D6.4 - Policy Package and Adoption Roadmap

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No. 101069782

URBANE

CIVITAS
Sustainable and smart mobility for all

Project & Document Information

Grant Agreement No	101069782	**Acronym**	URBANE
Project Full Title	UPSCALING INNOVATIVE GREEN URBAN LOGISTICS SOLUTIONS THROUGH MULTI-ACTOR COLLABORATION AND PI-INSPIRED LAST MILE DELIVERIES		
Call	HORIZON-CL5-2021-D6-01		
Topic	HORIZON-CL5-2021-D6-01-08	**Type of action**	IA
Coordinator	INLECOM INNOVATION		
Start Date	01/09/2022	**Duration**	42 months
Deliverable	D6.4	**Work Package**	WP 6
Document Type	R	**Dissemination Level**	PU
Lead beneficiary	POLIS		
Responsible author	Raffaele Vergnani		
Contractual due date	28/02/2026	**Actual submission date**	07/03/2026

Disclaimer and Acknowledgements

Funded by the European Union

This project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No 101069782

Disclaimer

Copyright message

Authoring, Revision & QA Information

Deliverable Contributors	
Contributor Name	**Organisation (Acronym)**
Raffaele Vergnani	POLIS
Alonso Davila Graf	POLIS
Yanying Li	ALICE
Pierre Roberts	ALICE
Jorge Velasco	CIDAUT
Blanca Yáñez Serrano	EIT UM
Zisis Maleas	CERTH
John Limaxis	INLE
Ioanna Fergadiotou	INLE

Version History				
Version	**Date**	**%**	**Changes**	**Author**
0.1	01/03/2023	5%	Initial ToC	VLTN
0.2	01/09/2024	10%	Chapter 2.4	POLIS
0.3	01/12/2025	40%	Chapters 3, 4, 5, 10, 11	POLIS, CERTH, ALICE, INLE
0.4	15/12/2025	50%	Chapter 8, Annex	CIDAUT, ALICE, EIT UM
0.5	25/12/2025	70%	Chapters 2.1-2.3, 5	INLE
0.6	03/03/2026	90%	Chapter 9	POLIS, INLE
0.7	09/02/2026	95%	Chapter 12, Executive Summary	POLIS
0.8	10/02/2026	95%	Review and restructuring	INLE
0.9	11/02/2026	98%	Chapter 7	INLE
0.9.1	18/02/2026	98%	Peer review	VLTN, CERTH
0.9.2	27/02/2026	99%	Revisions based on peer review feedback, Chapters 1.1-1.2	POLIS
0.9.3	28/02/2026	100%	Review, Addition of Chapter 6	INLE
0.9.4	06/03/2026	100%	Final Review	POLIS, VLTN
1.0	07/03/2026	100%	Final proof reading and submission	INLE

Executive summary

URBANE addressed a key challenge for European cities, how to make last-mile logistics greener, smarter, safer and more efficient while maintaining service quality and urban liveability. Through four Lighthouse Living Labs, two Twinning Living Labs and six Follower Cities, the project tested a portfolio of physical and digital solutions. These included shared micro-hubs and parcel lockers, cargo-bike and low-emission delivery models, autonomous delivery vehicles, Digital Twin and AI-enabled planning tools, and trusted collaboration mechanisms such as smart contracts.

This deliverable (D6.4) presents the Policy Package and Adoption Roadmap developed under Task 6.4, translating project evidence into actionable guidance for cities, operators, technology providers and policymakers.

It shows that scaling sustainable urban logistics depends not only on technology, but on enabling conditions such as clear governance and regulatory pathways, access to urban space, interoperable data frameworks, viable business models, capacity building and user acceptance.

The deliverable provides recommendations by governance level and innovation area, links them to standardisation and interoperability needs, and proposes a phased, readiness-based adoption roadmap, supported by the URBANE Impact Assessment Radar and transferability tools, to help cities move from pilots to durable implementation embedded in SUMP/SULP and local policy processes.

Contents

List of Figures

List of Tables

Glossary of Terms and Acronyms

Acronym / Term	Description
3PLs	Third-Party Logistics
ADV	Autonomous Delivery Vehicle
CCAM	Cooperative, connected and automated mobility
DT	Digital Twin
EDV	Electric Delivery Vehicle
EGUM	Expert Group on Urban Mobility
EU	European Union
GA	Grant Agreement
GDPR	General Data Protection Regulation
ITS	Intelligent Transport Systems
KPI	Key Performance Indicator
LEZ	Low-Emission Zone
LL	Living Lab
LSP	Logistics Service Provider
LTZ	Low-Traffic Zone
PI	Physical Internet
PPP	Public-Private Partnership
RFID	Radio Frequency Identification
SME	Small and Medium Enterprise
SUMP	Sustainable Urban Mobility Plans
SULP	Sustainable Urban Logistics Plans
UCC	Urban Consolidation Centre
WP	Work Package
ZEZ	Zero Emission Zone

1 Introduction

Urban freight transport is undergoing rapid transformation, driven by the growth of e-commerce, increasing congestion, environmental pressures, and the need for more resilient and sustainable city logistics systems. The URBANE project addressed these challenges by developing and demonstrating innovative last-mile logistics solutions across six European cities through Living Labs (LLs) operations. These solutions integrate new delivery concepts, advanced digital technologies and services, and sustainable vehicle systems.

The project is structured around two waves of Living LLs:

Wave 1 LLs

- Helsinki (Finland): Deployment of Autonomous Delivery Vehicles (ADVs) and Digital Twin (DT) technology supporting low-emission zones.
- Bologna (Italy): Implementation of micro-hubs and light electric delivery vehicles (EDVs) for zero-emission last-mile logistics.
- Valladolid (Spain): Introduction of fully electric fleets equipped with solar panels and Cooperative, Connected and Automated Mobility (CCAM) capabilities.
- Thessaloniki (Greece): Adoption of hub-and-spoke delivery models supported by DTs and AI-driven routing systems.

Wave 2 LLs

- Barcelona (Spain): Automated routing in cycle logistics supported by RFID technology.
- Karlsruhe (Germany): Intermodal logistics solutions combining ADVs with rail-based parcel transport.

A Follower Cities layer (Aarhus, Antwerp, Mechelen, La Rochelle, Prague 6, and Ravenna) (Wave3) assessed the feasibility of adopting selected innovations and digital tools developed in Wave 1 LLs, converting project knowledge into actionable local adoption pathways.

URBANE delivered solutions that enhance the efficiency, sustainability, and collaboration of urban freight operations through integrated interventions tested in real-life environments. The project adopted a systemic approach that combined physical infrastructure, digital intelligence, next-generation vehicles and governance enablers into a cohesive urban logistics ecosystem. Each LL has demonstrated the potential to reduce emissions, improve operational efficiency, and enhance stakeholder collaboration. The results highlight the scalability and transferability of URBANE's solutions across diverse urban contexts.

This deliverable, developed under Task 6.4 – *Policy Package and Adoption Roadmap* within WP6 *Upscaling and Policy Making*, builds on the insights generated by the LLs and the expertise of project stakeholders. It presents a structured set of policy recommendations designed to promote the adoption and upscaling of URBANE solutions by cities and regions seeking to modernize their logistics systems.

The goal of the document is to support the transition toward greener, more resilient urban logistics by providing a practical blueprint for innovation that prioritises sustainability, efficiency, and inclusivity. It offers tailored recommendations for local and regional authorities, industry actors, and policymakers, directly addressing the regulatory, technological, and operational barriers that often hinder progress in urban freight transport.

1.1 URBANE Outputs Mapping to GA Commitments

TABLE 1 - DELIVERABLE ADHERENCE TO GRANT AGREEMENT DELIVERABLE AND WORK DESCRIPTION

URBANE GA Item	URBANE GA Item Description	Del. Chapter(s)	Justification
DELIVERABLE			
D6.4 Policy Package and Adoption Roadmap	Toolkit for to design new eco-friendly delivery solutions, standardisation and policy recommendations	*Chapters 8–11 consolidate policy package, standardisation inputs, solution-based actions and an adoption roadmap grounded in URBANE evidence and transferability work.*	
TASK			
ST6.4.1 Policy Dialogues	This subtask will organise policy dialogues with local politicians and relevant EU institutions about the role of EU policy for urban freight planning and innovation upscale. This is relevant in the framework of EU legislation currently under revision that will need to be deployed when the project will start, such as the Urban Mobility Framework, TEN-T Guidelines, Alternative Fuel Infrastructure Directive, and the Smart and Sustainable Mobility Strategy. POLIS, ALICE and EITUM will capitalise on their respective political and thematic working groups as well as their direct connections with EU institutions.	*Chapters 7.1–7.2*	*Chapter 7 summarises the policy-dialogue process and its outputs (CIVITAS policy group engagement) and links these insights to adoption conditions. The methodological framing is described in 2.4.*
ST6.4.2 Contribution to Standardisation	This subtask will conduct elicitation of safety, security, cybersecurity concerns raised during the LLs implementation, and will propose measures to secure personal and commercially sensitive data. It will also define and implement a coordinated set of actions to identify results that are suitable for standardisation (applied DTs, smart contracts, models integration) into the most relevant standardisation bodies (e.g. ISO, CEN etc.).	*Chapters 8.1 –8.5*	*Chapter 8 provides the standardisation/interoperability analysis (incl. workshop insights and gap analysis) and identifies priority actions for relevant standardisation stakeholders.*
ST6.4.3 Policy Recommendations and Adoption Roadmap	This subtask will consolidate outcomes and lessons learned from the LLs and feedback collected from user acceptance tests during discussions with the broader URBANE community (AB, Stakeholders, citizens, technology providers, etc.) and consolidate them in	*Lessons described in Chapters 5–11* *Recommendations in Chapter 9–10*	*Chapters 9–11 consolidate lessons from LLs/follower cities into actor-based and solution-based recommendations and a phased, readiness-based adoption roadmap, including SULP integration guidance.*

URBANE GA Item	URBANE GA Item Description	Del. Chapter(s)	Justification
	practical guidelines for the co-design of new eco-friendly delivery solutions, employing DTs and blockchain technology. Shortcomings of the applicable regulatory framework, as well as market or other barriers for the project, will be identified and practical solutions will be put forward. Recommendations will refer to ethics considerations, data requirements, simplification, and harmonisation of the regulatory framework associated with URBANE's focus areas and interventions necessary for the integration of novel models in SUMPs/SULPs and the take-up of green delivery solutions in European cities and businesses.	*Adoption Roadmap in Chapter 11*	

1.2 Deliverable Overview and Report Structure

This deliverable is designed to provide both comprehensive insights and practical guidance for stakeholders.

Chapter 2 sets out the policy context for green urban logistics and summarises the methodological pillars used to derive actionable policy insights.

Chapter 3 describes URBANE's main solution domains and innovation areas.

Chapter 4 provides comparative insights from related EU-funded projects and initiatives, organised around common themes to position URBANE findings within the wider European knowledge base.

Chapter 5 presents evidence and lessons learned from the URBANE Lighthouse and Twinning Living Labs and the follower-city feasibility work, providing the empirical basis for the recommendations that follow.

Chapter 6 synthesises URBANE's findings on the main barriers to upscaling and adoption, structured across regulatory/ governance issues, operational/organisational constraints, market and business conditions, data and interoperability barriers, safety and cybersecurity, behavioural factors and transferability constraints.

Chapter 7 summarises the key insights from policy dialogues, particularly through URBANE's engagement in the CIVITAS Urban Logistics Cluster policy work.

Chapter 8 addresses standardisation and interoperability as enabling conditions for scale-up, drawing on the PI perspective, the International Expert Workshop, and URBANE's gap analysis of standardisation needs. **Chapter 9** presents the policy package organising recommendations by governance level and stakeholder group.

Chapter 10 provides solution-based and operations-focused recommended actions by innovation area. **Chapter 11** sets out the adoption roadmap, including readiness dimensions, phased adoption, and practical guidance on integrating URBANE solutions into SUMP/SULP and local policy processes.

The **Annex** contains a short description of the proposed business models for the URBANE Lighthouse LLs.

2 Policy context for green urban logistics in Europe

2.1 Urban freight challenges and the need for policy action

Urban freight is becoming a central policy issue for European cities because last-mile logistics is under growing pressure from e-commerce growth, increasing delivery volumes, congestion, environmental targets, and the scarcity of urban space. Fragmented delivery flows, low asset utilisation, weak data availability, and the limited coordination between public authorities and private operators make conventional urban logistics models increasingly difficult to sustain.

The policy relevance of urban freight is further reinforced by the URBANE results, implying that many of the solutions tested (micro-hubs, parcel lockers, low-emission fleets, DTs, routing optimisation, smart contracts, and autonomous delivery systems) cannot scale through market forces alone. Their deployment depends on public decisions about land use, permits and access regulation, curbside allocation, data governance, procurement, and integration with broader city planning. URBANE's LLs showed that the most important barriers are often not technological but institutional such as lack of suitable space, unclear rules for innovative vehicles and infrastructure, non-standardised data-sharing frameworks, and uncertainty over viable business models beyond pilot funding. For this reason, policy action is needed to actively enable transition. Policy can become a catalyst for adoption, replication, and long-term take-up of collaborative, greener last-mile delivery solutions across European cities and businesses.

The European policy context shaping URBANE cover several policy frameworks relevant to urban freight planning and the upscaling of innovation (the Urban Mobility Framework, TEN-T Guidelines, the Alternative Fuel Infrastructure Directive, the Smart and Sustainable Mobility Strategy). These frameworks influence how cities plan access, infrastructure, decarbonisation pathways, digitalisation, and the interaction between local last-mile logistics and wider transport networks. URBANE positioned green urban logistics at the convergence of several policy priorities including decarbonisation, digital transition, urban resilience, interoperability, and inclusive planning. The project's LLs combined physical interventions, digital services, innovative vehicles and collaborative business models. Implementation results within the LLs suggest that future regulation and support schemes should avoid siloed approaches. Urban freight policies that only focus on vehicle technology, for example, are unlikely to deliver full impact if they are not accompanied by supportive infrastructure, interoperable digital tools, and governance arrangements between cities and operators.

The wider CIVITAS and clustering activities also showed that URBANE is not operating in isolation, but as part of a broader European effort to create common approaches for urban freight innovation. Through the CIVITAS Urban Freight and Logistics Cluster, URBANE contributed to discussions structured around three strategic themes (public-private cooperation, data governance and digital infrastructure, and incentivising consumer behaviour and retail activities in e-commerce). These themes move the policy debate beyond technology deployment and towards the governance conditions needed for scale.

2.2 Relevance for SUMPs and SULPs

A central policy message emerging from URBANE LLs is that innovative freight solutions need to be integrated into formal urban planning instruments rather than remaining stand-alone pilots. This planning perspective is also confirmed by the follower-city work under Task 6.3. The feasibility studies showed that cities differ significantly in their level of maturity; some already have logistics strategies or infrastructure in place, while others are still preparing their first SULP. This diversity implies that adoption pathways must be sensitive to local readiness. For some cities, the immediate priority may be data collection, stakeholder mapping, and governance set-up, whilst for others, it may be scaling an existing micro-hub network, regulating locker deployment, or formalising city-operator collaboration. Therefore, SUMPs and SULPs could provide the planning architecture needed to connect experimentation to implementation.

URBANE's own evidence suggests that embedding freight in SUMP/SULP processes helps address one of the most persistent weaknesses of urban logistics policy, the treatment of freight as a secondary issue compared with passenger mobility. The project's city-platform and CIVITAS activities repeatedly highlight the need to discuss logistics together with public-space allocation, cycling infrastructure, neighbourhood services, decarbonisation, and broader urban functionality. Examples such as hub-and-spoke systems, micro-fulfilment centres in public space, cargo-bike-based deliveries, and shared neighbourhood hubs illustrate that freight planning increasingly overlaps with land-use planning, climate planning, and multimodal urban design.

2.3 URBANE's policy ambition within the wider EU innovation landscape

URBANE's contributions go beyond documenting pilot results. The project aimed to transform LL experience into policy-relevant guidance for a broader community of cities, operators, and European stakeholders. Adoption feasibility studies, policy dialogues, standardisation work, and the policy package are connected as parts of a practical upscale pathway. The Advisory Board, follower-city work, liaison with other initiatives and the development of the transferability platform all intended to support take-up, validation, and replication.

The CIVITAS dimension is particularly important. URBANE has contributed to the CIVITAS Freight and Logistics Cluster and to joint city-platform activities that aimed to transfer innovations from one urban context to another. These activities strengthen the legitimacy of the policy recommendations by anchoring them in peer exchange and cross-project learning (e.g. with GREEN-LOG and DECARBOMILE). They will also help identify which issues are repeatedly emerging across projects and cities, such as the need for neutral governance models for shared assets, comparable urban freight data, incentives for public-private cooperation, and practical mechanisms to influence consumer choices.

Another URBANE's policy ambition is its link to standardisation and interoperability. The project's work in these areas (see also D6.2 Liaison with other initiatives, Advisory Board) contributed to creating the conditions for scaling urban logistics innovation beyond the boundaries of individual research projects, by supporting common approaches to digital integration and data exchange.

2.4 Methodological approach to delivering actionable policy insights

The policy recommendations developed within the URBANE project are based on a structured review and synthesis process combining policy analysis, empirical evidence, and alignment with European initiatives. The methodology consists of four pillars:

The **first pillar** involved a systematic review of foundational policy documents and current literature. This ensured alignment with European mobility directives and sustainable urban logistics planning (SULP) guidelines. This pillar included alignment with the work of the Expert Group on Urban Mobility (EGUM) (Recommendations on Urban Logistics, Directives analysis and outputs from EGUM Subgroup 4). This ensures consistency with EU priorities on decarbonisation, digitalisation, and integrated urban mobility planning.

The **second pillar** incorporated a comprehensive review of past European research projects to build upon existing knowledge. Researchers examined the final reports and policy briefs of relevant initiatives. This comparative analysis identified recurring logistical challenges, technological trends, and successful policy interventions. This step prevents duplicated efforts and enhances the robustness of the URBANE recommendations.

The **third pillar** synthesised the lessons learned and crystallised the knowledge generated directly by the URBANE activities. Findings from the URBANE LLs were analysed to extract practical lessons, identify implementation barriers and enablers, and assess transferability across different urban contexts. Extracting these practical insights grounds the policy recommendations in proven, replicable project outcomes.

The **fourth pillar** was the strategic alignment with the CIVITAS Urban Freight and Logistics thematic cluster. Researchers mapped the drafted recommendations against the cluster's strategic goals, ensuring coherence, complementarity, and contributing actionable insights to the broader European community of practice.

Therefore, the resulting recommendations reflect a synthesis of strategic policy direction, practical experimentation, accumulated research evidence, and cross-project collaboration.

3 URBANE solutions and policy-relevant innovation areas

3.1 Overview of the URBANE intervention logic

URBANE was designed as a European innovation and demonstration action addressing the transition towards more sustainable, safe, resilient and efficient last-mile logistics. The project combined real-life demonstrations, digital tools, governance innovation and replication activities to support wider uptake across European cities. The project followed a delivery logic based on four Lighthouse LLs, two Twinning LLs and six Follower Cities, supported by an Innovation Transferability Platform and a set of exploitation, policy and standardisation activities. This intervention logic is important from a policy perspective because URBANE did not treat urban logistics innovation as a purely technical matter. Rather, it addressed last-mile delivery as a system shaped by physical infrastructure, operational processes, data-sharing arrangements, public-private coordination and local planning conditions. The project therefore linked demonstration activity with transferability, adoption feasibility, commercialisation and policy learning. In practice, the project did not only validate innovative solutions in the original LLs, but also tried to understand the conditions under which such solutions may be adapted, replicated and embedded in new urban contexts. The project tested how innovative last-mile solutions can be deployed in real operational settings, supported by digital and governance tools, and then transferred through structured methodologies and tools to other cities and market actors. This chapter presents the tested solutions and innovation domains in a form directly relevant to the policy package, providing the basis for the recommendations developed in later chapters.

3.2 Lighthouse and Twinning Living Labs

The project's demonstrations were organised around two layers. The first consists of four Lighthouse LLs in Helsinki, Bologna, Valladolid and Thessaloniki. These LLs were established as the primary environments in which the project's Wave 1 solutions could be developed, tested and refined in real-life conditions. They represent the core innovation sites from which technical, operational and governance lessons have been generated. The second layer consists of two Twinning LLs, in Barcelona and Karlsruhe. Their purpose was not simply to reproduce Lighthouse activities, but to assess the transferability and replicability of URBANE solutions in different urban contexts, with different priorities. The transferability work undertaken in these cities confirms that replication is not a process of direct copying. Rather, it requires adaptation to local governance structures, market conditions, spatial characteristics, infrastructure constraints and digital readiness. The Wave 2 work therefore focused on validating a structured transferability framework capable of supporting context-sensitive uptake. The Twinning LL experience is particularly relevant for the policy package because it demonstrates that successful uptake depends less on the maturity of a technology than on the degree of alignment between the innovation and the receiving city's ecosystem (readiness level). The transferability framework developed by URBANE is organised around six areas, aiming to provide a bridge between local demonstration results and broader policy guidance: contextual fit and ecosystem readiness; knowledge and data integration capacity; model and planning method transferability; technological and process interoperability; impact and KPI harmonisation; and adoption, scalability and long-term viability.

Further, the LL approach combined technical validation with stakeholder engagement and user acceptance. The LLs brought together municipalities, operators, retailers, citizens and technology providers in real operational settings. This allowed project partners to assess whether a solution worked technically, but also whether it was accepted, governable and scalable.

3.3 Follower cities and the transferability dimension

The six Follower cities (Aarhus, Antwerp, Mechelen, La Rochelle, Prague 6, and Ravenna), constitute the third layer of the URBANE intervention logic and played a central role in the project's upscaling strategy. Through Task 6.3, they were asked to assess the feasibility of adopting selected innovations and digital tools developed in the Wave 1 LLs. This process was designed to ensure that cities not directly involved in the first demonstration cycle could nevertheless benefit from the project's knowledge base and convert that knowledge into actionable local pathways for adoption.

The follower-city process combined peer learning, structured guidance and direct exchanges with the LLs. The cities were first invited to analyse the status of urban freight in their own contexts, identify local priorities, and match these priorities with URBANE solutions. This was followed by a series of deep-dive meetings, group exchanges and methodological support sessions. In addition, the follower cities were progressively introduced to the project's core digital tools, including CitIQore, Smart Contracts and the Impact Assessment Radar, which are main components of the Innovation Transferability Platform.

The resulting feasibility studies showed that the follower cities are interested in a wide range of solutions, including ADVs, shared parcel lockers, peripheral and neighbourhood micro-hubs, and cargo-bike-supported delivery models. Importantly, these studies did not only assess technical feasibility. They also considered regulatory, operational, governance and funding conditions, thereby providing a realistic picture of what adoption would require in each local context. This makes the follower-city work highly relevant to policy recommendations.

3.4 Core innovation domains addressed by URBANE

3.4.1 Shared urban logistics infrastructure

One of the principal innovation domains addressed by URBANE concerned shared logistics infrastructure, particularly micro-hubs and parcel lockers on public space. These solutions responded directly to challenges such as fragmented last-mile operations and low asset utilisation. They promoted consolidation, proximity to the customer and shared use of infrastructure, eventually reducing vehicle kilometres and improving the use of scarce urban space. The policy relevance of this domain is particularly strong. Shared hubs and locker systems require access to land, permissions for installation from city authorities, coordination across multiple operators, and in many cases a neutral governance arrangement capable of ensuring fair access and long-term viability. The follower-city work also confirmed that cities view these solutions as attractive, but challenging to implement, particularly where land use, ownership, competition issues or planning processes create barriers. For this reason, shared infrastructure is a key field for urban policy and public-private cooperation.

3.4.2 DTs, modelling and AI-enabled planning

Another core innovation domain concerns the use of DTs, simulation models, routing algorithms and AI-enabled planning tools to support urban logistics decision-making. The project's digital infrastructure includes an open DTs environment and the simulation CitIQore application, an open models' library, AI-driven services and algorithmic tools for route optimisation, planning support and impact estimation. These tools can both improve operational efficiency and enable better planning and policy decisions.

The transferability work demonstrates that these tools are particularly valuable because they help cities and operators assess future scenarios, test alternative configurations and estimate impacts before large-scale implementation. In this sense, they function both as technical optimisation tools and as policy support instruments. They can help decision-makers identify the conditions under which a solution is likely to work, compare baseline and post-implementation scenarios, and understand which changes are likely to produce the greatest environmental or operational benefits.

From a policy perspective, this innovation domain raises important issues of data quality, interoperability, technical capacity and access to modelling expertise. Not all cities are equally prepared to use all of the tools effectively, and the follower-city material suggests that digital readiness varies considerably across contexts. Accordingly, the successful uptake of DTs and AI-based planning tools depends on their technical robustness, but also on capacity-building measures that support their use in city administrations and local logistics ecosystems.

3.4.3 Data sharing, smart contracts and collaboration governance

URBANE introduced innovation in collaboration governance, including data exchange, consensus protocols and smart contracts. The project recognised that one of the main barriers to more efficient and sustainable urban logistics lies in the fragmentation of actors and the absence of trusted mechanisms for cooperation. Operators, cities, retailers and infrastructure owners often have different interests, limited incentives to share data, and concerns regarding confidentiality, liability and sharing business-sensitive information. Governance innovation is a necessary complement to physical and digital innovation. The development of the collaboration governance ledger and smart-contract-based approaches intended to support more transparent, reliable and scalable forms of coordination. These tools help define roles, automate agreed procedures, improve trust between actors and create clearer rules for access and service provision in shared delivery environments. Their policy significance lies in their function as building blocks for more formalised and interoperable urban logistics ecosystems, particularly where public authorities wish to encourage shared assets, fair market access and more accountable operational arrangements. This innovation area raises clear regulatory and ethical questions. Data protection, cybersecurity, commercial confidentiality and accountability arrangements are highly relevant where data-driven collaboration and automated agreements are involved.

3.4.4 Autonomous and low-emission last-mile solutions

URBANE explored the use of ADVs, collaborative delivery with light electric delivery vehicles, delivery with fully electric vehicles equipped with solar panels, and digital-as-a-service delivery with AI-enabled automated routing in cycle logistics. The policy significance of these solutions is considerable, as their deployment depends on local regulatory frameworks governing access, safety, vehicle use, interactions with pedestrians and cyclists, and integration with public space. The follower-city feasibility studies illustrate this clearly. Antwerp explored the adoption of ADVs, while other cities assessed combinations of cargo-bike delivery, micro-hubs and shared locker systems. In each case, the feasibility discussion extended beyond technology to include questions of regulation, governance, operations and public acceptance. This innovation domain is central to the policy package because it offers pathways to emission reduction, but also highlights the need for adaptive local regulation. Where conventional freight rules do not fit new delivery models, cities and national authorities may need to revise permitting schemes, test new operational zones, clarify liability and safety arrangements, and support experimental deployment under controlled conditions. URBANE's demonstrator portfolio provides a concrete basis for such discussion.

3.4.5 Consumer-facing delivery innovation and behaviour change

The last innovation domain concerns the interface between logistics systems and end users, including delivery convenience, acceptance of new service models, and the role of consumer behaviour in shaping last-mile demand. URBANE's work and related CIVITAS Urban Freight and Logistics Cluster policy discussions indicate that user expectations, retailer practices and communication strategies are important determinants of whether sustainable delivery models can scale. This is particularly relevant for shared delivery infrastructure, low-emission delivery windows, and alternative collection models such as parcel lockers and hub-based deliveries. The LL activities in URBANE allowed end users, citizens and stakeholders to be involved in the testing and refinement of innovations in real-world conditions. Co-creation activities can improve transparency and trust, and help aligning commercial solutions with broader public objectives towards improved accessibility and quality of life. These social and behavioural dimensions are not less important, but form part of the conditions for effective deployment. Therefore, the transition to greener urban logistics cannot rely solely on supply-side measures. It also requires communication, incentives, and regulatory frameworks that shape demand and support the adoption of sustainable delivery options by retailers and consumers. This is consistent with URBANE's contribution to the wider CIVITAS discussions, where consumer behaviour and e-commerce practices were identified as one of the three main policy themes requiring coordinated action.

4 Insights from related EU-funded projects & initiatives

4.1 Common urban logistics themes

The following section is a review of several previous EU-funded projects addressing similar themes to URBANE. The analysis included reviewing reports and material from the projects below:

- SPROUT (Sustainable Policy RespOnse to Urban mobility Transition),
- LEAD (Low-Emission Adaptive last mile logistics supporting 'on Demand economy' through DTs),

- MOVE21 (Multimodal and interconnected hubs for freight and passenger transport contributing to a zero emission 21st century),
- URBANIZED (modUlaR and flexible solutions for urBAN-sIzed Zero-Emissions last-mile Delivery and services vehicles),
- ULAADS (Urban Logistics as an on Demand Service),
- GREEN-LOG (Cooperative and Interconnected Green delivery solutions towards an era of optimised zero emission last-mile Logistics)
- DISCO (Data-driven, Integrated, Syncromodal, Collaborative and Optimised urban freight meta model for a new generation of urban logistics and planning with data sharing at European LLs
- DECARBOMILE (Five pillars to DECARBOnize the last MILE logistics
- UNCHAIN (Urban logistics and plaNning: AntiCipating urban freigHt generAtion and demand including dIgitalisation of urbaN freight).
- IKIGAI (Physical Internet and the Key steps to Innovation-driven supply chain transformation towards Green, Affordable, scalable and collaborative Zero-EmIssions Freight Transport solutions).

The analysis is paired with contributions from the Expert Group on Urban Mobility's (EGUM) recommendations to provide a well-rounded review of evidence. This review is structured in four categories (Regulations – Legal frameworks, Data Governance & Digital Infrastructure, Governance – Stakeholder cooperation, Business models – Market entry), each with their own subtopics and themes (Table 2).

TABLE 2 - URBAN LOGISTICS THEMES EXPLORED IN EU-FUNDED PROJECTS

	EGUM	SPROUT	LEAD	MOVE21	URBANIZED	UNCHAIN	ULAADS	GREEN-LOG	DECARBO MILE	DISCO	IKIGAI
Regulations and legal framework											
GDPR – CCTV cams	X										
SULPs, ZEZ/LTZ/LEZ	X	X	X	X	X	X	X	X	X	X	
Use of public space	X	X		X	X		X	X		X	
Bureaucracy, permits, licenses		X		X	X	X	X				
Standardisation	X	X			X				X	X	X
ESG reporting directives	X										X
Data Governance & Digital Infrastructure											
Digital Twins			X								
Smart Contracts											X
Data collection, management, sharing	X			X	X	X	X	X	X		
Data Spaces						X		X	X	X	X
Governance – Stakeholder cooperation											
Shared microhubs multistakeholder collaboration	X	X		X	X			X			
Contracts, guidelines, MoU, tenders		X		X							X

	EGUM	SPROUT	LEAD	MOVE21	URBANIZED	UNCHAIN	ULAADS	GREEN-LOG	DECARBO MILE	DISCO	IKIGAI
Stakeholder engagement – accountability	X	X	X			X			X		
Political will										X	
Business models – Market entry											
Operating models for city logistics										X	
Incentives	X	X		X	X		X	X	X		
Consumer/user behaviour – acceptance of innovations	X	X	X	X	X	X	X	X	X		

4.1.1 Regulations and legal framework considerations

GDPR – CCTV cameras

The General Data Protection Regulation (GDPR) is the European Union law that governs how personal data is collected, processed, and stored within the EU. When applied to CCTV camera feeds used in urban logistics (for example for monitoring loading zones, warehouses, or delivery routes), GDPR means that any footage capturing identifiable individuals (drivers, pedestrians, employees) counts as personal data. For this topic, the EGUM's "Recommendations on Urban Logistics, Expert Group on Urban Mobility subgroup 4, Sustainable urban logistics planning (SULP)" document, highlights that an EU-wide strategy regarding data collection applied to big businesses would allow stakeholders to circumvent the typical issues associated with the traditional case-by-case approach of public-private agreements such as GDPR, sensitivity, and competition[1]. This is particularly relevant to policy design, as public authorities need to ensure that urban logistics measures relying on CCTV or similar monitoring technologies are supported by clear legal bases, transparent governance arrangements, proportional data-use rules, and privacy-by-design safeguards that ensure compliance with data-protection obligations.

Sustainable Urban Logistics Plans (SULPs), Zero-Emission Zones (ZEZ), Low-Traffic Zones (LTZ) and Low-Emission Zones (LEZ)

The EGUM recommendations point out the utility of SULPs in pushing for more energy-efficient cities using existing technologies, but emphasises they need to cast a wider net with regard to transport of larger freight (such as waste) and need to implement the regulations outlined in SULPs in a rigid manner to ensure unified logistics operations; this should be accompanied by the implementation of a developed energy provision network for new zero-emission vehicles put into service by the SULP[2] [3]. Outputs from SPROUT, LEAD, MOVE21, URBANIZED and ULAADS all align with these points, specifically with SULPs utility in implementing new technologies and new partnerships. More specifically, outputs from SPROUT and MOVE21 focus on the implementation of multimodal hubs/mobility hotels to accommodate newly implemented sustainable vehicles mandated within SULPs, serving as multifunctional spaces that serve both service providers and the wider public[4] [5]. LEAD and URBANIZED place particular focus on the importance of the involvement of a variety

[1] EGUM Recommendations on Urban Logistics, Expert Group on Urban Mobility subgroup 4, SULP, p.8
[2] EGUM Recommendations on Urban Logistics, Expert Group on Urban Mobility subgroup 4, SULP, p.7
[3] EGUM Recommendations on Urban Logistics, Expert Group on Urban Mobility subgroup 4, SULP, R2.1 p.10
[4] SPROUT D7.1 SUMP-based policy response, p.70.
[5] MOVE21, Upscaling Plan And Transferability Assessment – Governance, Project deliverable D4.3, p.42

of experts in the design, evaluation and regular fine-tuning of SULPs; this should be done through the combination of SUMPs with SULPs and across implementation of evaluation metrics and KPIs, which can provide an opportunity to disseminate best practices to stakeholders within the EU[6] [7]. In combining SULPs and SUMPs, a cross-sectoral framework spanning several levels of governance needs to be implemented to promote sustainability and improved efficiency. This is a complex task due to the involvement of a wide range of stakeholders which need to be coordinated[8]. ULAADS highlights the need for SULPs to be designed in a flexible manner with a consideration for uncertainties, allowing them to be adaptable to change thus empowering cities to remain resilient to the unpredictable landscape of urban logistics[9] [10].

Use of public space

The most important challenge when considering the use of public space regarding logistics is its availability, which requires a rethinking of the ways by which we approach its organisation. A general agreement between all projects that address this topic (SPROUT, MOVE21, URBANIZED, DISCO) is that there is a need for rethinking the usage of public space towards shared usage models. This is achieved through the transition from individual vehicles to shared micromobility, by identifying local needs and regulations linked to implementation of new usages of public space (such as microhubs or mobility hotels), and by finding and repurposing unused/underused spaces (and, if needed, approaching private stakeholders such as housing associations and car parks)[11] [12]. These fall within the context of the recently adopted revision of the TEN-T Directive which requires urban areas to have at least one multimodal freight terminal by 2040, which should be compliant with regional, national, and TEN-T scale regulations[13]. This underlines the importance of logistics within the development of future urban fabric, meaning regulations for access and usage need to be carefully thought out and enforced to prevent wrongful exploitation of these spaces[14].

Bureaucracy, permits, licenses

Most of the projects emphasise a similar line of thought regarding this subtopic. This is most evident with regards to the importance of legal/regulatory frameworks, that are specifically well-rounded and robust – it is noted that enforcement is one of the most important aspects to the efficiency of these frameworks in enacting sustainable logistics solutions[15] [16]. Crucially, to bypass bureaucratic complications when attempting to implement solutions, it is important to be aware of the various duties and operations of every department inside organisations linked to the application of the frameworks and associated solutions. It is suggested that assigning specific roles to members to bridge gaps between departments and to create collaborative teams that cut across different parts of the organisation would help break down silos and encourage more cohesive work, a task which should be facilitated by innovation leaders and middle managers to ensure smooth

[6] LEAD D4.6: Roadmap and Policy Recommendations, p.31
[7] URBANIZED D7.4: Knowledge transfer performed across missions and use cases replicability guidelines, p.23, p.26
[8] ULaaDS D6.2: Guidelines, methods & policy recommendations to integrate ULaaDS in SUMP and SULP processes, p.17, p.31
[9] ULaaDS D6.1: Typology of uncertainties in policy making and urban planning for sustainable urban logistics, p.26
[10] ULaaDS D6.2: Guidelines, methods & policy recommendations to integrate ULaaDS in SUMP and SULP processes, p.47
[11] *PROUT D7.2 Urban Agenda policy briefs, p.16; MOVE21 Upscaling Plan And Transferability Assessment – Governance, Project deliverable D4.3, p.22, p.42*
[12] *URBANIZED D7.4: Knowledge transfer performed across missions and use cases replicability guidelines, p.23*
[13] *GUM Recommendations on Urban Logistics, Expert Group on Urban Mobility subgroup 4, SULP, R5.3 p.14*
[14] *ULaaDS D7.8 Policy paper on the future on-demand urban logistics, p.10*
[15] *SPROUT D7.2 Urban Agenda policy briefs, p.19*
[16] *ULaaDS D6.2: Guidelines, methods & policy recommendations to integrate ULaaDS in SUMP & SULP processes, p.18, p.30*

operations[17]. This should be paired with external support from policymakers in the form of subsidies and incentives to develop hubs, as well as investment in infrastructure and technologies to further improve the efficiency of logistics[18].

Standardisation

Standardisation is outlined as a key factor in the future of logistics, with projects stressing the need for harmonised rules and regulations with regard to the various vehicles currently present within the sector or predicted to enter it in the future. This extends mainly to cargo bikes and EVs, making the logistics flow more efficient through ensuring these vehicles and the containers used to store and transport cargo are both interoperable and compatible with each other[19] [20]. To further enhance these efforts, it is essential to champion the development and implementation of cutting-edge application technologies that effectively monitor and refine the quality of traffic data captured by Intelligent Transport Systems (ITS). Emphasising research and pilot projects that focus on incorporating standardised Physical Internet (PI) container designs across supply chains can play a pivotal role in optimising the movement of goods, thereby fostering greater efficiency and cohesion within logistics operations[21].

ESG reporting directives

The EGUM underlines that SULPs frameworks overlook the critical aspect of managing return flows. Cities have an opportunity to collaborate with the private sector, retailers, and both public and private waste collection entities to establish robust return systems. SULPs can facilitate the efficient handling of disposed items like electronic devices and clothing by integrating return processes into forward logistics (such as home delivery and pick-up services). Additionally, cities can enhance these efforts by organising dedicated pick-up days or incorporating return, repair, and waste management services into urban service centres[22].

4.1.2 Data governance and digital infrastructure

Digital Twins

The LEAD project addressed and presented recommendations regarding DTs. It is stressed that for this technology to be a success, a culture of exchange and learning needs to be fostered across a broad range of stakeholders (research institutions/academia, city stakeholders, and businesses) with central a "demand-driven, data-driven, and people-driven" approach[23]. The implementation of this technology needs to be well planned, ideally building on already existing technologies and experienced IT and HR departments to implement it in a manner that best serves citizens. Should a city not have one or either of these things, it should seek out experts to hire and train local and regional stakeholders; this should be accompanied by appropriate policies allowing the technology and relevant data to be continuously assessed and updated for continued efficiency and sustainability associated with DT technology. Within the EU-funded project DISCO, DT technology is not treated as a core operational mechanism enabling dynamic urban freight governance

[17] *OVE21 Project deliverable D6.7, Move21 Guide On Improving City's Capacities For Promoting Sustainable Mobility And Logistics Innovation, p.28, p.49*

[18] *URBANIZED D7.4: Knowledge transfer performed across missions and use cases replicability guidelines, p.27*

[19] *EGUM Recommendations on Urban Logistics, Expert Group on Urban Mobility subgroup 4, Accelerated Deployment of Innovative Sustainable Solutions, Action R5, p.10-11*

[20] *URBANIZED D7.4: Knowledge transfer performed across missions and use cases replicability guidelines, p.22*

[21] *SPROUT D7.1 SUMP-based policy response, p.69; URBANIZED D7.4: Knowledge transfer performed across missions and use cases replicability guidelines, p.26*

[22] *EGUM Recommendations on Urban Logistics, Expert Group on Urban Mobility subgroup 4, SULP, R2.3 p.11*

[23] *D4.6: LEAD Roadmap and Policy Recommendations, p.29*

through federated data environments. This approach is embedded in the project's broader ambition to develop and demonstrate a federated Urban Freight Data Space capable of synchronising real-time transport demand with logistics supply and warehousing operations while supporting predictive, integrated planning of freight flows at Functional Urban Area scale. In this context, DTs provide the modelling layer through which city authorities can monitor, manage and dynamically predict urban logistics flows, enabling scenario testing and optimised land-use planning decisions linked to TEN-T-oriented mobility systems.

Smart Contracts

Smart contracts in urban freight are self-executing digital agreements that use blockchain technology and automatically carry out logistics tasks when predefined conditions are met. Instead of relying on emails, invoices, or manual checks between shippers, carriers, warehouses, and city authorities, the rules of the agreement are written as code and enforced by the system itself. For urban freight, where operations are fragmented and time-sensitive, smart contracts help reduce friction between many actors operating in dense environments. They can be used to coordinate last-mile deliveries, manage curbside access, handle micro-hub usage, or enforce city regulations such as delivery time slots and congestion rules. Because the contract is shared and immutable, all parties see the same rules and outcomes, which lowers disputes and increases trust. Smart contracts are not addressed by EGUM recommendations, presenting an ideal area for recommendations from URBANE's experiences and takeaways.

Data collection, management, sharing

Many of the highlighted projects underline that urban logistics data must extend beyond traffic flows and vehicles to encompass the types of goods transported, loading processes, and storage requirements. Establishing a common, EU-wide framework for data collection which is aligned with broader strategies like the European Data Strategy and Smart Mobility Strategy is seen as foundational. Such a framework should not only define what data to collect but also how to structure agreements for data purchasing, usage, and analysis, ensuring that cities and companies can address gaps, irregularities, and errors in data streams[24] [25]. A recurring priority is the need for structured collaboration among diverse stakeholders, including local governments, businesses, academic institutions, and community organisations. Clear roles, responsibilities, and data exchange processes are essential to foster trust and efficiency, with anonymised, aggregated data sharing emerging as a best practice to balance utility and privacy[26] [27]. URBANIZED and EGUM further advocate for advanced control systems and open data standards, which enable seamless integration across platforms and ensure compliance with privacy laws. These technical and regulatory measures are critical to unlocking the potential of cross-sectoral data sharing, particularly in supporting innovative logistics models rooted in the PI[28] [29]. MOVE21 highlights that true progress requires stakeholders to collectively embrace risks, costs, and communication challenges, especially when scaling solutions like mobility hubs to reduce emissions and private car dependency[30]. ULaaDS determines that flexibility is equally vital, as rigid approaches often fail to account for the unique needs of cities or the varying capacities of stakeholders, underscoring the importance of context-sensitive strategies[31]. Cities are positioned as key enablers in this ecosystem as they can create

[24] *EGUM Recommendations on Urban Logistics, Action R1.1 & R1.3, p.8; D4.6*
[25] *LEAD Roadmap and Policy Recommendations, p.29*
[26] *LEAD D4.6: Roadmap and Policy Recommendations, p.29*
[27] *ULaaDS D6.2 Guidelines, methods & policy recommendations to integrate ULaaDS in SUMP and SULP processes, p.32*
[28] *URBANIZED D7.4 : Knowledge transfer performed across missions and use cases replicability guidelines, p.26*
[29] *EGUM Recommendations on Urban Logistics, Expert Group on Urban Mobility subgroup 4, SULP, Action R1.1 p.8*
[30] *MOVE21 D4.3: Upscaling Plan And Transferability Assessment – Governance, p.30, p.41*
[31] *ULaaDS D6.2: Guidelines, methods & policy recommendations to integrate ULaaDS in SUMP and SULP processes, p.43*

environments where data moves freely and efficiently in a trusted manner[32] [33] through the establishment of data-driven collaborations and by embedding shared logistics and reverse operations into urban service centres.

Data Spaces

In the context of urban logistics, a Data Space refers to a digital environment where data are managed and stored for logistics operations in urban areas in a decentralised but governed manner. The integration of digital technologies improves efficiency, visibility and management. Several European projects have addressed the use of Data Spaces in the field of urban logistics. Data Spaces are not addressed by EGUM. URBANE provides experiences and recommendations deriving from the liaison activities with DISCO and other projects (see Deliverable D6.2 Liaison with other initiatives, Advisory Board).

4.1.3 Governance – Stakeholder cooperation

Shared microhubs – multistakeholder collaboration

It is recognised that involvement of stakeholders in the setup and operation of microhubs is of the utmost importance. From the earliest stages of the planning of a microhub, it is advised to involve as many relevant stakeholders as possible (public, private, HORECA, SMEs) and encourage continued dialogue and discussion to establish a clear picture of the most viable long-term structures and functions of the microhub[34] [35]. There is acknowledgement of the importance of dialogue through internal communication among stakeholders (both formal and informal) and external communication to the wider public, as it helps build a solid foundation for the development of microhubs and validates the need for it[36]. Yet this collaboration needs to go beyond simple discourse and establish clear business plans adapted to both local and business needs, a balance that is difficult to achieve due to varying needs and expectations. It is thus important to identify a governing actor capable of mediating between stakeholders and ultimately taking concrete actions when needed[37] [38]. In establishing the microhub, particular attention should be paid to its design and location. The design needs to tend to local needs and demand, with its location ideally being in converted vacant space or parking identified through usage of KPIs (pollution, traffic effects, noise levels, and employment creation[39] [40]. To aid in location scoping, digital tools should be designed through public-private partnerships to identify location and digitise associated assets for successful and efficient implementation[41]. If a microhub is already present on a territory, it is recommended that its owner opens its operations to a broader set of users to create a common delivery network to lower emissions[42] [43].

Contracts, guidelines, MoU, tenders

[32] *URBANIZED D7.4: Knowledge transfer performed across missions and use cases replicability guidelines, p.26*
[33] *MOVE21 D4.3: Upscaling Plan And Transferability Assessment – Governance, p.41*
[34] ULaaDS D7.8 Policy paper on the future on-demand urban logistics, p.10
[35] EGUM Recommendations on Urban Logistics, Expert Group on Urban Mobility subgroup 4, SULP, Action R6 p.15
[36] Project deliverable D6.7, Move21 Guide On Improving City's Capacities For Promoting Sustainable Mobility And Logistics Innovation, p.29
[37] EGUM Recommendations on Urban Logistics, Expert Group on Urban Mobility subgroup 4, SULP, Action R5 p.13
[38] MOVE21, Upscaling Plan And Transferability Assessment – Governance, Project deliverable D4.3, p.31
[39] EGUM Recommendations on Urban Logistics, SULP, Action R5 p.13
[40] EGUM Recommendations on Urban Logistics, Accelerated Deployment of Innovative Sustainable Solutions, Action R2, p.7-8
[41] EGUM Recommendations on Urban Logistics, Accelerated Deployment of Innovative Sustainable Solutions, Action R2, p.7-8
[42] EGUM Recommendations on Urban Logistics, Accelerated Deployment of Innovative Sustainable Solutions, Action R3, p.8-9
[43] URBANIZED D7.4: Knowledge transfer performed across missions and use cases replicability guidelines, p.20

It is outlined that to drive sustainable urban logistics, public-private collaboration must be formalised through tailored contracts, agile protocols, and conflict-resolution methods[44]. Rather than short-lived projects, stakeholders should place their focus on longer-term, cross-departmental programs that integrate transport, planning, environment, digital infrastructure, and economic development policies into a coherent framework. Such structured cooperation builds mutual trust, improves transparency, and creates stable investment conditions for logistics operators and technology providers. It also enables continuous monitoring, shared performance indicators, and adaptive learning processes that allow policies to evolve with changing urban dynamics. Ultimately, embedding collaboration into formal governance structures helps align strategic goals, reduce institutional fragmentation, and ensure that innovation contributes consistently to broader sustainability objectives[45].

Stakeholder engagement – accountability

The fragmented legal landscape across EU countries creates challenges for data collection in commercial transactions, complicating efforts to standardise processes. EU-level guidelines should thus be developed to provide local authorities with actionable strategies for engaging diverse stakeholders, from local SMEs to international corporations. Through tailored communication approaches, cities can streamline engagement efforts, which would reduce administrative burdens and create more efficient partnerships with businesses and community groups[46]. Beyond communication, cities need practical methods to reconcile competing stakeholder interests and resolve conflicts that may arise during planning and implementation; this includes developing structured techniques for negotiation and mediation, ensuring that all voices are heard and that solutions are equitable[47]. Additionally, as cities increasingly integrate privately operated shared mobility services with public transport systems, they require clear guidance on regulatory tools to influence how these usage and operations of vehicles and services, as well as how data is shared. Systematic guidance, supported by real-world examples, can help cities navigate these complexities while ensuring that mobility remains accessible and aligned with public needs[48]. Transparency plays a pivotal role in building stakeholder trust. When presenting information in an accessible manner, city stakeholders can demonstrate accountability in their decision-making processes, reduce misunderstandings and address concerns proactively. This approach clarifies policies and encourages broader public participation and understanding, reinforcing the legitimacy of urban logistics initiatives[49].

Political will

Political will to enforce more sustainable comes from two angles; on the first hand, it comes from 'spokespersons' capable of advocating for solutions in a manner to effectively communicate their utility or need to political stakeholders; on the other, these messages need to be framed in the context of current political discourse and urgent issues[50]. Political will is highly relevant to URBANE, as the uptake of sustainable urban logistics measures depends on sustained municipal commitment, credible internal champions, and the framing of proposed solutions in line with wider city priorities.

[44] *SPROUT, D7.1 SUMP-based policy response, p.68*
[45] *MOVE21, D6.7 Move21 Guide On Improving City's Capacities For Promoting Sustainable Mobility And Logistics Innovation, p.28.*
[46] *EGUM Recommendations on Urban Logistics, Action R1.4, p.9*
[47] *SPROUT, D7.1 SUMP-based policy response, p.68*
[48] *SPROUT, D7.2 Urban Agenda policy briefs, p.20*
[49] *LEAD, D4.6: LEAD Roadmap and Policy Recommendations, p.30*
[50] *Project deliverable D6.7, Move21 Guide On Improving City's Capacities For Promoting Sustainable Mobility And Logistics Innovation, p.27*

4.1.4 Business models – Market entry

Operating models for city logistics

Operating models define how roles and responsibilities are allocated between public authorities, private operators, and hybrid entities in organising last-mile parcel delivery. They directly shape governance, investment incentives, and the feasibility of business models for solutions such as microhubs, parcel exchange platforms, and collaborative logistics. The literature commonly distinguishes three archetypes, **administrative fiat**, **provision of infrastructure**, and **market-regulated approaches**, which cities may adopt sequentially over time or combine in hybrid forms. Below is a summary of these models, but more detailed information on this matter can be found in D5.1 Business Models and Commercialisation Plans.

1. **Administrative fiat** places the city in full control of infrastructure and operations. The municipality owns and manages the parcel exchange platform and microhubs, and it contracts or runs the last-mile fleet (often under a white-label scheme). Private carriers may be required by regulation to hand over parcels to the city-managed system, typically losing the direct customer interface in the last mile. This model offers maximum public control over environmental targets, service quality, and equity of access, but it can face inefficiencies and resistance from operators. From a business model perspective, revenues are usually collected from carriers through service fees, while major costs (infrastructure and fleet) remain on municipal budgets. Therefore, strong regulatory authority and, in many cases, compulsory participation are preconditions for viability.
2. **Provision of infrastructure** is a hybrid model where the city provides enabling assets, such as microhubs, lockers, or a parcel exchange/digital platform, while leaving last-mile delivery to private carriers or contracted operators. The city sets the rules and ensures interoperability, while 3PLs typically retain the customer interface and manage fleet and labour. This approach is frequently aligned with PPP logic, enabling cities to stimulate innovation and consolidation without carrying full operational risk. Revenue and cost structures are shared, cities invest in infrastructure and may recover costs via service fees, while operators cover delivery operations. A key governance challenge is ensuring neutral, transparent access and avoiding free-riding or underutilisation that can undermine shared infrastructure schemes.
3. **Market-regulated approaches** rely mainly on private initiative under baseline city regulation. Microhubs and lockers are owned and operated by private actors (e.g., 3PLs or real estate developers), and parcel exchange platforms may be run by neutral private providers. The city's role is limited to setting standards (e.g., emission requirements, access times) and monitoring compliance. This model can accelerate deployment and innovation but risks fragmentation, duplication of assets, and limited collaboration, therefore fails to cater to sustainability objectives. In business model terms, costs and revenues are internalised by private actors, and platform viability depends on reaching sufficient scale; without complementary public standards and incentives, this model may underdeliver on public externalities (congestion, emissions, curbside order).

Overall, these models form a continuum from high public control to high private autonomy. Suitability depends on local context, such as political ambition, market maturity, and ecosystem fragmentation. Cities may begin with a market-led approach, move toward infrastructure provision to consolidate and coordinate, and use administrative fiat in cases where public objectives require stronger control. Across models, a consistent insight is that success depends on aligning stakeholder incentives and embedding transparent governance, particularly where shared assets (microhubs, curb access, and data platforms) must be coordinated to avoid fragmentation.

For completion, the **Annex** provides a summary of the proposed business models for the URBANE lighthouse LLs. They are described in detail, including revenue model definitions, CAPEX/OPEX considerations, and growth stage in D5.1 Business Models and Commercialisation Plans.

Incentives

Incentives are seen as crucial in promoting the acceptance of implementing innovations, particularly from the perspective of private stakeholders. Indeed, businesses of varying scale need to see the advantages of participating in the establishing of innovations, be it for collaborating with competitors, adopting and implementing new solutions (EVs or microhubs, for example), or to provide a variety of services to users and inform them on the most sustainable alternatives[51] [52] [53]. Incentives they need to be paired with effective deterrent measures (such as penalties) to environmentally harmful measures[54]. Incentives can also be seen as the practical bridge between pilot adoption and market uptake, particularly when benefits and costs are distributed unevenly across stakeholders. A balanced incentive package typically combines financial, regulatory, and operational levers. Incentive schemes are essential for market uptake because even strong operating and business models fail when stakeholders perceive misaligned benefits and risks. Across the literature and EU pilots, the most common scale-up barrier is exactly this misalignment.

Consumer/user behaviour – acceptance of innovations

In order to shift user behaviour towards a culture of acceptance, all selected projects and groups underline key points. For concrete change to happen, users must have awareness, understanding, and trust in the innovations and solutions being put into place. This begins with clear communication from both the public and private sectors regarding the solutions and why they are beneficial to users[55] [56] [57]. Cultivating a sense of ownership in citizens through continued involvement, paired with a gradual phasing in of solutions to allow for user adaptation allows for greater acceptance of innovations[58] [59]. Moreover, market entry depends on behavioural adoption because last-mile logistics services are ultimately shaped by daily habits, service expectations, and perceived trade-offs. Adoption matters for both organisational users (logistics operators, retailers, property managers, fleet managers, and delivery staff) and end-consumers receiving deliveries. Where behaviour change is required (e.g., new delivery options, pick-up/drop-off behaviours, or data-sharing), adoption improves when users receive immediate benefits/incentives (time saved, fewer exceptions, better route stability) and when the city signals continuity through stable access rules, designated curbside practices, and consistent enforcement.

[51] EGUM Recommendations on Urban Logistics, Expert Group on Urban Mobility subgroup 4, SULP, Action R7 p.15-16
[52] MOVE21, Upscaling Plan And Transferability Assessment – Governance, Project deliverable D4.3, p.40
[53] URBANIZED D7.4: Knowledge transfer performed across missions and use cases replicability guidelines, p.22-23
[54] ULaaDS D6.2: Guidelines, methods & policy recommendations to integrate ULaaDS in SUMP and SULP processes, p.19
[55] SPROUT D7.1 SUMP-based policy response, p.69
[56] LEAD D4.6: Roadmap and Policy Recommendations, p.30-31
[57] URBANIZED D7.4: Knowledge transfer performed across missions and use cases replicability guidelines, p.22
[58] ULaaDS D6.2: Guidelines, methods & policy recommendations to integrate ULaaDS in SUMP and SULP processes, p.24
[59] MOVE21, Upscaling Plan And Transferability Assessment – Governance, Project deliverable D4.3, p.40

5 Evidence base and lessons learned from URBANE Living Labs

5.1 Extracting lessons from Living Labs and demonstrators

For the purposes of the policy package, the main value of the demonstrator evidence lies in showing where public intervention is most needed. Cities and higher-level authorities have a decisive role in enabling land access, clarifying rules, supporting interoperability, facilitating trusted cooperation, embedding freight in planning instruments, and reducing the transaction costs of innovation uptake. This chapter synthesises the evidence generated through the implementation and validation of URBANE's Lighthouse and Twinning LLs, and the follower-city feasibility studies, to identify the lessons that are most relevant for policy design, transferability and large-scale adoption. This is considered as the empirical basis from which policy recommendations, regulatory observations and adoption pathways can be derived.

The primary methodological basis for this synthesis is the validation framework developed in URBANE and applied in Deliverable D2.1. This framework combines city-level and use-case-level KPI assessment with social impact evaluation and process evaluation. In practice, lessons have been extracted from operational and environmental results, from stakeholder perceptions, governance dynamics, and the barriers and drivers observed during implementation. The approach was explicitly designed to support comparability across LLs and to contribute to a wider evidence base for urban freight innovation. The project adopted a broader ecosystem perspective, and attention was given to alignment with the Sustainable Development Goals and the Do No Significant Harm principle, and a triangulation methodology was used to assess social, environmental and economic dimensions together. This is important for the present deliverable, for policy recommendations to reflect a balanced view of effectiveness, feasibility and public value.

The transferability dimension was also built into the evidence-generation process from an early stage. D2.1 explicitly notes that the findings across the Lighthouse LLs were compared through the SEAMLESS framework to identify barriers to implementation and possibilities for scaling and replication. These lessons were then carried forward into the Wave 2 LLs and the follower-city process, where the emphasis shifted from validation in original contexts to adaptation in new ones. As a result, the evidence presented in this chapter is useful for policy purposes because it covers implementation and early replication experience.

5.2 Lessons from Wave 1 Lighthouse Living Labs

The four Lighthouse LLs generated evidence across several use cases. Even if the local configurations differed, Wave 1 results show a common pattern. The greatest implementation challenges were often not related to the technical concept itself, but to local governance arrangements, data access, institutional readiness, and the ability to secure cooperation from the relevant actors. Another important common finding is that the LLs were valuable as pilot testbeds and as structured learning environments. D2.1 concludes that the four Lighthouse LLs generated lessons across social, environmental and economic dimensions and demonstrated a high degree of transferability potential for similar urban contexts. This supports the role of the LLs as a credible source of policy-relevant evidence.

5.2.1 Helsinki

The Helsinki LL focused on reducing conventional delivery routes in dense urban areas by combining a micro-hub concept with a set of innovative last-mile delivery options, notably ADVs and cargo bikes. The implementation was iterative, with three pilot sprints designed so that the next phase could be adjusted on the basis of operational experience and user feedback from the previous one. This iterative structure proved to be one of the LL's major strengths, allowing Helsinki to refine the operational model step-by-step. The evidence from Helsinki shows that autonomous and low-emission delivery solutions can be made operational even in demanding urban and climatic conditions, but only under carefully managed setup. The pilots demonstrated the feasibility of combining ADVs, cargo bikes, modular lockers and urban micro-hubs, while also revealing several practical constraints. These included difficulties in obtaining permission to install temporary infrastructure, sensitivity of equipment to winter conditions, the need for user-friendly delivery interfaces, and the importance of achieving sufficient parcel volumes to make the service economically meaningful. Successful marketing also had a visible effect on uptake, suggesting that demand and communication are central to operational performance. A particularly important lesson is that technical feasibility does not by itself ensure service viability. Parcel volume, social acceptability, legal authorisation and governance coordination were all decisive factors. The follower-city reflections on the Helsinki LL reinforce the conclusion that shared micro-hubs require strong city support for land allocation. Also, ADV deployment requires early and flexible engagement with public authorities. Communication strategies are needed to build public understanding and avoid mistrust. Helsinki therefore illustrates how innovative delivery systems depend on an enabling policy environment as much as on the technology itself.

5.2.2 Bologna

The Bologna LL tested a collaborative model based on Nearby Delivery Areas, micro-hub networks and light zero-emission vehicles in the historic centre. Its main innovation lay in the shared use of micro-hubs (acting as transhipment points) by operators who would normally be market competitors, thereby creating a concrete test of collaborative logistics and a local PI test case. The demonstrator was explicitly linked to Bologna's SUMP and SULP, which gave the intervention a strong policy anchor. The main lesson from Bologna is that collaborative logistics arrangements are possible, but they require active governance and carefully designed cooperation mechanisms. The evidence indicates that attracting transport operators beyond the initial project partners was difficult, in part because of concerns around data sharing, freight security, system integration costs and operational disruption. These issues were not resolved simply by offering a potentially efficient infrastructure solution. Rather, they required direct engagement with operators, bilateral discussions, and efforts to clarify the value proposition for each participant. The experience suggests that shared urban logistics infrastructure needs a strong governance model and cannot be treated as a purely technical deployment. Bologna also generated lessons that proved highly relevant for replication. The follower-city activities highlight the value of the SULP as a policy framework, the practical viability of a locker system open to multiple logistics actors, and the potential role of modular vehicles and flexible transhipment in enabling Freight-as-a-Service models. At the same time, it points to unresolved questions concerning who should lead such services, how to broaden operator participation, and how to ensure economic sustainability once the initial pilot phase ends.

5.2.3 Valladolid

The Valladolid LL addressed a rather different dimension of urban logistics governance. Its use cases covered AI-supported monitoring of loading and unloading areas through CCTV, an innovative contactless trunk-delivery service, and techno-economic comparison between combustion vehicles, commercial electric vehicles and prototype solar cargo-bike solutions. The use cases showed that the management of urban freight does not depend only on delivery vehicles and logistics assets, but also on the quality of traffic management, curbside control, urban data and the ability to compare alternative delivery configurations on a sound evidence base. Valladolid LL linked operational innovation with enforcement and urban management conditions. This is confirmed by the replication discussion in Ravenna, where the Valladolid use case on AI monitoring of loading and unloading areas is treated as a way of creating the necessary governance context for more ambitious logistics measures, such as zero-emission delivery models. In other words, Valladolid points to an important lesson for policymaking that before cities can scale collaborative and low-emission logistics systems, they may first need better visibility, management and control of freight-related use of urban space. From a policy perspective, the Valladolid experience showed that digital monitoring and data-enabled curbside management are not secondary issues. They are often prerequisites for more advanced freight interventions. Cities need to know how loading areas are used, whether regulations are being respected, and where inefficiencies or conflicts arise. Without this baseline capability, the design of access rules, enforcement measures, and incentive schemes for sustainable logistics is likely to remain weak.

5.2.4 Thessaloniki

The Thessaloniki LL focused on a hub-and-spoke model based on parcel lockers supported by DTs, together with analysis of the ideal composition of new low-emission fleets and related services. This combination is significant because it brings together two key policy-relevant questions, (a) how to create more efficient delivery structures through shared infrastructure, and (b) how to support fleet transition through planning and decision-support tools. Thessaloniki LL showed the strategic relevance of combining digital planning tools with physical delivery interventions. Secondly, it underlined that parcel-locker-based solutions should not be viewed as isolated market products, but as part of a broader logistics reorganisation effort that includes service design, locker location optimisation, fleet choices and operational modelling. This is consistent with the project’s wider emphasis on DTs, transferability tools and impact assessment as enablers of better urban logistics planning. The replication evidence also suggests that the Thessaloniki case has relevance for other cities interested in parcel lockers and low-emission zones, particularly where municipalities are seeking practical instruments to reduce delivery-related congestion and reorganise freight flows in dense centres. The key lesson emerging is that physical delivery infrastructure, digital modelling and local planning need to be developed together. Where one of these elements is missing, the potential benefits of the others may not be fully realised.

5.3 Lessons from Wave 2 - Twinning Living Labs

The Twinning LLs in Barcelona and Karlsruhe were designed to assess the replicability of URBANE solutions and to test the Innovation Transferability Platform under new contextual conditions. The transferability process followed a structured methodology intended to adapt Wave 1 innovations to local ecosystems, define local use cases, establish baseline conditions and compare performance under “before” and “after” scenarios. This is a particularly valuable source of policy evidence because it highlights what changes when a solution moves from its original setting to a different environment. The main lesson from Wave 2 is that transferability depends on context-aware adaptation. Urban logistics innovation is not only a matter of selecting the right technology, but of preparing the right ecosystem for it.

5.3.1 Barcelona

The Barcelona LL generated particularly clear evidence on the value of multimodal, digitally enabled and low-emission logistics operations. The implementation of digital tools and RFID-supported workflows produced measurable efficiency gains in parcel handling and route execution, while also enabling end-to-end traceability. In addition, DT simulations helped quantify broader sustainability benefits, showing that partial electrification of the first-mile segment combined with cargo-bike-based last-mile delivery can support zero-emission logistics strategies in dense urban settings. At the same time, Barcelona demonstrated that digitalisation requires robust operational design. The pilot underlined the need for resilient hardware, reliable communication protocols and continuous integration of detailed operational data in order to improve modelling accuracy and support dynamic routing. In this respect, Barcelona showed that the benefits of digital tools do not arise automatically from installation. They depend on sustained data quality, careful systems integration and practical adjustments based on field conditions.

5.3.2 Karlsruhe

Karlsruhe provided an equally important set of lessons. The modelling work suggested that tram-based logistics combined with electric robots could provide a low-emission alternative to diesel-based last-mile operations, especially in contexts where the electricity mix is already decarbonised. However, the LL also made very clear that non-technical constraints can dominate the pace and feasibility of transfer. The integration of freight operations into an existing public transport system raised legal, safety and organisational questions that could not be resolved by project partners alone and required engagement with supervisory and rail authorities. The transferability lesson from Karlsruhe is therefore highly relevant for policy design. Early mapping of the regulatory landscape is essential, especially where innovative logistics models intersect with transport safety rules, labour considerations, infrastructure sharing and data protection obligations. The LL also observed that institutional procedures often move more slowly than pilot timelines, meaning that regulatory or permitting needs must be anticipated well in advance. For policymakers, Karlsruhe demonstrated that if cities wish to support ambitious multimodal freight concepts, they must create governance and regulatory pathways that match the timescales and needs of interventions.

5.4 Cross-case synthesis of implementation lessons

Across the LLs, several recurring patterns can be identified. The project repeatedly found that operator concerns about competition, security, confidentiality, liability and additional effort can slow uptake. This confirms that public-private cooperation needs credible governance mechanisms, trusted intermediaries and clear allocation of roles and benefits. Secondly, spatial and regulatory readiness matters as much as technical readiness. The Helsinki and Bologna experiences show that access to land, permissions and infrastructure are decisive for implementation, while Karlsruhe illustrates the weight of safety and regulation. The follower-city studies repeatedly highlighed legal restrictions, field-testing requirements, governance constraints and the need for early dialogue with authorities. In other words, many barriers to scaling green urban logistics lie in planning and regulation rather than in the solutions themselves. Further, digital tools are useful but only when supported by data quality, interoperability and organisational capacity. Barcelona's experience shows that DTs, RFID and optimisation tools can improve efficiency and traceability, but also that inaccurate or incomplete data can distort results. Helsinki and Thessaloniki similarly suggest that digital modelling is closely linked to operational effectiveness. Cities and operators need both technical capability and governance arrangements for data sharing if digital solutions are to become reliable for planning and operations. Last, transferability requires adaptation rather than replication. Cities do not begin from the same legal, spatial, market or governance conditions, and therefore cannot be expected to implement a common model in identical form. What can be transferred are not fixed templates, but solutions' logic, decision-support tools, governance principles, and implementation guidelines that can be adapted locally. One of the most important lessons is that policy recommendations support differentiated pathways to adoption.

5.5 Evidence from follower cities on adoption feasibility and replication conditions

The follower-city work provided a valuable additional layer of evidence because it tested how LL lessons are interpreted by cities that were not part of the Wave 1 and Wave 2 demonstrations. Cities followed a structured workflow in which they moved from understanding the URBANE innovations to assessing local readiness, identifying constraints and defining concrete action plans. The resulting feasibility studies combined SWOT analysis, implementation planning and reflection on infrastructure, data, governance, funding and timeline requirements. As such, they are a particularly useful source for understanding the practical conditions of scaling. The follower-city conclusions confirm several of the patterns already visible in the LLs. Aarhus emphasised the importance of selecting locations early, ensuring neutral management of hubs and maintaining a clear dialogue with logistics companies, while also identified legal restrictions and lack of field testing as important barriers. La Rochelle highlighted the potential of lockers and micro-hubs, but also the need for fair contractual models, operator engagement and alignment with heritage and security constraints. Mechelen concluded that an open, interoperable locker ecosystem is technically feasible, but that the main barriers are organisational, contractual and regulatory rather than technological. Antwerp treated autonomous delivery systems as an opportunity to learn about spatial design, legal compliance and stakeholder coordination. The follower-city work also showed that replication is most credible where cities can link solutions to existing policy frameworks such as SULPs, define a clear problem to be solved, involve stakeholders early, and build an action plan around realistic governance and funding conditions. This reinforces the central proposition of the present deliverable that successful uptake depends on policy design, city preparedness and context-sensitive implementation, not on technological transfer alone.

6 URBANE's evidence on barriers to upscaling and adoption

6.1 Overview

The evidence gathered across the URBANE LLs, Twinning LLs, follower-city feasibility studies, business planning work and policy exchanges showed that the upscaling of innovative urban logistics solutions is constrained by a combination of regulatory, organisational, market, data-related and social barriers. A consistent finding across the project is that the principal obstacles to adoption are rarely technological in nature alone. In many cases, the solutions tested in URBANE are already sufficiently mature to demonstrate operational value, yet their wider deployment remains dependent on enabling conditions that lie outside technology. This chapter structures those barriers in a policy-relevant way. The intention is to identify what would need to change, building directly on evidence, while also reflecting the themes raised through the CIVITAS policy discussions. These barriers define the problems to which the policy package must address.

6.2 Regulatory and governance barriers

In URBANE, many solutions encountered difficulties in implementation because they required permissions, exemptions, contractual frameworks or institutional arrangements that were not readily available. This was particularly visible in relation to autonomous delivery systems, shared logistics infrastructure and multimodal freight concepts involving public transport or the public domain. The Karlsruhe transferability work illustrated that legal and safety issues can dominate when innovative freight services intersect with pre-existing rail, safety or labour regulations. The same analysis stresses that early mapping of the regulatory landscape is essential. The follower-city feasibility studies confirm that regulatory uncertainty is a recurrent obstacle to adoption. Antwerp identified the need for a more flexible legal framework for ADVs, combined with clearer pathways for field trials and future city-wide integration. Aarhus similarly found that legal restrictions and the lack of field-testing possibilities complicate the implementation of micro-hubs and cargo-bike-based logistics, particularly in relation to vehicle size, speed, parking and operating conditions. These examples demonstrate that where new delivery modes are concerned, cities and operators require legal clarity and room for controlled experimentation.

Governance barriers are equally significant. URBANE repeatedly showed that solutions involving shared infrastructure or multi-actor operations need a governance model capable of balancing public objectives with competitive market priorities. Open locker systems, collaborative micro-hubs and Freight-as-a-Service arrangements require rules on access, responsibilities, service levels, liability and cost-sharing. The follower-city analysis of Mechelen is particularly enlightening; while an open parcel-locker ecosystem is technically feasible, the main barrier is ensuring fair access between competing operators. Similar issues also arise in the policy-group discussions, where neutral management of micro-hubs is highlighted. A broader governance challenge also concerns fragmentation of responsibilities within public authorities. Urban freight often cuts across mobility planning, public space management, environmental regulation, digital governance, economic development and local enforcement. Where these responsibilities remain separated, cities may find it difficult to define coherent strategies, allocate resources or provide a single interface for operators and technology providers. The follower-city work implicitly emphasised the need to embed logistics in SULPs and municipal mobility plans, promote capacity building and improve interdepartmental coordination.

6.3 Operational and organisational barriers

Another barrier category concerns operational and organisational readiness. Even where a solution is legally permitted, implementation may still be slowed by misalignment between the operational model and the receiving city's ecosystem. URBANE's transferability work repeatedly demonstrated that successful deployment depends on contextual fit, local coordination capacity and the ability of stakeholders to integrate the new solution into existing working practices. A recurring issue in URBANE was the difficulty of securing active participation from logistics operators and other commercial actors beyond the immediate project consortium. Barcelona drove negotiations with third-party logistics service providers and retailers that did not lead to participation. Market actors may hesitate to engage in pilots where the operational effort is significant, expected benefits are uncertain, or the implications for current business processes are unclear. Similar concerns were raised in the wider policy discussions, where the need for clearly defined roles among municipalities, logistics providers, shippers and last-mile operators was identified as central to the success of public-private cooperation schemes.

Implementation barriers are higher where solutions depend on cooperation among actors who do not naturally collaborate. Shared hubs, interoperable lockers and data-sharing platforms require operators to coordinate activities that may previously have been managed individually. This can create uncertainty around control, confidentiality, workload and operational disruption. The follower-city evidence pointed to this repeatedly, stressing the importance of clear dialogue with logistics companies, co-creation among operators and landowners, and fair contractual models for access to public space and shared infrastructure.

Organisational barriers also arise within city administrations. New forms of urban logistics often require capacities that municipalities do not yet possess, such as the ability to evaluate advanced logistics data, negotiate complex service agreements, or manage emerging technologies such as ADVs. The follower-city activities explicitly noted the need to build internal capacity. The policy-group discussions underlined that local authorities require greater capability to manage data, define access conditions and support implementation over time.

6.4 Market uptake and business model barriers

The project evidence indicated that market uptake remains one of the most persistent challenges for innovative urban logistics. While URBANE solutions can demonstrate operational and environmental benefits, this does not automatically translate into commercially viable business cases. The D5.1 business planning framework makes clear that large-scale uptake depends on robust revenue models, clearly identified users, cost and investment planning, and sustainable growth trajectories. A common barrier across cities is uncertainty over who will pay for shared infrastructure or service innovation once the pilot phase ends. This issue is particularly visible in relation to parcel lockers and micro-hubs. La Rochelle's feasibility study highlighted the need for value-sharing between authorities and operators. The proposed approach of allowing private operators to finance installation and operation in exchange for access to public space reflects an attempt to address this barrier, but also shows that viable business models need to be carefully designed.

The policy discussions added another important dimension. The transition to new technologies, equipment or electric vehicles may create significant difficulties for small businesses with low profit margins and limited access to capital. In such cases, the policy challenge is to ensure that the cost of transition does not exclude smaller operators. This is a particularly important consideration for zero-emission freight policies, since high upfront costs may otherwise undermine adoption.

Another market barrier concerns uncertainty about value capture across the delivery chain. Adoption is impacted by a chain of behaviours involving operators, retailers, property managers, fleet managers, delivery staff and end-consumers. Organisational users prioritise reliability, cost predictability and operational simplicity, while end-consumers respond to convenience, transparency and service quality. If one part of this chain does not perceive sufficient benefit, adoption may stall. This is especially relevant for shared systems, where the party bearing the cost of change is not always the party receiving the greatest benefit.

6.5 Data access, interoperability and digital governance barriers

Data-related barriers are among the most significant and recurrent obstacles identified by URBANE. The project's solutions depend on the availability of reliable data, interoperable systems and trusted frameworks for data exchange. However, the evidence from both project implementation and policy dialogue showed that cities still lack standardised frameworks for urban freight data, and that the deployment of digital tools often raises practical concerns around cost, training, access, privacy and governance. The follower-city work in D6.3 emphasised that cities need to assess local data needs as part of their adoption planning. This demonstrates that digital readiness is not optional, but a core component of successful implementation. The open architecture of the DT, routing tools and traceability components supports reuse across cities, but successful transfer still depends on data integration and deployment remains dependent on the quality and accessibility of local data systems. Digital governance raised a new set of challenges around trust, accountability and compliance. Where smart contracts, data-sharing platforms or collaborative digital services were introduced, actors worried about commercial confidentiality, access rights, liability and the protection of personal data. For digital tools to reach their potential and use at scale, trusted governance frameworks and standardised protocols are needed.

6.6 Safety, security and cybersecurity barriers

Safety, security and cybersecurity are central to the adoption of emerging delivery technologies and data-enabled coordination systems. In Karlsruhe, for example, the integration of freight operations into a public transport environment required direct engagement with supervisory and rail authorities to clarify applicable safety standards and responsibility allocation. Security-related constraints also emerged in relation to urban space and shared infrastructure. La Rochelle's feasibility study highlighted the need to account for heritage and security requirements when identifying suitable locations for parcel lockers. This showed that even easy infrastructure deployments may face local security restrictions that affect site selection, design and governance arrangements. Cybersecurity and data protection concerns emerged where logistics systems had to rely on digital coordination, smart contracts or routing software. Implementing digital tools entails privacy considerations and trusted digital governance arrangements. This means that cities and operators require assurance that they handle sensitive operational and personal data in a secure and legally compliant manner. These issues are likely to be solved as urban logistics systems become more connected and more dependent on interoperable digital infrastructures such as Data Spaces.

6.7 Social acceptance, behavioural and communication barriers

URBANE's evidence suggests that innovative urban logistics solutions do not succeed solely by being operationally efficient. They must also be acceptable to users, understandable to citizens and compatible with the expectations of consumers, retailers and delivery personnel. Users need awareness, understanding and trust. Clear communication from public and private actors, demonstrations of benefits, citizen workshops and continued feedback mechanisms were identified as important factors for increasing acceptance. Organisational users, including logistics operators and retailers, are sensitive to process disruption, integration effort, unclear return on investment and uncertainty regarding regulatory stability. End-consumers, by contrast, tend to respond to convenience, reliability and visible service benefits, provided that the new solution does not reduce speed, flexibility or control. This is highly relevant for parcel lockers, new pick-up and drop-off routines and consolidated deliveries. If adoption creates friction without immediate visible benefit, resistance is likely to remain high. The wider CIVITAS-related work set consumer behaviour as a distinct policy theme. URBANE's contribution to the policy cluster emphasised that influencing consumer choices depends on transparency, service reliability and awareness of impacts. This suggests that behavioural barriers are part of the overall adoption environment and need to be addressed through communication, incentives and gradual implementation strategies.

6.8 Differences between city typologies and transferability constraints

This category concerns variation between urban contexts. Cities differ in planning maturity, regulatory flexibility, market structure, availability of public space, digital readiness, stakeholder relations and political priorities. The follower-city evidence supports this strongly. Some cities were able to connect URBANE solutions to existing SULPs, zero-emission zone discussions or public-domain locker networks, while others still needed to build baseline governance structures, identify locations, clarify legal conditions or improve stakeholder coordination. The replication conditions for lockers, micro-hubs, cargo-bike logistics or autonomous delivery systems therefore vary considerably depending on the receiving city. The core barrier here is the mismatch between solution requirements and local readiness. This transferability constraint has direct implications for policy design. URBANE's evidence suggests that adoption roadmaps should be staged and context-sensitive, rather than based on a single set of measures for all cities.

7 Findings from policy dialogues

7.1 Approach to policy dialogues

The policy-dialogue undertaken within URBANE provide an important complement to the technical and implementation evidence presented in the previous chapters. The LLs and transferability work revealed how solutions perform in practice, the policy exchanges help explain how these solutions are perceived by public authorities, logistics operators, cluster partners and other stakeholders, and what forms of policy action are considered necessary to support wider adoption. This chapter draws primarily on the CIVITAS Urban Freight and Logistics Cluster's policy work and consultations with different stakeholder groups in the course of the project such as the City Platform participants. URBANE's policy engagement contributed directly to a wider European discussion on the governance, data, behavioural and interoperability conditions required for sustainable urban logistics.

7.2 Engagement in the CIVITAS Urban Logistics Cluster Policy group

URBANE's engagement with the CIVITAS Urban Logistics Cluster is important. The project contributed to workshops involving clustered projects and to a bilateral interview between the URBANE coordinator and a CIVITAS representative. Activities intended to provide strategic input on urban freight governance, data sharing and behavioural change, grounded in project work and results. The meetings were convened to identify preliminary policy recommendations and best practices around three core thematic areas (Table 3).

TABLE 3 - CIVITAS CLUSTER THEMATIC AREAS

Thematic Areas	Key preparation milestones of joint publication
1.Public-Private Cooperation for Zero-Emission Last-Mile Logistics 2.Data Governance & Digital Infrastructure for Urban Logistics 3.(Regulating) and Incentivising Sustainable Consumer Behaviour & Sustainable Retailor Activities in E-Commerce	**June 2024:** Policy Group Launch Workshop **July 2025:** Expert Best Practices Collection **Winter 2025:** Policy Brief First Draft **Spring 2026:** First Draft Validation Meeting **June 2026:** Policy Paper Official Publication

The URBANE project has actively engaged with the CIVITAS initiative (see also deliverable D6.2) and participated in several Cluster meetings. These interactions have allowed URBANE to provide updates on pilot progress and share lessons learned but also to contribute directly to the development of joint policy recommendations with other projects – these are scheduled for publication in May 2026. Table 3 highlights the thematic areas of the policy recommendations by the CIVITAS initiative, which closely align with the interventions, objectives, and goals of the URBANE. For instance, as part of the project, Public-Private collaborations were tested to support zero-emission last-mile logistics through pilot solutions such as micro-hubs and micro-consolidation centres. Another example, covering the second thematic area, was URBANE smart contracts and other digital tools aimed at improving operational efficiency, trust and coordination among involved parties in collaborative last mile delivery models. The project's LLs informed and reinforced the policy recommendations, creating a direct link between innovation on the ground and strategic guidance for sustainable urban logistics.

URBANE participated in the workshop involving all clustered projects, and a subsequent bilateral interview between INLECOM (URBANE coordinator), and the CIVITAS cluster representative. The workshop provided a structured setting for each project to share experiences around three guiding questions per thematic:

1. Achievements, insights, and best practices.
2. Remaining challenges.
3. Opportunities to improve public–private collaboration, future funding priorities, and research gaps.

URBANE highlighted several achievements and best practices from its LLs. Building on the lessons from the workshop, these insights subsequently informed the discussion/interview between the CIVITAS representative and the URBANE coordinator. During this session, attention was focused on the following:

1. **Public–Private Collaboration:** Successful schemes rely on clearly defined roles among municipalities, logistics providers, shippers, and last-mile operators. Examples like micro-hubs and parcel lockers demonstrated that long-term success depends on shared responsibilities, viable business models beyond project funding, and careful site selection for accessibility, safety, and coverage.
2. **Data Governance:** Effective data collection and sharing are essential for policy design and operational optimisation. Key factors include standardised protocols, trusted governance frameworks, and strengthening local authorities' capacity to manage data, clarify access conditions, and ensure economic viability of data-driven logistics solutions.
3. **Consumer Behaviour and Communication:** Transitioning to sustainable urban logistics requires coordinated strategies between cities and companies. Influencing consumer choices depends on transparency, service reliability, and raising awareness of environmental impacts.

It should be noted that although URBANE project finished before the publication of the joint recommendations publication, its partners remain committed to actively contributing to the development and refinement of policy recommendations after the end of the project and provide strategic input to support the development of policy frameworks that reflect both operational realities and emerging best practices.

A central message emerging from the policy exchanges is that urban freight innovation has reached a stage where many technical concepts are sufficiently mature and the policy discussions moved on the conditions for long-term adoption and impact. The workshop and interview explored whether the collaboration models were sustainable after project funding, whether they could be replicated, which actors needed to be involved, what data arrangements were necessary, and what policy drivers at local, national or European level could support the effort. Last it amplified cross-project learning, reflecting the effort to avoid duplication and to ensure that recommendations build on an accumulated evidence base rather than on a single project perspective. In total, URBANE's participation in the CIVITAS Urban Logistics Cluster provided a structured channel to position project results within a wider European policy discussion. The main added value of this engagement was not the identification of new barriers, but the validation of URBANE's findings against a broader cross-project agenda focused on the three themes. This confirmed that the issues emerging from URBANE are also shared across the wider European urban logistics community, as summarised below:

Public-private collaboration

The policy dialogue reinforced the conclusion that collaboration models need to be designed as long-term governance arrangements rather than as pilot-based partnerships. The main implication is that cities and operators need clearer frameworks for shared responsibilities, access conditions and continuity beyond project funding. This is particularly relevant where shared assets or services require coordination between actors with different incentives.

Data governance and digital infrastructure

The stakeholder exchanges highlighted that the main challenge is no longer the absence of digital tools, but the lack of trusted conditions for their routine use. The most important added point from the dialogue process is the need to move from project-based digital experimentation towards common governance frameworks for interoperability, access conditions, data-sharing protocols and institutional capacity.

Consumer behaviour, communication and demand-side measures

The policy dialogue added a stronger demand-side perspective. Beyond the implementation barriers already identified, stakeholders underlined that sustainable logistics solutions must be understandable, attractive and convenient for users if they are to scale.

Role of cities, operators, retailers and EU-level actors

A useful contribution of the dialogue process was to clarify the differentiated roles of the main actor groups. Cities are expected to act as enablers and coordinators, operators as implementation partners, retailers and consumers as demand-shaping actors, and EU-level bodies as providers of support and interoperability frameworks.

The main forward-looking message from the policy dialogue is that future action should focus less on isolated pilots and more on the conditions for scale. Priorities include governance models for shared logistics infrastructure, interoperable data frameworks, stronger local authority capacity, and better alignment between experimentation, standardisation and long-term uptake.

8 Standardisation, Interoperability and Enabling Frameworks

8.1 Why standardisation matters for scaling URBANE solutions

Standardisation and interoperability are central to the transition from isolated urban logistics pilots to scalable and repeatable deployment models. The October 2025 international expert workshop on standardisation and the Physical Internet (see Deliverable D6.2), concluded that urban logistics has become a particularly important entry point for Physical Internet (PI) implementation because cities face mounting pressure from e-commerce growth, rising last-mile demand, congestion, emissions and limited urban space. However, the same workshop stressed that the ability to scale and replicate solutions such as shared micro-hubs, parcel lockers and consolidated freight flows depends critically on common standards for physical infrastructure, digital interfaces, data exchange and operational rules. Without such standards, urban logistics innovations risk remaining fragmented, localised and difficult to replicate. This issue is especially relevant for URBANE because the project's innovation portfolio is inherently multi-actor and system-based. Shared parcel lockers, collaborative hubs, blockchain-enabled smart contracts, DTs, AI-based planning tools and multimodal logistics solutions rely on some degree of compatibility between infrastructure, digital systems, governance arrangements and service interfaces. Where such compatibility is weak or absent, each new implementation tends to require bespoke integration, bilateral negotiation and local workaround solutions, which increase cost, delay adoption and limit transferability. Standardisation can therefore be understood as a means of reducing costs and creating the conditions for urban logistics innovation to scale.

The following sections provide an overview of how standardisation is being applied in last mile logistics and why it is closely related to the PI paradigm. Subsequently, the results of an internal survey examining the standardisation potential and level of interest of URBANE's activities are presented. Finally, drawing on these two sources of information, an analysis of the main standardisation gaps identified is provided.

8.2 Physical Internet perspective and implications for urban logistics

The PI provides a useful strategic lens through which to interpret URBANE's standardisation agenda. It is intended to create an open, modular and interoperable logistics system in which shared procedures, common interfaces and collaborative use of assets can increase efficiency, resilience and sustainability. Urban logistics is viewed as a particularly promising domain for practical implementation because last-mile operations are under pressure to improve asset use, reduce environmental impacts and better coordinate fragmented delivery activities. According to ALICE's roadmap to the Physical Internet[60], the fourth generation of logistics networks, characterised by international accessibility and seamless multisectoral integration, emphasise fully integrated networks with ability to manage their own resources while accessing external services in an open and standardised manner. Such integration will enable economies of scale through larger operational volumes, optimising the use of logistics infrastructures which will result in standardisation across assets, procedures, protocols, and data communication.

In urban logistics, standards can provide a common framework for evaluating and comparing the performance of different urban logistics systems, ensuring that urban logistics systems perform in a safe, environmentally friendly and efficient manner. Standardisation of last-mile logistics operations is a multidimensional issue that affects several interconnected topics, as presented schematically in Figure 1.

FIGURE 1 - ISSUES WITH STANDARDISATION POTENTIAL IN THE LAST MILE LOGISTICS LANDSCAPE[61]

One major challenge for the standardisation of last mile operations is to agree on the level of abstraction required for the different technologies, services and operations involved. In order for standards to be practical, they must be sufficiently detailed to ensure clarity and facilitate adoption by the different

[60] https://www.etp-logistics.eu/wp-content/uploads/2020/11/Roadmap-to-Physical-Intenet-Executive-Version_Final.pdf

[61] https://share.ansi.org/Shared%20Documents/News%20and%20Publications/Links%20Within%20Stories/Draft%20KATS%20ISO%20TSP%20on%20Urban%20Logistics.pdf

stakeholders, while remaining sufficiently generic to accommodate the inherent variability and complexity of real-world logistics operations. Achieving this balance ensures that standards are both usable and adaptable, enabling logistics networks to operate efficiently without stifling the natural diversity of operations. Such an approach supports widespread industry adoption, encourages innovation, and allows process standards to evolve in line with the diverse and dynamic nature of modern supply chains[62].

Standardisation landscape for last mile/urban logistics

Standardisation in the field of last-mile logistics technology and services is a cross-cutting topic covering many different and complementary topics: packaging, transport, digitalization, sustainability, supply chains, etc. Standardisation in the last-mile logistics section can have the following impacts on society:

- Help improve social, economic, and sustainable urban logistics
- Improve the stable and sustainable quality of logistics processes and services
- Help continue sustainable growth of urban logistics market
- Reduce the risk of workplace accidents
- Help respond to changed value chain of logistics due to continuous digital transformation
- Reduce overall logistics costs and burdens globally

There are several international Technical Committees (TCs) working, directly or indirectly, in promoting the harmonisation of last-mile logistic operations like those explored in URBANE, for instance:

- ISO/TC 22 - Road vehicles
- ISO/TC 204 - Intelligent transport systems
- ISO/TC 268 - Sustainable cities and communities
- ISO/IEC JTC 1 - Information technology
- ISO/TC 307 – Blockchain and distributed ledger technologies
- ISO/TC 321 - Transaction assurance in E-commerce
- CEN/TC320 - Transport - Logistics and services
- GS1 standards (e.g. Product Classification (GPC), GS1 Global Data Model, GS1 Digital Link)
- CEN-CENELEC-ETSI/SF-SSCC – Sector Forum on Smart and Sustainable Cities and Communities.

Particularly relevant for URBANE is the **ISO/TC 344 on Innovative Logistics[63]**. The aim of this TC is the "*standardisation of services, techniques and management in the field of logistics, specifically including the process of distributing goods from manufacturer or distributor to regional hub, distribution center, and ultimately to businesses such as urban retailers, and to improve the quality, safety and efficiency of distribution operations, and to enhance the stability, flexibility and sustainability in logistics*". The scope of their works includes:

- Development of general requirement, framework, metrics, guidance, performance indicator, evaluation for innovative logistics etc.
- Innovative provision of service assurance for logistics (e.g. innovative operation of distribution center, including overseas warehouse in cross-border trade, capacity building for operators, etc.).
- Innovative operation, service and synergy optimisation in logistics (e.g. order processing, cargo consolidation, sorting, picking, storage, repackaging and protective handling, loading, unloading, capacity allocation, shipping, distribution, other customized services, etc.).

[62] https://www.imec-int.com/sites/default/files/2025-03/A-Blueprint-for-the-Physical-Internet.pdf
[63] https://www.iso.org/committee/9824329.html

Some examples of the work under development at the ISO/TC 344 are the ISO/TR 25326 on use cases for green logistics activities, and the ISO/CD 25403 on ESG framework for logistics.

Physical Internet and Standardisation

Standardisation constitutes a fundamental pillar of the PI paradigm (see also deliverable D1.1 URBANE framework for optimised green last mile operations). PI-related standardisation encompasses protocols, modular containers, and interfaces to push for an increase in efficiency and sustainability[64]. This separation and harmonisation of physical, digital and operational components support PI principles by enabling scalable, dynamic, and flexible planning processes, whereby diverse flows can be matched to available network services in accordance with evolving preferences and real-time conditions.

The PI paradigm integrates standardised, modular and intelligent containers with novel logistics protocols and business models, resulting in a collaborative, highly distributed and leveraged logistics and distribution system. Within this framework, goods are encapsulated in containers of modular dimensions (Figure 2) and, analogously to data packets in the digital Internet, are routed towards their final destinations using PI identifiers. This routing is performed through highly efficient, shared transportation, storage and handling means, enabling optimal utilisation of infrastructure and assets[65].

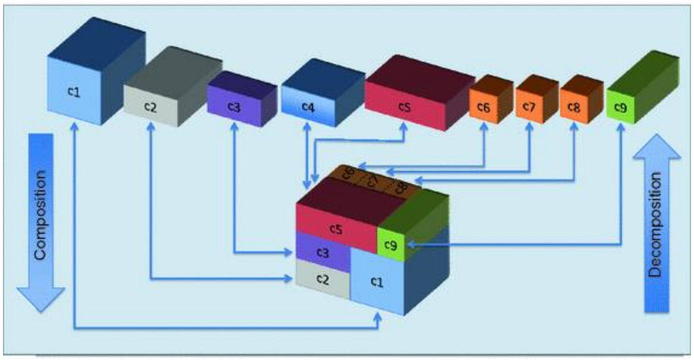


FIGURE 2 - THE USE OF STANDARDISED Π-CONTAINER SIZES ALLOWS EASY COMPOSITION AND DECOMPOSITION, MAXIMIZING SPACE USAGE

As highlighted by Pan et al.[66], several elements of the PI paradigm are either standardised by design or present a strong potential for further standardisation:

- **π-container**: the containers used are unitised, standardised, and modular, to ease their processing and handling within PI-systems
- **π-freight routing protocols**: inspired by TCP/IP in the digital internet, PI freight routing protocols optimise end-to-end routing and standardise the transport process, from the sourced to the destination passing through π-nodes for consolidation and modal shifts.
- **π-material handling**: standardised materials and equipment are deployed to handle π-containers through automated and standardised processes in intra-logistics systems (e.g. factories, warehouses, modal shift terminals.)

The PI Norm as lever for standardisation[67]: In recent years, efforts have been devoted to formalising PI principles into a reference framework known as the PI Norm. The Physical Internet Norm (PI Norm) comprises a set of shared, industry recognized procedures, technical specifications, and operational guidelines designed

[64] https://ipic2025.pi.events/sites/default/files/downloads/IPIC2025_Proceedings.pdf
[65] https://www.scl.gatech.edu/sites/default/files/downloads/towardsphysicalinternet-impactlogisticsmh_benoitmontreuil.pdf
[66] Montreuil, B. Toward a Physical Internet: meeting the global logistics sustainability grand challenge. Logist. Res. 3, 71–87 (2011). https://doi.org/10.1007/s12159-011-0045-x
[67] https://physical-internet.eu/pi-norm/

to ensure compatibility and interoperability across logistics operations. It establishes a common language and a unified framework that enables companies, technology systems and infrastructure to work together seamlessly, regardless of their location, sector or service provider. By fostering interoperability among various stakeholders and modes of transport, the PI Norm contributes to the dual objectives of minimising environmental impact and enhancing the efficiency of freight transport.

The PI-Norm covers three main areas:

- Operational procedures: guidelines for handling, routing and exchanging goods between operators to ensure smooth transfers between modes of transport such as road, rail, waterways and maritime.
- Technical specifications: standardised requirements for packaging, labelling, digital identifiers, and load units to enable the automated and accurate processing of goods.
- Digital protocols: the formats and interfaces that enable systems to securely exchange and share information in real time.

The PI Norm is not intended to be static. As technologies, regulations, and market demands change, the PI Norm will grow organically increasing the number shared and industry-recognised standards and procedures. Continuous refinement will be achieved through sustained collaboration among industry stakeholders, policymakers, and research organisations, ensuring its long-term relevance.

8.3 Insights from the International Expert Workshop on PI and standardisation

On the 22nd October 2025, an International Expert Workshop titled *"International Standardisation Needs for Scaling Up Innovation and Advance Implementation of Physical Internet in Urban Logistics & Beyond – From pilots to large scale implementation"* was organized by ALICE. The workshop counted with the participation of ISO experts, ALICE members, relevant project Consortia (URBANE, DISCO, IKIGAI, Shift2Zero) and external guests. The main objective of the Workshop was to identify emerging issues in standard development or where experts feel that standardisation is challenged by the PI practitioners.

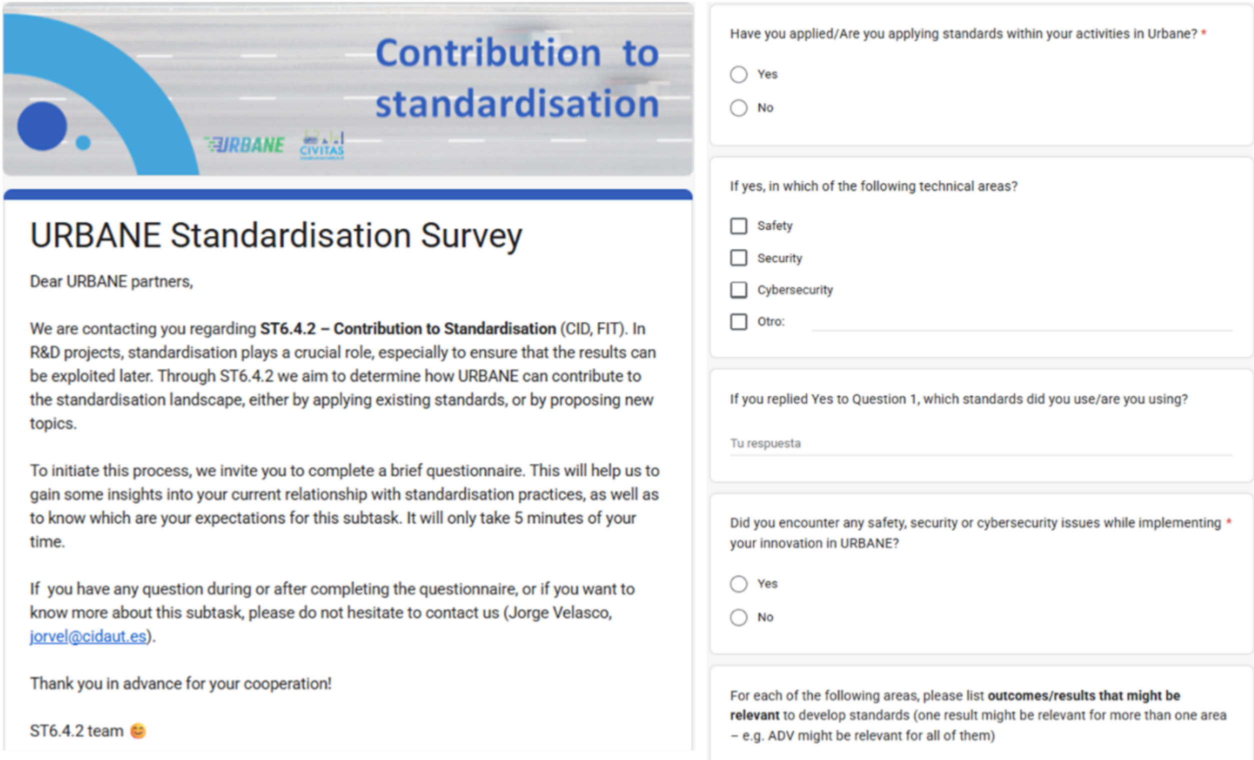
During the Workshop, it was emphasised that ISO has made significant efforts to develop standards relevant to urban logistics and Physical Internet applications. Ongoing work includes standards for parcel locker systems, as well as related initiatives such as unmanned stores and other shared urban logistics infrastructures. Although these standardisation activities provide an essential foundation for interoperability, safety, and scalability, there is still a lot of work to be done. In this regard, the transition towards a harmonised and widespread PI would be accelerated if a dedicated ISO Technical Committee for PI was created.

Furthermore, the workshop led to a set of recommendations, which are briefly enumerated here for the sake of completeness:

- Prioritise small, targeted standardisation efforts with demonstrable benefits
- Strengthen links between projects and national/international standardisation bodies
- Begin implementation in parallel with standardisation
- Continuously monitor R&I activities and standardisation progress

Survey circulated among URBANE partners

After the demonstration of URBANE innovation within the 6 pilots (Wave1+Wave 2), a survey was conducted and circulated among the URBANE partners to reflect on lessons learned and to better understand their connection to standardisation and to identify which areas of their work could benefit from greater or enhanced standardisation (Figure 3).


Contribution to standardisation

URBANE Standardisation Survey

Dear URBANE partners,

We are contacting you regarding **ST6.4.2 – Contribution to Standardisation** (CID, FIT). In R&D projects, standardisation plays a crucial role, especially to ensure that the results can be exploited later. Through ST6.4.2 we aim to determine how URBANE can contribute to the standardisation landscape, either by applying existing standards, or by proposing new topics.

To initiate this process, we invite you to complete a brief questionnaire. This will help us to gain some insights into your current relationship with standardisation practices, as well as to know which are your expectations for this subtask. It will only take 5 minutes of your time.

If you have any question during or after completing the questionnaire, or if you want to know more about this subtask, please do not hesitate to contact us (Jorge Velasco, jorvel@cidaut.es).

Thank you in advance for your cooperation!

ST6.4.2 team 😊

Have you applied/Are you applying standards within your activities in Urbane? *

- Yes
- No

If yes, in which of the following technical areas?

- Safety
- Security
- Cybersecurity
- Otro:

If you replied Yes to Question 1, which standards did you use/are you using?

Tu respuesta

Did you encounter any safety, security or cybersecurity issues while implementing your innovation in URBANE? *

- Yes
- No

For each of the following areas, please list **outcomes/results that might be relevant** to develop standards (one result might be relevant for more than one area – e.g. ADV might be relevant for all of them)

FIGURE 3 - EXTRACT FROM THE SURVEY ON STANDARDISATION CIRCULATED AMONG URBANE PARTNERS.

Four partners replied to the survey: ALICE, COBO, NORCE, and INLECOM. The findings revealed that some partners are already employing standards in the following technical areas: physical and digital standards for parcel lockers, cybersecurity, public procurement, and process modelling. Besides, 75% of respondents acknowledged having detected standardisation needs during their work within URBANE. Furthermore, half of the participants declared to have encountered safety, security or cybersecurity issues while implementing their innovations, challenges that potentially could have been avoided through the use of adequate standards. It is interesting to remark that one of the partners surveyed is actively participating in the ISO TC344/SC1 on retail logistics.

Based on the partners' initial replies, they were then asked to identify the main outcomes and results that might be employed to develop standards in the safety, security, cybersecurity, and in other technical (more generic) areas. The following feedback was received:

Safety domain: Insurance policies and procedures for the goods stored in the micro-hubs, and for the facilities themselves**;** Risk assessment and management; Reliability of logistics operations; Availability of logistics services; Functional Safety Assurance; Hazard analysis (e.g. HAZOP, FMEA, FTA); Incident reporting and management; Safety Integrity Levels (SIL); Robustness against failure.

Security domain: Authentication and authorization for users**;** Confidentiality standards; Integrity standards; Intrusion detection and prevention; Physical security; Auditability and traceability.

Ciber-security domain: Blockchain: implementation and access management**;** Vulnerability management; Threat modelling and analysis; Incident response and recovery; Cryptographic security; Secure communication protocols; Data protection and privacy; Secure software development lifecycle; Cyber-resilience.

Other technical domain: Parcel locker**;** Data sharing standards.

An overview of the results of the feedback obtained through the survey is shown below in Figure 4:

Project Name: URBANE **Task:** ST6.4.2

Total participants:

1. Have you applied/Are you applying standards within your activities in Urbane?

Response	Percent	Visual
Yes	100.00%	
No	0.00%	

2. If yes, in which of the following technical areas?

Response	Percent	Visual
Safety	0.00%	
Security	0.00%	
Cybersecurity	25.00%	
Physical and digital standard of pacel lockers	25.00%	
Public procurement	25.00%	
Modelling	25.00%	

3. If you replied Yes to Question 1, which standards did you use/are you using?

Response	Percent	Visual
Italian Code of Public Contracts - D.lgs. n. 36/2023 (cod. contr.)	25.00%	
UML	25.00%	
DIDs	25.00%	
Verifiable Credentials	25.00%	
OAuth	25.00%	

4. Did you encounter any safety, security or cybersecurity issues while implementing your innovation in URBANE?

Response	Percent	Visual
Yes	50.00%	
No	50.00%	

6. Have you detected any standardisation need during your work in URBANE?

Response	Percent	Visual
Yes	75.00%	
No	25.00%	

7. Have you or your organization ever participated in the elaboration of a standardisation

Response	Percent	Visual
Yes	0.00%	
No	100.00%	

8. Is your organization active nowadays in any Standardisation Committee or Technical Group?

5.a. In the safety domain, please list outcomes/results that might be relevant to develop

Response	Percent	Visual
Insurance policy for the goods stored in the micro-hub and the facility	25.00%	
Risk Assessment and Management	25.00%	
Reliability	25.00%	
Availability (AVA)	25.00%	
Functional Safety Assurance	25.00%	
Hazard Analysis (HAZOP, FMEA, FTA)	25.00%	
Incident Reporting and Management	25.00%	
Safety Integrity levels (SIL)	25.00%	
Robustness Against Failures (ROB)	25.00%	

5.b. In the security domain, please list outcomes/results that might be relevant to develop

Response	Percent	Visual
Insurance policy for the goods stored in the micro-hub and the	25.00%	
Authentication and Authorization (AUTH)	25.00%	
Confidentiality (CONF)	25.00%	
Integrity (INTG)	25.00%	
Access Control	25.00%	
Intrusion Detection and Prevention (IDP)	25.00%	
Physical Security	25.00%	
Auditability and Traceability (AUD)	25.00%	

5.c. In the cybersecurity domain, please list outcomes/results that might be relevant to develop st

Response	Percent	Visual
Blockchain: implementacion and access management	50.00%	
Vulnerability Management (VULN)	25.00%	
Threat Modeling and Analysis (TMA)	25.00%	
Incident Response and Recovery (IRR)	25.00%	
Cryptographic Security	25.00%	
Secure Communication (SCOM)	25.00%	
Data Protection and Privacy (DPP)	25.00%	
Secure Software Development Lifecycle (SSDLC)	25.00%	
Cyber Resilience	25.00%	

FIGURE 4 - SCREENSHOT OF THE ANALYSIS OF THE STANDARDISATION SURVEY RESPONSES

8.4 Gap analysis - Standardisation needs emerging from URBANE use cases

The last mile logistics sectors usually moves faster than public policies. Standardisation could support policymaking, helping it to keep pace with the new and changing urban freight realities (e.g. use of logistics space). Currently, logistic networks are still characterized by a scattered and unbalanced set of terms, rules, standards and regulations, which may differ from city to city within a country.

In this vein, there are some aspects of the last mile logistics ecosystem linked to URBANE interventions where standardisation could provide tangible benefits:

- The feasibility of using ADVs for last-mile operations is currently dependent on local regulations and priorities. The absence of standards specifying the functional and technical requirements of ADVs that would ensure operational safety and compatibility with physical infrastructure of the city (e.g. multimodal delivery along with trams – Karlsruhe LL) often prevents ADVs from wider implementation.
- Smart parcel lockers (e.g. Bologna LL) are also affected by the lack of technical and functional standards ensuring that they can incorporate multiple data sources and that they can be used by different operators, often leading to redundant and non-optimal deployment strategies.
- Traditional logistics networks lack transparency due to siloed data and incompatible IT systems. Sometimes the logistics activity is not even properly digitalised, as exemplified in the Valladolid LL, in which the occupancy of L/U zones is controlled manually by a dedicated person. Promoting

standard data exchange platforms and protocols would foster trust amongst stakeholders and would make data collection and usage easier and cheaper.

- Sustainability Standards: there's no unified standard for evaluating the impact of logistics operations, making comparison between logistics operators almost impossible.
- Light electric vehicles and cargo bikes (like those employed in Valladolid/Barcelona LLs) frequently operate in the absence of well-defined standards regarding technical specifications, traffic integration, and safety requirements. This slows their deployment in urban and often causes frictions with other mobility agents (e.g. pedestrians, bikes, passenger vehicles, etc.)

The following table outlines the relationship between URBANE's technologies, current standardisation gaps and suggested initiatives to bridge the gaps:

TABLE 4 - KEY TECHNOLOGIES OF URBANE TOOLS, STANDARDISATION GAPS & RELEVANT STANDARDISATION BODIES

URBANE Technology	Gap detected	Suggested intervention	Relevant standardisation bodies
Intelligent parcel lockers	These infrastructure assets are frequently proprietary solutions, not allowing seamless access by multiple logistics operators	Progress towards a common set of technical standards for parcel lockers ensuring interoperability and open access to shared infrastructure assets	ISO TC 344
Autonomous vehicles for last-mile deliveries	Its implementation is severely influenced by policies at local level and there are no clear regulations ensuring its operational safety and compatibility with other delivery methods	Regulatory adaptation must run in parallel with technological development and pilot execution. Safety and compatibility standards should be developed to foster adoption	ISO TC 22 ISO TC 204
Innovative electric vehicles for last-mile operations	The technical features of this kind of vehicles are not comprehensively defined by regulation, which causes frictions in what concerns their co-existence with other road agents (micromobility, cars, vans, pedestrians)	A clear set of rules establishing technical and operational limits for electric cargo bikes and guidelines for ensuring a smooth integration in urban traffic networks would foster its adoption	ISO/TC 268
Blockchain & smart contracts	The implementation of these technologies is often hindered by reluctance from operators and from a non-appropriate IT infrastructure and information security procedures	Develop a clear legal framework for smart contract implementation for logistics, including data management and data privacy considerations	ISO/IEC JTC 1 ISO/TC 307 ISO/TC 321 GS1
DT platform containing last-mile delivery services and models	The implementation of these technologies is often hindered by reluctance from operators and from a non-appropriate IT infrastructure and information management procedures	Initiatives should enable to move from fragmented and proprietary implementation to interoperable, modular, and open-source architectures	ISO/IEC JTC 1 GS1

URBANE Technology	Gap detected	Suggested intervention	Relevant standardisation bodies
IoT tools (e.g. RFID)	The wireless nature of RFID makes it vulnerable to unauthorised data scanning. Besides, there are interoperability issues between solutions provided by different vendors	Initiatives should focus on ensuring global interoperability and cost-effective deployment of RFID solutions	ISO/IEC JTC 1 GS1
Impact Assessment Radar	There is not a common framework to establish reliable metrics for logistics operation performance that allows the comparison between different agents or services	Progress towards widely accepted and consistent methods for the calculation and reporting of logistics operations impact, prioritising transparency	ISO/TC 268 ISO TC 344

One of the clearest standardisation needs concerns the physical interoperability of shared logistics assets. The workshop report highlights parcel lockers, shared urban logistics infrastructure and modular physical assets as key areas where interoperability is essential for scale. This is highly consistent with URBANE's demonstrator portfolio, where micro-hubs, lockers, modular transhipment systems and shared delivery environments are expected to serve multiple operators and users. Where physical standards are lacking, each asset type may become tied to a specific service provider, city configuration or proprietary system, thereby reducing the efficiency gains associated with sharing. Project results indicate that lockers such as those tested in Bologna are affected by the absence of technical and functional standards that would ensure compatibility with multiple data sources and allow use by different operators. In the absence of such standards, there is a risk of redundant and non-optimal deployment, with parallel proprietary networks rather than interoperable systems. This is particularly important from a policy perspective, as cities seeking to support open and efficient logistics ecosystems may otherwise unintentionally reinforce market fragmentation through poorly coordinated infrastructure deployment. The wider Physical Internet perspective reinforces this logic. emerging PI Norm as a framework (see IKIGAI project) composed of shared procedures, technical specifications and digital protocols intended to ensure compatibility and interoperability across logistics operations. Within this framework, operational procedures, standardised load units, identifiers, packaging rules and digital exchange formats are all treated as building blocks for a more modular and interoperable logistics system. Although the PI Norm is still evolving, its relevance to URBANE lies in the fact that it provides a conceptual basis for understanding why shared urban logistics assets require standardisation if they are to move from niche pilots to broader systems of use.

Building on the overall standardisation needs identified above, URBANE also highlights a number of more specific issues related to physical interoperability, digital integration, and operational conditions for emerging urban logistics services.

Physical interoperability and shared assets

For URBANE, the main additional issue under physical interoperability concerns the risk that shared logistics infrastructure remains operator-specific rather than becoming genuinely open and reusable. This is particularly relevant for parcel lockers, modular transhipment assets and micro-hub components, where the absence of common physical and functional specifications can result in parallel proprietary systems, inefficient deployment and reduced sharing potential. From a policy perspective, this means that cities supporting shared infrastructure should pay closer attention to interoperability requirements in procurement, permitting and access conditions.

Digital interoperability and data exchange

A further important point concerns the need to move beyond fragmented digital solutions towards interoperable environments that can support routine cooperation across actors and systems. In URBANE, this is particularly relevant for DTs, smart contracts, monitoring tools and impact-assessment components.

Operational rules, safety and service quality

A final issue concerns the lack of sufficiently clear operational standards for emerging logistics services and vehicles. URBANE highlights that ADVs, cargo bikes, light electric vehicles and collaborative service models may face adoption barriers not only because of regulation, but because the operational rules needed to ensure safety, reliability and service quality are still underdeveloped. This suggests that standardisation efforts should also address minimum conditions for safe and dependable operations, especially where shared infrastructure, multimodal systems or public-private delivery arrangements are involved.

8.5 Priority actions for standardisation stakeholders

The evidence reviewed in this chapter points towards a set of practical priorities for standardisation stakeholders connected to URBANE.

- Focus on a limited number of high-value domains where standards could unlock immediate replication benefits. These include interoperable parcel lockers, common data-sharing protocols, safety and technical specifications for autonomous and low-emission delivery systems, and trusted digital governance mechanisms for collaborative operations. These are the areas where URBANE has both practical implementation experience and clearly identified barriers linked to the absence of common standards.
- Strengthen cooperation between research projects, cities, industry actors and standardisation bodies. The workshop findings strongly support this approach, noting that standards need to evolve alongside technological development, operational innovation and sustainability requirements. For URBANE, this means that LL evidence, transferability work and user feedback could be systematically translated into standardisation inputs rather than treated as self-contained project outputs.
- Establish a strong link between standardisation and policymaking. Last-mile logistics often evolves faster than public policy and standardisation can help policymakers keep pace with changing urban freight reality.

9 Policy package

9.1 Purpose and structure of the policy package

The purpose of this policy package is to translate the evidence generated through URBANE into a coherent set of recommendations that can support the adoption and scaling of innovative green urban logistics solutions. In line with Task 6.4, the package is intended to address the aforementioned barriers, improve the integration of novel delivery models into city planning, support safety, security and cybersecurity, and contribute to standardisation and wider uptake across European cities and businesses. The action-oriented recommendations presented in this chapter build on all strands of evidence including the Lighthouse and Twinning LLs, the follower-city feasibility studies, the stakeholder and CIVITAS policy exchanges and the standardisation and commercialisation. The package is structured by governance level and stakeholder group. This reflects a key finding of URBANE, that transition to greener and more collaborative urban logistics cannot be delivered by a single actor category. Cities, regional and national authorities, EU institutions, logistics operators, retailers, infrastructure owners, technology providers and citizens influence the conditions for adoption. The recommendations below therefore distinguish between actor groups.

9.2 Policy recommendations for local and metropolitan authorities

R1. Treat urban freight as a core planning issue, integrating innovative logistics measures into SUMPs, SULPs and related policy instruments. The URBANE evidence showed that interventions are far more likely to support long-term change when they are linked to formal planning frameworks rather than implemented as isolated pilots.

R2. Establish clear local governance models for shared urban logistics assets. The demonstrator and follower-city findings show that micro-hubs, collaborative delivery schemes and interoperable locker systems require rules on access, responsibilities definition, cost-sharing and service conditions. Local authorities should consider using neutral management structures, transparent permitting rules and clearly defined contractual arrangements to support fair participation by multiple operators.

R3. Secure and manage urban space proactively for sustainable logistics. Lack of suitable space is one of the most persistent barriers identified, affecting hubs, lockers, loading zones and low-emission distribution schemes. Municipalities should move from ad hoc site allocation towards strategic spatial planning for freight, including the identification of suitable locations for consolidation facilities, dedicated loading and unloading areas, and pick-up and drop-off infrastructure. This should be linked to broader objectives on public-space quality and accessibility.

R4. Strengthen local capability in data governance and digital logistics planning. URBANE's digital tools and policy dialogue demonstrate that cities need improved capacity to collect, manage and use urban freight data, and to define conditions for access and interoperability. Local authorities should invest in data-readiness assessments, freight data governance protocols, internal capacity building and digital planning tools capable of informing scenario analysis and decision-making. This should include attention to privacy, commercial confidentiality and cybersecurity.

R5. Use local policy as an enabler of experimentation. Innovative logistics solutions often require adaptation of access rules, pilot permits, testing conditions or procurement approaches. Local authorities should create controlled spaces for experimentation, accompanied by monitoring and evaluation, rather than expecting innovative services to fit immediately within legacy regulatory structures.

R6. Support public communication and user trust as part of implementation. URBANE made clear that awareness, understanding and trust are necessary for sustained uptake. Cities should complement regulatory and infrastructure measures with targeted communication, demonstration activities, citizen engagement and transparent information on expected benefits and trade-offs. This is very important where new delivery patterns affect neighbourhood space, access conditions or user routines.

9.3 Policy recommendations for regional and national authorities

Regional and national authorities can create enabling conditions that local authorities cannot establish alone.

R1. Develop clear legal and regulatory pathways for emerging urban logistics solutions, particularly in relation to autonomous delivery systems, low-emission delivery vehicles, and the use of shared public infrastructure. Provide clear legal definitions, pilot authorisation procedures and safety guidance.

R2. Support regional and national coordination frameworks for urban freight planning. Many municipalities, especially smaller ones or cities at an earlier stage of SULP development, lack the capacity to design freight strategies independently or to negotiate effectively with logistics providers and technology actors. They need methodological guidance, planning templates, and funding support.

R3. Develop supportive funding for low-emission and collaborative logistics infrastructure (grant schemes, co-financing instruments etc.) that lower the cost of transition, ensuring that support measures do not disadvantage smaller operators and SMEs.

R4. Promote consistent data-governance and reference interoperability frameworks across jurisdictions. (e.g. guidance on urban freight Data Spaces).

9.4 Policy recommendations for EU institutions and programmes

R1. Support urban freight as a strategic policy and innovation field linked to decarbonisation, digital transition, urban resilience and the urban space. EU institutions should ensure that urban freight remains visible in future implementation guidance and research and innovation programming.

R2. Strengthen support for interoperability and standardisation in areas directly relevant to urban logistics. EU institutions and related programmes should support targeted standardisation pathways in collaboration with ISO, CEN and other relevant bodies.

R3. Align research and innovation funding more closely with real adoption conditions. The policy-dialogue material indicates that stakeholders see a continued need for support on governance models, data-sharing frameworks, user acceptance, standardisation and business viability, not only on technical performance. Future European calls should promote integrated demonstration and adoption approaches that combine technical innovation with standardisation work and local capacity building.

R4. Support structured replication mechanisms between cities. URBANE's follower-city and Twinning LL processes showed that transferability benefits from peer exchange and context-sensitive adaptation. EU programmes should continue to support city-to-city replication formats and peer-learning mechanisms that help municipalities move from interest to implementation.

R5. Encourage common European approaches to monitoring and evaluation of urban logistics innovation. The project's validation and impact-assessment work demonstrated the value of comparable KPIs, structured before/after assessment and broader evaluation of economic, environmental and social effects. EU programmes should consolidate and disseminate such approaches.

9.5 Recommendations for logistics operators and service providers

R1. Engage proactively in collaborative urban logistics models. URBANE demonstrated that shared hubs, parcel lockers and collaborative delivery systems can improve efficiency and sustainability, but also that uptake is limited where operators are unwilling to cooperate or where the rules of participation remain unclear. Operators should participate early in co-design processes and help shape fair, workable operational models.

R2. Invest in data readiness and interoperability as strategic capabilities. Operators that wish to benefit from future collaborative and zero-emission logistics systems should develop internal capabilities for secure data sharing, system integration and data-driven service improvement.

R3. Incorporate business-model innovation into sustainability transitions. Operators should test new revenue and partnership models alongside infrastructure and fleet innovation, particularly where shared services or multimodal concepts are involved.

R4. Strengthen communication with both public authorities and users. Operators should treat communication, onboarding and user trust as core components of service design.

9.6 Recommendations for retailers, developers, infrastructure owners and technology providers

R1. Align site development, retail operations and building management. The evidence from URBANE showed that the siting and design of lockers, hubs and collection infrastructure are crucial to service performance and adoption.

R2. Support open and interoperable service ecosystems rather than isolated proprietary systems. Technology providers and infrastructure owners should develop solutions that can connect with wider logistics ecosystems, reducing duplication and increasing the potential for shared use.

R3. Engage actively in business-model co-design with cities and operators. Retailers and infrastructure owners should be part of the discussion on co-financing, service contracts and responsibilities.

R4. Support communication and behavioural change. Retailers and digital service providers may influence delivery choices and inform consumers about sustainable options.

9.7 Cross-cutting recommendations on ethics, data governance, safety & user trust

R1. Embed safety, security and cybersecurity considerations into the design, procurement and governance of urban logistics innovations from the outset.

R2. Treat data governance as a policy issue, not merely a technical one. Policies and implementation frameworks should define what data is needed, and also under what terms they may be shared.

R3. Build user trust through transparency, reliability and demonstrable value. Adoption is more likely when the innovation is understandable, easy to use and visibly beneficial.

R4. Adopt phased and context-sensitive implementation strategies. The project evidence strongly suggested that cities and stakeholders vary significantly in readiness, capacity and local conditions. Policy frameworks should support different entry points, allowing actors to begin with data collection, stakeholder coordination, local pilots or spatial planning before moving towards larger-scale deployment.

10 Solutions-based recommended actions by Innovation Area

This chapter complements the policy package by reorganising key recommendations around the main innovation areas addressed by URBANE. The rationale for doing so is practical. Cities and stakeholders are often not starting from an abstract governance level, but from a concrete solution under consideration. A solution-based perspective helps translate the broader policy package into more operational guidance. The recommendations below are grounded in URBANE's evidence.

10.1 Shared micro-hubs, lockers and urban logistics infrastructure

Shared infrastructure refers to physical and organisational logistics assets that are used jointly by multiple stakeholders instead of being owned and operated solely by one company. Shared infrastructure includes micro hubs, parcel lockers, UCCs and similar physical facilities that are accessible to multiple logistics companies and service providers. These facilities can serve as places where goods are consolidated, sorted, transferred or temporarily stored before final delivery into dense urban areas. The following recommended actions are aimed at helping cities and stakeholders establish, govern and sustain shared logistics infrastructure effectively:

For local authorities

- Streamline permitting processes. Simplify and expedite permit approvals for piloting and deploying new delivery technologies to reduce delays and enable rapid testing and scaling of innovative logistics solutions. The most significant challenge faced within the Helsinki LL was securing a suitable location for their operations. Obtaining a permit to rent land from the city of Helsinki proved to be a lengthy and resource-intensive process, causing delays and requiring careful navigation of bureaucratic procedures. This slowed down implementation and demanded considerable effort to meet all the regulatory requirements.
- Adopt open, multi-operator locker models. Cities should promote or require parcel lockers in the public domain to operate as open, interoperable infrastructure accessible to multiple delivery operators on fair and transparent terms. The primary directive for city planners and procurement officers should be the enforcement of "open access" or "carrier-agnostic" interoperability. When a municipality releases a tender or signs a concession agreement for the installation of parcel lockers on public grounds, the contract must explicitly prohibit exclusivity. The operator granted the license to use the land should be contractually obligated to open the interface of their locker network to other logistics providers.
- Prioritise location planning. In Helsinki and Barcelona, early location selection has been identified as a crucial element for efficient operations. Cities should prioritise the development of distributed micro-consolidation centres and integrate small-scale logistics spaces into urban planning frameworks. Public authorities could also facilitate deployment by reserving or temporarily allocating publicly owned or underused spaces to zero-emission and sustainable logistics operators. Implementing more comprehensive planning phases before launching new pilots is essential. Strategic placement of lockers should incorporate multiple data sources and stakeholder needs. In Thessaloniki, the locker location analysis resulted in ACS adopting at least five proposed sites from over one hundred potential sites identified. The assessment combined ACS demand data, customer survey results, urban planning data, and CERTH's DT to optimise cost-effective network design.

RCM's regional sustainability objectives guided the process, supporting the development of a shared locker alliance network through data-driven planning.

For private operators

- Prioritise consistent and growing volumes to ensure profitability. In the Helsinki LL, a key finding was that delivery volume must be high to justify the hub's viability. A way is to focus replication efforts in areas with high residential delivery volumes and political commitment. Bologna evidence has also shown that the microhub would give a greater benefit if it was also exploited as a pickup point by the final recipient.
- Secure city support by encouraging active involvement in identifying and providing suitable, affordable hub locations.
- Establish a neutral hub manager. Identify a neutral party to oversee hub operations (parcel sorting, receiving) and facilitate collaboration among stakeholders and overall management of the premises.
- Ensure that there is a responsible party for the management, maintenance and technical assistance of micro hubs. Common issues can include equipment malfunctions, such as failed door mechanisms, requiring remote repairing or on-site intervention. The evidence from the Bologna LL highlights the importance of incorporating a third-party call centre operator into the first-level assistance structure to manage handling of technical problems and ensuring the smooth operation of the system.

For EU Commission Services

- Promote EU funding for logistics infrastructure prioritising the inclusion of SMEs. Currently, the high cost of building proprietary delivery networks creates a significant barrier to entry for smaller players. If EU funds are directed toward carrier-agnostic parcel lockers and micro-hubs, local retailers and small couriers will gain the same high-tech delivery capabilities as global logistics giants.
- Integrate shared logistics infrastructure into urban mobility and land-use planning frameworks. The objective is to encourage local authorities to allocate public land or repurpose underused spaces for UCCs, micro-hubs, and parcel lockers. EU guidance on common technical standards for parcel lockers, micro-hub operations, and data exchange platforms can enable access by multiple logistics operators. URBANE has shown that shared logistics assets perform best when they are embedded in wider freight, land-use and mobility planning, rather than negotiated on a case-by-case basis.

10.2 Autonomous delivery systems

URBANE project tested two types of ADVs in last-mile deliveries. Helsinki and Karlsruhe LLs have tested autonomous delivery robots to evaluate performance, public acceptance, and operational challenges for adoption. The project evidence suggests that these solutions may offer value in specific use cases, especially for localised or low-volume deliveries, but also that their adoption is heavily dependent on regulatory flexibility, safety assurance, operational design and public trust. The following recommended actions identify the conditions that cities and policymakers need to address in order to move ADV deployment beyond controlled pilots towards broader and more sustained adoption:

For local authorities

- Prioritise the early mapping of the regulatory landscape. Cities need a clear overview of relevant laws, safety standards, labour regulations and data protection obligations before they define detailed pilots. This mapping should be documented in an accessible manner for all actors in the ecosystem, including private operators and technology providers.

- Establish clear legal pathways for pilot projects to transition into permanent policy measures. As Antwerp's experience demonstrates, the absence of a regulatory framework can prevent cities from effectively managing the deployment and integration of emerging technologies such as ADVs. Create a framework that reflects the city's priorities and leaves room for evolution. Institutional learning and regulatory adaptation must proceed hand in hand with technological development if such systems are to reach maturity.
- Do not underestimate non-technical domains. More persistent obstacles were again found in non-technical domains, such as the establishment of safety regulations for mixed passenger–freight tram operations, public acceptance, and liability issues. These findings echo the experiences reported from the Helsinki LL. In Helsinki, too, the implementation of automated delivery systems faced significant delays due to regulatory uncertainty and the lack of established procedures for approving novel transport modes.
- Ensure that automation is linked to public-value use cases. Not all urban logistics contexts benefit equally from autonomous delivery, and URBANE's transferability logic suggested that context matters greatly. Cities should therefore assess automation in relation to clearly defined policy objectives, such as improved neighbourhood access, lower-emission hyperlocal delivery, service provision in specific spatial environments or reduction of failed delivery attempts, rather than treating automation as an end in itself. This would allow deployment decisions to be better aligned with planning needs and public interest considerations.
- Build public understanding and trust alongside technical deployment. The project's adoption-related material made clear that user trust and social acceptance are necessary for uptake. In the case of autonomous delivery systems, communication and visibility are likely to be particularly important because concerns may arise around safety, surveillance, reliability or the perceived appropriateness of the technology in shared public space. Authorities (and operators) should provide transparent information and opportunities for public feedback during pilot and early deployment phases.

For private operators

- Optimise Robot Deployment. Conduct analysis to determine the optimal robot size based on delivery volume and urban environment characteristics. In the Helsinki LL, the smaller robot demonstrated better adaptability to the urban environment and gathered more positive public responses when residents encountered it in urban environment. Optimal robot size depends on delivery volume, with larger robots requiring higher parcel quantities to justify their use.
- Allocate time, funding, and expertise to manage technical complexity. Technical challenges can be complex, they are generally manageable with sufficient time, resources, and know how. Engineering solutions for vehicle automation, navigation, data exchange, or communication between robots and tram systems are achievable within a well-structured research and development framework.

For EU Commission Services

- Develop dedicated EU-level regulation that provides a harmonised framework for the authorisation, safety certification and operational deployment of ADVs. TwinswHeel projects that by 2030, the European regulatory environment should support the mass deployment of logistics ADVs, with a market potential of 100,000 units. However, realising this potential will require the EU to actively support domestic manufacturing, protect European intellectual property, and secure supply chains for critical components, including batteries.

- Create structured regulatory pathways for controlled experimentation with autonomous delivery systems. The evidence from URBANE has shown that many of the main barriers concern permissions, legal definitions, field-testing possibilities and the fit between new vehicles and existing urban rules. Authorities should therefore define experimental frameworks with clear responsibilities, operational limits, monitoring obligations and safety requirements, so that innovation can proceed without regulatory ambiguity.
- Consider safety, security and operational integration as foundational policy conditions rather than secondary concerns. URBANE's standardisation work identified significant gaps in standards for ADVs in complex urban settings, particularly regarding technical and functional requirements. Authorities should evaluate automation against its ability to interact safely with pedestrians, cyclists and urban infrastructure and pilot design should incorporate robust risk management, incident-handling and public communication from the start

10.3 Digital Twins, AI tools and impact assessment for data-driven decision-making

DTs, CitIQore application, AI-enabled planning tools, the smart contract generator and the Impact Assessment Radar form a central enabling layer within URBANE. The CitIQore application was specifically developed to support non-expert users in visualising historical and real-time insights and exploring “what-if” scenarios. These tools are important not only for operations, but also for policy design because they help cities and stakeholders assess options, compare scenarios and estimate likely impacts before implementation. The following recommended actions are intended to support cities and stakeholders in deploying and embedding these tools effectively:

For local authorities

- Use DTs and related decision-support tools as planning instruments. URBANE has shown that these tools can help municipalities understand context-specific delivery networks, explore alternative combinations of measures and identify opportunities for improvement. Local and metropolitan authorities should integrate digital planning tools into urban logistics strategy development, SULP preparation and pilot design, while ensuring that the outputs remain understandable and useful for non-specialist decision-makers.
- Invest in data quality, institutional capability and governance as prerequisites for meaningful digital use. The value of DTs and impact-assessment tools depends on the availability of reliable data and on the capacity of cities and operators to interpret results correctly. The follower-city process confirmed that data and digital tool needs must be assessed alongside infrastructure, governance and funding conditions. Policy support for DTs should include capacity-building, data-readiness assessment and practical governance guidance.
- Ensure that digital tools remain interoperable and open enough to support transferability. One of the main promises of the URBANE platform is that it can support multiple LLs and different city contexts. To sustain this value, future deployments should avoid excessive customisation that prevents reuse and should instead favour architectures, models and interfaces that can be adapted across contexts with manageable effort. This is both a technical and a policy issue, since public investment in digital planning tools should maximise long-term transferability and reduce duplication.

- Integrate CCTV with transparent, multipurpose urban management objectives. Public authorities should approach CCTV as part of an integrated urban management and safety ecosystem. This means clearly defining policy objectives for CCTV use, not only with a focus on freight but taking into consideration other aspects such as crime prevention, traffic management or public space protection, and aligning them with transparent governance frameworks.

For private operators

- Simplify and streamline data input processes for decision-support models. Developing standardised data templates and automation tools can significantly reduce the time and effort required for data preparation, enabling faster and more efficient decision-making. In Thessaloniki LL, the data input requirements for the various models used, particularly the Facility Location Model, were extensive and required considerable effort to organise and standardise. This complexity occasionally delayed the decision-making process and required additional resources.
- Increase the robustness and resilience of technological components. RFID readers, antennas, wiring, batteries, and communication equipment should be housed in weather-resistant, shock-absorbing, and shielded enclosures to withstand real urban operating conditions. In Barcelona, the pilots demonstrated that reliable parcel detection requires multiple antennas in specific positions within the cargo-bike container. In Bologna, higher-than-expected data consumption from microhub SIM cards has been observed.
- Design solutions as open, modular systems. Use open-source components where possible, define clear APIs and data models, and document configuration guidelines. This reduces adaptation costs and makes it easier to integrate with local ICT infrastructures and Data Spaces. The open architecture design of the DT, routing tools and traceability components has shown that modules developed in one context can be re-used with relatively limited adaptation elsewhere. The main changes concern data integration, parameter values and user interfaces rather than core algorithms.
- Prioritise interoperability of CCTV systems. Private companies involved in the design, deployment and operation of CCTV systems should prioritise interoperability and privacy-by-design. Solutions should be adaptable to different urban contexts and capable of integrating with other smart city systems.
- Refine models through continuous integration of operational data. In Barcelona LL, DTs and routing optimisation models should be fed with detailed real-world data (e.g. unloading times, route inefficiencies, courier behaviour, parcel variability) to improve predictive accuracy and support dynamic routing.

For EU Commission Services

- Promote common KPI frameworks and structured impact assessment, extending the CIVITAS KPI framework, to support comparability across solutions and cities. URBANE's validation methodology and the use of the Impact Assessment Radar has shown the value of consistent monitoring for environmental, economic and social outcomes. Policymakers and funding bodies should encourage the use of comparable impact-assessment approaches so that decisions on scaling and transferability are based on evidence.

10.4 Collaboration governance, smart contracts and trusted data sharing

A distinctive feature of URBANE is its focus on collaboration governance, including consensus protocols, smart contracts and blockchain-enabled coordination. The smart-contract generator is already available for cities and this component forms part of the wider transferability infrastructure alongside DTs and the Impact

Assessment Radar. The rationale for this architecture is to support collaborative services in local logistics networks through trusted and transparent arrangements. The following recommended actions are intended to support cities and stakeholders in adopting smart contracts in collaborative logistics settings:

For local authorities

- Support the establishment of trusted governance frameworks for shared logistics ecosystems. Many of the barriers identified in URBANE stem from weak trust between actors, uncertainty around access conditions, and concerns over confidentiality, roles and liabilities. Smart contracts and related digital governance tools offer one possible mechanism for formalising agreements and reducing ambiguity, but they need to be embedded in a wider governance framework that is understandable, lawful and acceptable to all participating actors. Public authorities should promote governance experimentation and define minimum principles for transparency, accountability and fair participation in collaborative services.
- Recognise blockchain and distributed ledger technologies as practical tools for enhancing transparency, traceability and trust in urban logistics operations. URBANE demonstrated that blockchain integration does not require a fundamental restructuring of existing IT infrastructure. In Thessaloniki, the modular design of the blockchain component allowed straightforward integration with existing tracking systems. In Barcelona, the combination of RFID and blockchain demonstrated the value of interoperable traceability tools, while in Helsinki, blockchain provided a reliable real-time interface for monitoring delivery progress. Cities should build on this evidence by promoting shared digital standards that support transparency, performance monitoring and regulatory compliance, and by creating governance conditions that allow blockchain-enabled data sharing to be extended beyond individual pilots towards routine operational use
- Link digital governance tools to practical service and policy needs rather than introducing them as stand-alone technological features. URBANE's blockchain architecture is valuable because it is tied to identifiable urban logistics use cases, including service-level transparency, secure sharing and collaborative decision-making. Future deployment should follow the same principle. Smart contracts and ledger-based tools should only be promoted where they respond to clear operational and governance problems, such as managing access to shared hubs, monitoring collaborative delivery rules or clarifying responsibility across actors.

For private operators

- Ensure that trusted data sharing is accompanied by strong privacy, security and access-control safeguards. The standardisation-related work and policy discussions both indicate that cybersecurity, data protection, identity management and confidentiality are key concerns. This means that trusted data-sharing frameworks need to define who may access which data, under what conditions, for what purpose, and with what accountability. Without such safeguards, digital collaboration mechanisms may struggle to gain acceptance even where the underlying technical platform is sound. The adoption of Data Spaces can contribute towards this direction.

For EU Commission Services

- Drive the development of common data formats, exchange standards and trusted governance protocols that enable urban logistics digital systems to operate across organisational and city boundaries. The wider policy and standardisation discussions make clear that fragmented digital systems are a barrier to scale. Common data formats, exchange rules and trusted governance protocols would reduce transaction costs, simplify onboarding and support wider reuse across cities and service providers. This is especially relevant where publicly supported logistics ecosystems are intended to remain open and interoperable over time.

10.5 Citizen communication, user acceptance and behavioural incentives

Successful adoption depends on awareness, understanding and trust, and that communication, demonstrations, workshops and feedback loops are all important tools for increasing acceptance. This is especially relevant where innovations change how deliveries are received, where infrastructure appears in public space, or where digital systems affect visibility and control over the delivery process.

Public authorities and operators should:

- Explain a given solution, why it is being introduced, how it benefits the city and users, and what measures are in place regarding safety, privacy and service quality. This is particularly important for autonomous systems, open locker networks, data-enabled services and any intervention that visibly changes neighbourhood logistics patterns.
- Design behavioural incentives around convenience and reliability, not only environmental messaging. URBANE has shown that end-consumers are most likely to switch when the new solution is easy to use, reliable and visibly beneficial. Retailers, platforms and logistics operators should incorporate sustainable delivery choices into the customer journey in ways that provide immediate value. This is likely to be more effective than relying solely on awareness campaigns.
- Involve users and local stakeholders early in implementation. The LL approach has shown the value of testing innovations in real conditions and adjusting them through feedback. Cities and operators should maintain this logic beyond the project setting by using pilot co-creation, user feedback, local workshops and ongoing monitoring to refine service design and improve legitimacy.

11 Adoption Roadmap

11.1 Purpose of the adoption roadmap

The adoption roadmap aims to translate the policy recommendations developed in the previous chapters into a structured pathway for implementation and scaling. While the policy package identifies what different actor groups should do, the roadmap addresses how cities and other stakeholders can move from interest in URBANE solutions to practical uptake. The evidence gathered shows that adoption is not a single decision point, but a progressive process involving diagnosis, stakeholder alignment, regulatory clarification, pilot design, evaluation and, ultimately, integration into routine planning and operations. The follower-city feasibility studies are especially valuable in this respect because they show that cities differ widely in readiness, local priorities, governance maturity, data availability, market structure and regulatory constraints. As a result, the roadmap cannot assume a uniform starting point. Instead, it must provide a flexible structure that can accommodate different local conditions while maintaining a common implementation logic.

The roadmap proposed here is based on two core principles:

1. Adoption must be phased, with each phase building the conditions needed for the next one.
2. Adoption must be readiness-based, meaning that cities and stakeholders should assess their own institutional, spatial, digital, market and social conditions before choosing the most appropriate implementation path.

This reflects the broader URBANE finding that transferability depends less on copying a fixed solution than on adapting a solution's logic and enabling conditions to the receiving context.

11.2 Readiness dimensions for adoption

A central element of the roadmap is the assessment of readiness across key dimensions. In this respect, the URBANE Impact Assessment Radar (see deliverable D3.5 Data-driven Impact Assessment Radar) can support the identification of city readiness Level 1 (Readiness / Strategic planning). Six ecosystem pillars can help a city assess "what should I improve in my ecosystem?":

- **Governance readiness** concerns the ability of public authorities and stakeholders to coordinate implementation, including planning frameworks (e.g., SULP/SUMP alignment), internal coordination, stakeholder dialogue, and suitable legal/contractual pathways.
- **Sustainability readiness** concerns the city's capacity and commitment to deliver environmental efficiency outcomes (e.g., emissions reduction and resource efficiency) and to align urban logistics measures with sustainability objectives and monitoring.
- **Infrastructure readiness** concerns the availability of suitable physical and operational assets (e.g., sites, hubs/lockers, loading space, charging) and their fitness to support the intended logistics solution.
- **Actors' readiness** concerns whether the relevant public and private actors are present and willing to participate/collaborate, including operators, retailers, infrastructure owners and technology providers, with sufficient capacity to implement and sustain the solution.
- **Accessibility readiness** concerns how easily the solution can be used and integrated locally (e.g., network connectivity, service coverage, user access, and practical integration into the urban environment and delivery chain).
- **Safety & Security readiness** concerns the conditions to operate safely and securely, including operational safety, risk management, protection of assets and data, and safeguards for privacy and cybersecurity where digital systems are involved.

11.3 Phased Adoption

In line with the phased and readiness-based approach, the adoption process is organised as follows:

Phase 1 Diagnose and prepare

This phase focuses on understanding the local freight problem, identifying relevant solution areas and assessing enabling conditions. It should include baseline analysis, stakeholder mapping, readiness screening and review of relevant policy frameworks. The main output is a clear problem definition and a shortlist of solutions that best fit local needs and conditions.

Phase 2 Co-design

This phase defines how a selected solution could work locally, with which actors, under which governance arrangements and with what resources. It should include stakeholder co-design, governance and business-model discussion, site assessment, clarification of roles, and early attention to permits, safety and data-sharing conditions. The objective is to reduce uncertainty before implementation.

Phase 3 Pilot and validate

This phase consists of controlled pilot implementation. Pilots should be treated as learning exercises, not just technical demonstrations, and should assess operational performance, governance functionality, user response, safety and wider impacts. Structured feedback loops are essential so that adjustments can be made during implementation.

Phase 4 Evaluate, formalise and integrate

Once evidence is available, the focus shifts from experimentation to institutionalisation. This phase should include evaluation against agreed indicators, clarification of long-term responsibilities, business viability review, and integration into planning, regulatory or procurement frameworks. The key objective is to move from pilot results to formal decisions on future uptake.

Phase 5 Scale, replicate and monitor

This phase addresses expansion beyond the pilot setting. Scaling should be supported by continued monitoring, common KPI frameworks, impact assessment, communication and stakeholder review. URBANE's transferability work shows that scale-up requires adaptation, not simple duplication, and that interoperability and standardisation become increasingly important at this stage.

It should be noted that the roadmap is **not strictly linear**. A structured evaluation at the end of Phase 3 may conclude that the solution requires significant revision before formalisation can be considered. In such cases, cities should return to Phase 2 to revisit governance arrangements, business models or operational design before proceeding. Similarly, a negative or inconclusive outcome in Phase 4 should not be treated as a failure, but as evidence that conditions are not yet sufficient for scale, and should trigger a targeted reassessment of the relevant readiness dimensions. Continuous monitoring should support operational refinement, governance adjustment and future replication.

Further, although the roadmap is phased, its sequence will differ by **actor group**. Cities and public authorities focus on planning alignment, coordination, enabling regulation and long-term policy integration. Logistics operators and service providers focus on operational testing, data integration and service viability. Technology providers need to prioritise interoperability, usability and local adaptability.

Last, **financing and procurement** need to be considered from the co-design phase onwards. URBANE has shown that uptake depends on viable revenue logic, financing pathways and clear allocation of costs and benefits. Possible approaches include public investment, public-private co-financing, operator-financed deployment under public conditions, innovation procurement and temporary support for early-stage uptake. Long-term sustainability also depends on continuity in governance, policy support and access conditions.

11.4 Integration into SUMP/SULP and local policy processes

11.4.1 Embedding urban freight in local mobility, climate and public-space policy

A central conclusion of URBANE is that innovative urban logistics solutions only achieve lasting impact when they are integrated into formal planning and governance processes. Embedding freight in Sustainable Urban Mobility Plans and Sustainable Urban Logistics Plans helps move solutions from temporary pilots to recognised elements of local mobility and sustainability policy. It also strengthens the connection between logistics innovation and wider priorities such as climate policy, public-space management, accessibility and digital transition. Freight should be linked to wider urban agendas such as decarbonisation, low-emission zones, neighbourhood accessibility, public-space design, digital governance and local economic development. This helps logistics measures generate broader policy value.

11.4.2 Entry points for URBANE solutions within SUMP/SULP cycles

URBANE's portfolio includes a range of solutions that can be integrated into different stages of the SULP cycle (Figure 5). At the diagnosis stage, DTs, freight data collection, impact assessment tools and analysis of loading and unloading activity can support a more accurate understanding of freight flows, bottlenecks, curbside use and potential intervention areas. These tools are particularly useful where cities lack a strong evidence base on freight and need to move from anecdotal understanding to structured planning. They also help municipalities identify where emissions, inefficiencies or spatial conflicts are concentrated and which urban logistics challenges should be prioritised in the plan.

At the visioning and measure-development stage, URBANE solutions can support the design of targeted policy packages. Shared micro-hubs, interoperable parcel lockers, cargo-bike-supported delivery systems, low-emission fleet transition measures, automated delivery pilots and data-enabled coordination tools can all be framed as potential measures within a SULP or as freight-related actions within a wider SUMP. Their role within the plan should not be to provide isolated technical fixes, but to contribute to broader objectives such as decarbonisation, improved public-space management, congestion reduction, resilience and more efficient local service provision.

At the implementation stage, the LL logic itself provides an important methodological contribution. URBANE has demonstrated the value of phased piloting, stakeholder co-design and structured evaluation, all of which align well with iterative planning approaches. In practical terms, cities can use pilots as implementation instruments within their SULP/SUMP cycle, provided that these are explicitly linked to planning objectives, monitored systematically and designed to inform later formalisation. This helps avoid the common problem of pilots operating in parallel to policy rather than feeding into it.

At the monitoring and review stage, URBANE's validation framework and Impact Assessment Radar provide a useful model for structured assessment. Their emphasis on comparable indicators, before/after analysis and wider social, environmental and economic effects can support more rigorous monitoring of freight-related measures within urban plans. This is especially valuable because freight interventions often struggle to demonstrate their broader contribution if monitoring is limited to narrow operational indicators alone.

Last, effective integration requires stronger internal coordination across departments and regular dialogue with external stakeholders. Internal working groups and external platforms can help align priorities, reduce fragmentation and support implementation. A key role of SUMP/SULP integration is to convert pilot results into durable policy and service frameworks.

11.4.3 A URBANE case study – How the Thessaloniki LL supported the regional SULP

The Thessaloniki LL pilot supported the SULP process for the region of Central Macedonia by converting day-to-day operational challenges in the urban and logistic landscape in Thessaloniki into planning questions that can be measured and assessed.

SULP pillars and planning steps supported by the Thessaloniki pilot

The Thessaloniki LL pilot in URBANE contributed directly to the early phases of the SULP cycle, corresponding to Steps 1 to 5 and partially Step 6 of the SULP methodology (Figure 5 - The SULP Methodology). The pilot established a structured working environment, clarified the planning framework, analysed the Thessaloniki last-mile logistics situation, and developed and assessed alternative scenarios with stakeholders. It also produced quantified indicators that provide evidence for SULP target setting. These activities were implemented as a coherent sequence rather than isolated analyses, so that each step built on a consistent baseline and shared assumptions across actors.

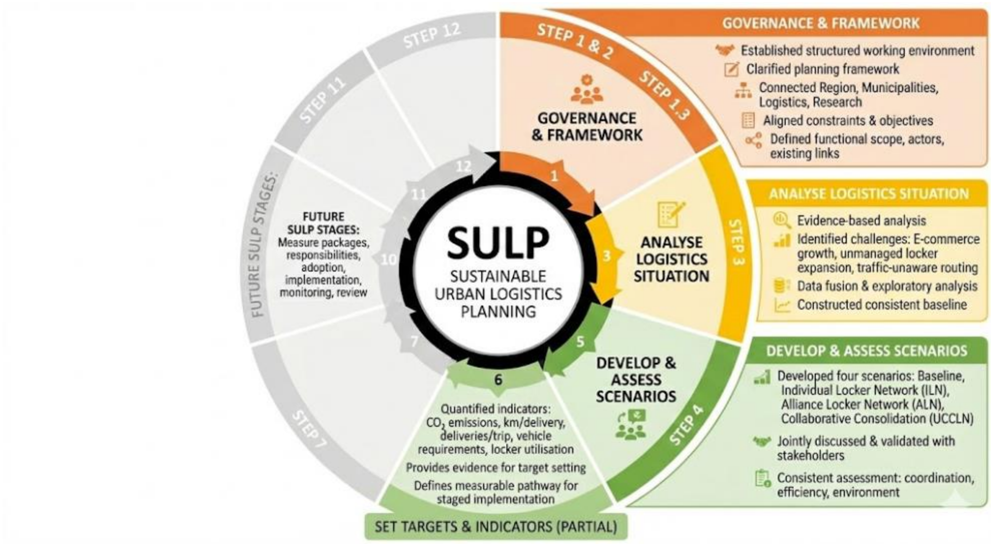


FIGURE 5 - THE SULP METHODOLOGY

The LL created a governance structure that connected the Region of Central Macedonia, municipal stakeholders, logistics operators, and research partners within a common planning process. This structure enabled alignment between operational logistics constraints and public planning objectives and ensured that SULP relevant questions were jointly defined. The pilot also supported definition of the planning framework by identifying the functional scope of the Thessaloniki last mile system, the main actors involved in parcel delivery and locker deployment, and the links between SULP considerations and existing urban mobility and logistics initiatives in the region. This ensured that the subsequent analytical work addressed realistic institutional and spatial conditions rather than abstract system representations.

In terms of operational results, at least 16 parcel lockers were placed based on URBANE outputs and actions during pilot duration. A blockchain integrated system was piloted to support participation in a locker alliance network. These results provide evidence that pilot level deployment is possible and that integration requirements can be managed in a real setting. This evidence is useful in SULP implementation planning because it reduces uncertainty about what can be delivered within typical administrative and operational constraints.

These results support SULP prioritisation because they show a clear relationship between the degree of coordination and the scale of impacts. They also provide an evidence-based rationale for staged implementation. Authorities can start with measures that enable better placement and utilisation of lockers, then create conditions for alliance-based coordination, and later evaluate consolidation-based models when governance readiness is higher.

The pilot included locker performance indicators, including pickup related measures and fill rate improvements linked to demand induction (see example in Figure 6). These indicators support SULP because they reflect user adoption and operational stability. They are also relevant to public space decisions, since authorities need evidence that locker installations deliver measurable benefits and maintain high utilisation.

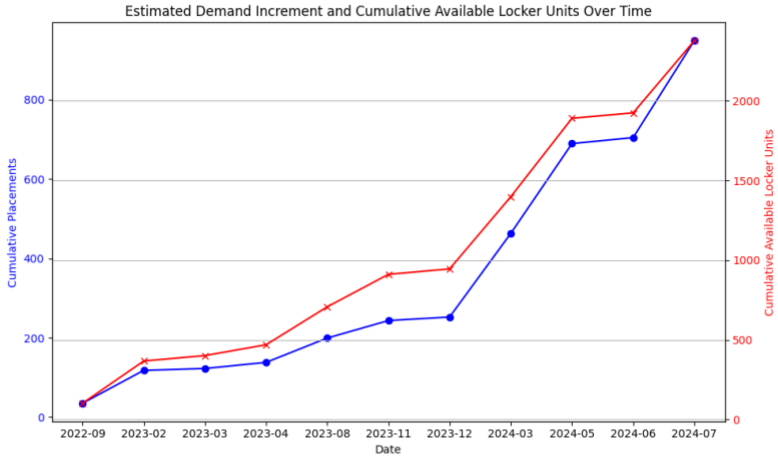


FIGURE 6 - ESTIMATED DEMAND INCREMENT (CUMULATIVE PLACEMENTS) AND CUMULATIVE AVAILABLE LOCKER UNITS OVER THE PROJECT IMPLEMENTATION PERIOD (SEP 2022 – JUL 2024)

Concluding, the pilot evaluated all scenarios using indicators aligned with SULP monitoring needs. These included CO_2 emissions, kilometres per delivery, deliveries per trip, and freight vehicle requirements. Locker utilisation indicators complemented system level KPIs by capturing performance at the infrastructure level. The quantified results provide evidence that supports Step 6 of the SULP process, which concerns target definition. They demonstrate how increasing coordination and consolidation produces progressive efficiency and environmental gains. They also define a measurable pathway from individual deployments toward collaborative systems that can guide staged SULP implementation and monitoring.

Key outcomes for strategic guidelines for the Regional SULP

The Thessaloniki LL generated practical lessons that can be generalised into strategic guidance for SULP design and implementation. These lessons concern infrastructure planning, collaboration models, analytical tools, governance conditions, and implementation pathways. They provide intuition on how urban freight measures evolve from isolated deployments toward coordinated systems under real planning constraints.

1. Infrastructure location and utilisation determine system level impacts.

The pilot confirmed that the spatial configuration of lockers and micro hubs strongly influences delivery efficiency, vehicle activity, and emissions. Poorly coordinated deployments can increase spatial pressure without proportional logistics benefits. Coordinated placement improves utilisation and enables consolidation effects across operators. For SULP, this implies that location planning should be treated as a regulated spatial decision supported by utilisation evidence and system level indicators.

2. Collaboration between operators is the main driver of large-scale benefits.

Scenario results showed that shared locker networks and consolidation concepts produce significantly higher efficiency and environmental gains than individual networks (Figure 7). The transition from isolated to coordinated infrastructure enables higher delivery density and reduced vehicle kilometres. However, collaboration requires governance structures, operational rules, and trust mechanisms. For SULP, this implies that policy measures should focus on enabling shared infrastructure and defining conditions for cooperative operation rather than only promoting individual deployments.

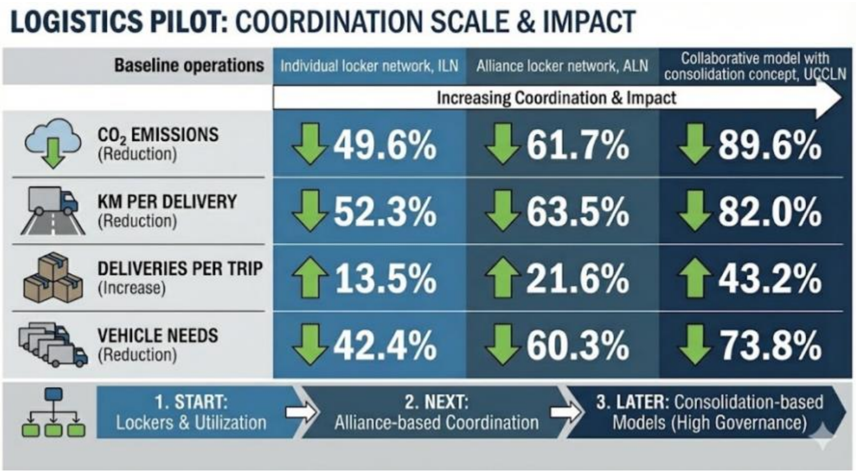


FIGURE 7 - PROJECTED ENVIRONMENTAL AND OPERATIONAL IMPACTS OF INCREASING COORDINATION MODELS IN URBAN LOGISTICS, FROM INDIVIDUAL LOCKER NETWORKS TO ALLIANCE-BASED AND CONSOLIDATION-BASED COLLABORATIVE MODELS

3. Digital modelling tools are necessary for evidence-based planning and acceptance.

The pilot demonstrated that DTs and optimisation models provide a consistent basis for scenario comparison and impact estimation. These tools allow planners and stakeholders to visualize trade-offs, test assumptions, and quantify expected outcomes before implementation. They also support monitoring after deployment through repeatable indicators. For SULP, this implies that analytical tools should be embedded in the planning and monitoring cycle rather than used only in preparatory studies.

4. Data sharing and trust mechanisms are prerequisites for coordinated logistics systems.

Collaborative deployment requires exchange of operational data and coordinated decision making across independent actors. The pilot showed that technical solutions such as secure and traceable data exchange mechanisms reduce perceived risks and support participation. Governance clarity and transparency were as important as technical integration. For SULP, this implies that data interfaces, access rules, and security provisions should be defined as implementation requirements for shared logistics measures.

5. Implementation should follow a staged pathway with measurable milestones.

The pilot experience indicated that operators and users may initially resist collaborative models and new technologies. Demonstration of measurable benefits and gradual integration reduced these barriers. A phased pathway from individual optimisation to alliance based coordination and later consolidation proved realistic. For SULP, this implies that measures should be introduced in stages with evaluation checkpoints based on KPIs, allowing adjustment before scaling.

11.4.4 Implications for different city typologies

URBANE's transferability and follower-city evidence has made clear that integration into SUMP/SULP processes will look different depending on city typology and planning maturity. Cities with existing SULPs or more advanced urban logistics strategies may be able to use URBANE results to refine and expand specific measures, for example by adding a micro-hub strategy, integrating interoperable lockers or strengthening data-governance and impact-monitoring frameworks. For these cities, the challenge is often one of implementation depth, cross-departmental coordination and scale-up.

Cities at an earlier stage of development may require a different entry point. Their immediate need may be to establish freight as a recognised planning topic, gather baseline data, create stakeholder structures and define a first set of policy priorities. In such cases, the contribution of URBANE is less about direct replication of a solution and more about offering a structured pathway for diagnosis, planning and pilot selection. This distinction is important because it reinforces the need for context-sensitive planning rather than one-size-fits-all templates.

Dense historic centres, metropolitan areas, medium-sized cities and cities with constrained public space may also differ in which URBANE solutions are most suitable. For example, some may prioritise shared lockers and cargo-bike micro-hubs, while others may focus first on curbside management, consolidation or digital planning tools. SUMP/SULP integration should therefore support differentiated pathways while maintaining common principles around sustainability, interoperability, governance and evidence-based implementation.

11.4.5 Recommendations for integrating URBANE solutions into local policy processes

Cities should include freight diagnostics, stakeholder mapping and logistics objectives within their SUMP/SULP cycle. This provides the analytical basis for selecting relevant URBANE-inspired measures and ensures that freight is not treated as an afterthought. Specific recommended actions include:

- Connect freight measures to wider urban priorities such as climate neutrality, accessibility, public-space quality, local commerce and digital transition to improve the viability of logistics interventions and address multiple policy goals at once.
- Use pilots as planning instruments, not only as technical tests. Define in advance how a pilot relates to local policy objectives, what evidence it is expected to generate, and how successful results will be fed back into formal planning and governance processes.
- Establish permanent coordination arrangements for urban freight within city administrations and in relation to external stakeholders. This is necessary to sustain the implementation of measures over time and to avoid freight policy being fragmented across departments and initiatives.
- Incorporate monitoring, data governance and evaluation into local policy processes from the outset. The URBANE evidence has shown that cities need stronger capacity to measure impacts, compare options and refine interventions over time. Embedding these functions in SUMP/SULP implementation will support more robust and adaptive policy.
- Use plan revisions and implementation updates as opportunities to formalise successful innovations. Translate pilot lessons into formal rules, infrastructure strategies, procurement choices, spatial decisions and partnership arrangements that can survive beyond project-based funding cycles.

12 Conclusions

URBANE has shown that the transition towards greener, smarter and more collaborative urban logistics is both necessary and feasible, but only when innovation is supported by the right governance, planning and market conditions. Sustainable last-mile logistics is a policy challenge for European cities, closely linked to decarbonisation, digitalisation, urban space management and service resilience. The project confirms that tested solutions including micro-hubs, parcel lockers, Digital Twins, smart contracts, cargo-bike delivery and autonomous systems do not scale through technical advancements alone. Uptake depends on regulatory clarity, authorities' support, access to space, trusted data governance, viable business models and, importantly, user acceptance. Transferability depends on adaptation rather than copying a "good practice". Cities differ in legal, spatial, organisational and market conditions, so adoption must be phased and context-sensitive. Public authorities can play a decisive enabling role in scale up where freight is integrated into SUMP/SULP processes, space is allocated for sustainable logistics, controlled experimentation is supported, and governance conditions are designed to enable fair participation and long-term continuity.

URBANE further underlines that shared infrastructure, collaborative delivery models and data-driven services can only scale where actors cooperate through clear governance arrangements, interoperable systems and common standards. The project's work on standardisation, Digital Twins, smart contracts and shared logistics assets contributes directly to these enabling conditions. The adoption roadmap is further supported by tools such as the Impact Assessment Radar, which helps cities assess readiness at strategic level across six ecosystem pillars - governance, sustainability, infrastructure, actors, accessibility, and safety and security. Behavioural and social factors remain equally important, making evident that clear and early communication, awareness, convenience and trust shape whether innovative collaborative delivery models are accepted by operators, retailers, consumers and citizens.

The project's legacy goes beyond individual pilots. URBANE delivers a comprehensive framework for connecting demonstrator evidence, policy learning and institutional uptake. The Innovation Transferability Platform supports solution assessment, scenario comparison and context-sensitive adaptation, interoperability potential with Data Spaces and other urban logistics tools (including demonstrated cross-project integration and federation approaches).

Finally, real-life implementation also requires attention to operational conditions such as clear procedures for privacy-sensitive monitoring technologies, capacity building for digital-tool uptake and data management, and appropriate regulatory instruments such as permits.

Together, the recommendations and roadmap developed in this deliverable are intended to support the transition from isolated pilots to reliable, scalable and policy-embedded urban logistics innovation in European cities and beyond.

Annex - URBANE lighthouse LLs business models

The sections below provide a summary of the proposed business models for the URBANE lighthouse LLs. More detail about them, including revenue model definitions, CAPEX/OPEX considerations, and growth stage can be found in D5.1 Business Models and Commercialisation Plans.

Helsinki LL Model

The Helsinki model is built around a shared microhub used exclusively by LSPs as a consolidation point to comply with LEZ requirements. At launch, the hub is not customer-facing (no parcel pick-up/drop-off) and supports multiple couriers operating independently while sharing the same location (assumed three LSPs). Revenues come from two core streams: (1) first-mile handling fees (sorting, loading, and short-term storage at the microhub) and (2) per-parcel last-mile delivery fees for deliveries from the hub to final destinations, with tariffs differentiated by parcel characteristics (e.g., size/weight), delivery distance, and urgency. The operational assumption is a partial adoption scenario (initially 35% of an estimated 150,000 parcels/year in the target districts), reflecting realistic early-stage collaboration rather than full market participation. As volumes increase, the model can expand through value-added services (priority processing, specialised handling, returns/reverse logistics) and subscription-based offers (fixed-rate pricing or dedicated space), with the option to later evolve into a customer-facing hub and additional shared services (e.g., EV charging).

Bologna LL Model

The Bologna LL represents a pragmatic entry route emerging through URBANE that promotes a PPP model which reduces early-stage risk while enabling rapid operational learning in a real urban context. The PPP can be framed around a shared objective; improving the efficiency and sustainability of last-mile deliveries while balancing the city's public-interest mandate (e.g., reduced congestion, emissions, and curbside pressure as per their already established SUMP and SULP) with private operators' need for predictable demand, operational feasibility, and bankable revenues. In practice, the PPP model is best positioned as a staged arrangement: an initial pilot phase focused on service validation and performance evidence (KPIs, operational constraints, user acceptance), followed by a scale-up phase anchored in procurement or concession-like mechanisms. The city's role can include enabling measures (access rules, curbside management, data-sharing agreements, and permitting), while private partners provide operational capacity (fleet, staffing, routing and service management). A clear governance set-up is essential: decision rights, liability boundaries, service-level expectations, and data responsibilities should be explicitly defined to avoid "pilot lock-in" and ensure a credible pathway to procurement or long-term contracting. From a market-entry perspective, Bologna also offers a replicable blueprint: a municipality-led framework that can be transferred to other cities by standardising the partnership components (roles, KPIs, contract templates, and incentive levers), while allowing local adaptation in regulations and urban form. This means that the model also allows for seamless scalability across different city areas, progressively growing in a controlled manner.

Thessaloniki LL Model

The Thessaloniki model is based on shared UCCs where first-mile operators deliver parcels using their existing fleets. Revenues are generated through a per-parcel charge that includes a handling and sorting component (covering receipt, registration, organisation by delivery zone/locker availability) and supports the onward last-mile distribution from the UCC. While the optimal set-up assumes full collaboration (all city-centre parcels routed through the shared UCC network), the model adopts a realistic phased uptake starting at 33%

collaboration, reflecting the initial participation level of a major first-mile carrier in the LL. The pricing logic is designed to cover operating costs and generate margin to enable growth, while delivering public benefits through consolidation (fewer trips, reduced congestion and emissions) as demonstrated in the pilot.

Valladolid LL Model

The Valladolid model is based on a simple pay-per-use structure, where carriers using the microhub are charged a per-parcel handling fee. This fee covers the full set of microhub services, including reception, sorting, scanning, temporary storage, and last-mile delivery via cargo bike, linking revenues directly to usage and enabling gradual uptake without fixed commitments (particularly relevant for smaller carriers with fluctuating volumes). The main market-entry risk is uncertainty: the microhub concept was not tested locally during the URBANE pilot and no first-mile couriers participated, meaning adoption and willingness-to-pay are not yet evidenced. Financial viability therefore depends on achieving sufficient parcel volumes and setting a competitive per-parcel price that is attractive versus carriers' current last-mile costs while still covering fixed operating costs and generating a margin for reinvestment. As utilisation grows and the model proves operational value, the microhub can evolve by adding complementary revenue streams or shifting to alternative pricing options (e.g., service tiers or contracted packages).

Procurement and contracting pathway

To translate URBANE pilots into sustained market uptake, cities need a clear procurement and contracting pathway that bridges experimentation with long-term service provision. This pathway should define how evidence generated during pilot operations (service reliability, operational feasibility, user acceptance, safety, and public-value KPIs) will be used to justify a scale-up decision and the selection of a contracting mechanism.

In early phases, cities typically rely on lighter arrangements (e.g., pilot agreements, memoranda of understanding, or innovation partnerships) to validate the concept and establish baseline performance and cost parameters. **As the service matures**, the contracting approach should shift toward a scalable instrument that enables predictable demand, standardised service levels, and transparent competition, such as a service contract using blockchain technology, a framework agreement, a concession-like model, or other mechanisms that fit local procurement rules and market structure.

A core design choice is **risk allocation**: whether the public entity carries demand risk through minimum service volumes, availability payments, or outcome-based payments, or whether demand risk remains with the operator through market-based revenues (e.g., retailer/logistics fees). Contracting should clearly define roles and responsibilities across:

- operational delivery (fleet, staffing, routing, customer support)
- enabling measures (permits, access rules, curbside management), and
- data governance (data access, reporting, privacy, interoperability).

Performance management is critical: smart contracts should embed measurable KPIs (e.g., delivery success rate, punctuality, utilisation, emissions intensity, safety incidents, complaints), reporting, and remedies or bonuses. To avoid "pilot lock-in," the pathway should also clarify the conditions under which the city transitions from a non-competitive pilot setting to an open procurement (e.g., pre-defined decision gates, minimum KPI thresholds, and transparent evaluation criteria). Finally, bankability considerations, such as contract duration, price indexation, escalation clauses, asset ownership, and termination terms, should be addressed early, as they determine whether private partners can credibly invest in operations, integration, and capacity. This is the reason why one of the key takeaways from the URBANE project is the importance of stakeholder participation between competing partners taking place from the onset of the decision-making.

Value proposition and revenue logic per stakeholder

URBANE's market entry depends on a coherent articulation of value creation and revenue logic across stakeholders, because benefits and costs are distributed along the logistics chain. This connects to stakeholder mapping and the need to identify a value proposition for each of them from the beginning. A practical way to frame this is to distinguish:

- direct paying customers
- operational users who influence performance and adoption, and
- public actors who capture societal value and can enable market formation.

For each group, the value proposition must be explicit and measurable, while the revenue logic should clarify what is monetised, who pays, and why the model remains attractive once incentives taper.

For **logistics operators and carriers**, the value proposition is primarily operational: higher delivery reliability, fewer failed deliveries, improved route stability, better fleet utilisation, and reduced operational friction in constrained urban areas (e.g., access, curbside conflicts). The revenue logic can follow a service-fee structure (per parcel, per stop, per route, or per contracted capacity/time window), potentially supplemented by performance-linked components (bonuses for service levels or emissions reductions) where public procurement is involved.

For **retailers**, e-commerce actors, and shippers, the value proposition typically links to customer experience and cost-to-serve improved delivery success, customer satisfaction, reduced exceptions/returns, and more predictable service levels. Revenue logic may be embedded in shipping fees, premium delivery options, or B2B service subscriptions tied to delivery volumes and service tiers.

For **property owners**, business improvement districts, and site managers (e.g., large generators/receivers such as hospitals or campuses), the value proposition is often "order and predictability": fewer ad-hoc curbside conflicts, reduced congestion at building interfaces, improved safety, and better-managed deliveries. Here, revenue logic can take the form of access or service agreements (monthly service fees, site service packages, or microhub service contracts) aligned with facility management budgets. For end-consumers, the value proposition is convenience, control, and trust (predictable time windows, tracking, fewer missed deliveries), while the revenue logic is indirect: consumers may pay via premium delivery options, but more commonly the model relies on B2B revenues where consumer adoption is driven by convenience rather than direct pricing.

For **public authorities**, the value proposition is public-value creation, such as reduced emissions, congestion, noise, and improved safety and curbside order. While cities are not always the direct payer, they are often the market-shaper: they can introduce enabling policies, access privileges, and outcome-based incentives that convert public benefits into predictable demand signals. Where cities do contract services directly, revenue logic may take the form of service contracts or outcome-based payments tied to verified performance (e.g., emissions intensity reductions, delivery consolidation rates, fewer vehicle-kilometres).

Across all stakeholders, a robust business model should explicitly address "who benefits vs who pays" and include mechanisms to reduce misalignment, such as shared-savings arrangements, tiered service offers, or performance-based components, so that operational users have a clear reason to adopt and paying parties see a credible return.

Contacts:

Project Coordinator:
Ioanna Fergadiotou
ioanna.fergadiotou@inlecomsystems.com

Project Manager:
John Lymaxis
john.limaxis@inlecomsystems.com

Communication, Dissemination, and Upscaling Manager:
Raffaele Vergnani
RVergnani@polisnetwork.eu

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the granting authority. Neither the European Union nor the granting authority can be held responsible for them. Any communication or dissemination activity related to the action must use factually accurate information.

**Funded by
The European Union**