:** This central layer executes the core logic and utilization of all platform entities. Implemented as a suite of services (REST API Layer), it facilitates the presentation layer's access to application data stored in the data layer. **Data Layer:** This layer is the repository for all application data.

An outer layer of the system is an external fair pricing calculation tool, developed by CERTH/HIT, interfaces with the VFC through a specified REST API, ensuring that fair pricing for storage space reservations can be determined independently of the platform and potentially reused in other contexts.

The VFC employed ASP.NET Boilerplate framework for its development, leveraging technologies such as JQuery, Bootstrap, JavaScript, HTML, OpenLayers, and Open Street Maps for the frontend. The backend, a Windows service, utilizes .Net MVC Core2.2, Swashbuckle AspNetCore Swagger, and ASPNET Boilerplate to manage user roles and access to application resources. The backend provides a REST API Layer for CRUD operations (Create, Read, Update, Delete) across all entities managed by the application.

The VFC's database is structured with a focus on the 'Warehouses' entity, which encompasses details about individual storage spaces and their specific features, such as size and special equipment. Each warehouse is segmented into 'Compartments', with attributes like capacity and availability being methodically tracked. The platform also records user data under the 'Companies' category, which represents the different stakeholders utilizing the VFC, and manages their interactions through the system. Moreover, the 'BookingRequests' entity is crucial as it facilitates the processing and tracking of space reservation requests from users, ensuring efficient transaction flow within the VFC ecosystem.

The process that is followed now

By the user (LSP): Upon registration or login, users search for warehouse space, applying filters as needed. Upon selection, the system checks and confirms availability. Users then book the available space, receive a booking confirmation, and manage the space, including logistics coordination and updates to usage or booking terms.

By the available warehouse space owner: After logging into the platform, the warehouse owner can view or edit details of existing spaces, add new warehouse capacities, and manage booking requests. They have the ability to approve or reject new bookings and monitor the specifics of confirmed reservations, ensuring effective utilization and oversight of their warehouse spaces.

Additional Features in the context of DISCO and UFDS integration:

Connection of the VFC to the Logistics Real Estate Database: The integration of all the available data sources of the city including dynamic data retrieved by online commercial real estate source and static data retrieved by surveys and the mapping process of underused spaces (Port Warehouses, Rail Station unused spaces) to the VFC. (DISCOPROXI, DISCOESTATE).

Real-Time Microhub and Locker Capacities: In the context of DISCOBAY, the VFC will dynamically reflect the capacities of microhubs and lockers, offering more granular control over space allocation in response to e-commerce demands.

FlexCurb	FlexCurb is a solution developed to transform curb management in urban environments. It's a response to the growing complexity of urban transportation and the need for smarter curbside planning. **Core Components of the FlexCurb system** The FlexCurb package consists of two primary components targeting different end-users: **Planning Platform for Cities:** This digital tool is designed for city administrators to digitize curb regulations, create a digital inventory of curb spaces, and manage them effectively. It allows for the visualization and analysis of curb space allocation, enabling cities to plan and make data-driven decisions that align with strategic urban goals, like reducing traffic congestion or prioritizing certain types of vehicles. **Driver App:** Aimed at commercial drivers, this mobile application provides real-time information about curb conditions and available spaces. It facilitates efficient logistics operations by allowing drivers to check the availability of loading parking spaces and to check in, which improves the efficiency of their operations. **Features related to DISCO measures** **Dynamic Zoning measures:** FlexCurb can be utilized for the creation of dynamic curb zones, which can adapt to different demand needs at different times of the day or week.
Tietorahti app	The Tietorahti app is a comprehensive mobile application designed for truck drivers in Finland to facilitate their navigation and logistics management. **Core Components of the FlexCurb system** The app was created by Tietorahti Oy, leveraging Esri's ArcGIS AppStudio. The information is presented to the drivers through a map-based interface where they can access information crucial for their journeys (different layers of information can be enabled). Drivers can view data on height and weight limits of bridges and roads, truck stops, repair shops, gas stations, and parking availability. **Features related to DISCO measures** Tietorahti's capabilities align well with the objectives of DISCO-X innovations like DISCOCURB and DISCOPROXI. The extensive data collection and visualization capabilities of the app can aid in efficient routing and road use optimization. Helsinki’s measure of DISCOCURB is around the implementation of a Dynamic Low Emission Zone which could be presented as a separate map layer in the Tietorahti interface.

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