E-Laas

Energy optimal urban Logistics As A Service

Deliverable report

Deliverable no.	D0.1
Deliverable title	Updating state of the art based on a review of the scientific literature and analysis of reports and other sources
Scope of this report	WUT contribution to D0.1
Responsible partner	Warsaw University of Technology (WUT)
WP	0
WP title	Definition of scenarios and reference cases
WP leader	WUT, SU
WP involved partners	CUT, TU
Access	unlimited, online availability
License	CC BY 4.0
First version date	23.06.2024
Final version date	01.04.2026
Online publication date	02.06.2026

How to cite:
Szczepański, E., Izdebski, M., Jachimowski, R., Jacyna, M., Kłodawski, M., Lewczuk, K., Murawski, J., & Paszkowski, J. (2026). *Updating state of the art based on a review of the scientific literature and analysis of reports and other sources* (Project E-Laas, Deliverable D0.1). Warsaw University of Technology.

Project implemented as part of the call ERA-NET Cofund Urban Accessibility and Connectivity (ENUAC China Call) organized by JPI Urban Europe and the National Natural Science Foundation of China (NSFC).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 875022.

Project funding information

E-Laas project is carried out in an international consortium. Project coordinator in Europe: Chalmers University of Technology (Sweden), project coordinator in China: Shanghai University (China), consortium members: Tsinghua University (China), Warsaw University of Technology (Poland), cooperation partners: Stockholms stad, Trafikkontoret (Sweden), ParkUnload (Spain), Metropolis GZM (Poland), Shanghai Urban-Rural Construction and Transportation Department (China), Volvo Group Trucks Technology and Operations (Sweden).

- *The Chinese part of the project is funded by National Natural Science Foundation of China*

- *The Swedish part of the project is funded by Swedish Energy Agency*

- *The Polish part of the project is funded by the National Science Centre, Poland (project no. 2022/04/Y/ST8/00134). The value of the co-financing is PLN 878 107.00. Project duration 27/04/2023 - 26/04/2026 (36 months).*

Table of contents

1. Summary

In accordance with the project proposal, D0.1 constitutes the first result of WP0 "Definition of scenarios and reference cases". Its role is to update the state of the art by reviewing scientific literature, research projects, reports and urban policy documents in order to ensure that further project work will be based on current research trends, actual user needs and broader technological, environmental and policy conditions shaping contemporary cities. Therefore the D0.1 report provides the initial knowledge base for the subsequent definition of scenarios, reference cases, modelling assumptions, data requirements and assessment indicators.

The report identifies which characteristics of urban logistics systems should be considered in further research, how such systems should be described, which actors and processes should be included, and what types of data and assumptions will be needed to ensure that later analyses are useful for modelling, simulation, optimisation and policy formulation. The report also supports the assumed impact path by linking scientific knowledge with practical city-level needs and with the challenges faced by logistics operators, public authorities and users of delivery services.

The analysis presented in D0.1 is organised around three complementary research activities:

- **scientific literature review**, covering sustainable urban logistics, first- and last-mile delivery, vehicle routing, electric vehicle routing, energy management, digitalisation, optimisation methods, decision-support tools and social aspects of urban freight transport.
- **research project review**, covering completed and ongoing projects funded under European and national programmes, including projects related to last-mile delivery, urban freight transport, multimodal logistics, low- and zero-emission delivery systems, digital logistics platforms, smart loading zones, and data-driven logistics.
- **review of urban transport policies and city practices**, covering urban logistics measures planned or implemented in Polish and European cities, with particular attention to Sustainable Urban Mobility Plans (SUMPs), urban freight strategies and examples of integrated urban logistics policy.

The scientific review shows that urban logistics is increasingly moving from the analysis of isolated transport operations towards a systemic understanding of freight flows in cities. Modern urban logistics systems should be analysed as integrated ecosystems involving vehicles, infrastructure, logistics facilities, energy systems, users, service providers and public authorities. This is particularly important for zero- and low-emission delivery systems, where route planning, vehicle range, energy consumption, service reliability and infrastructure capacity are strongly interdependent.

A key conclusion from the literature review is that sustainability should not be treated only as a secondary effect of operational optimisation. Environmental and energy-related objectives should be embedded directly in the design, organisation and assessment of urban logistics systems. This means that further research will need to consider not only emissions from vehicles, but also the broader carbon footprint of delivery flows, the interaction between logistics operations and the power grid, and the role of infrastructure in enabling or limiting low-emission delivery systems.

The review of research projects confirms that many relevant initiatives have already addressed selected aspects of urban logistics, including micro-hubs, cargo bikes, electric vehicles, parcel

delivery systems, smart loading zones, policy guidelines, digital platforms and decision-support tools. At the same time, the outcomes of these projects are dispersed across different thematic areas and are often difficult to compare directly. This indicates that further work will require an integrated analytical structure capable of combining concepts, data, models, behavioural assumptions and policy-relevant indicators within one coherent framework.

The project review also reveals limitations related to data availability. Although many projects provide reports, descriptions, guidelines or partial results, access to detailed source data is limited. Therefore, later modelling and simulation work will not be able to rely only on existing open datasets. It will need to combine public data, spatial data, transport network data, expert assumptions, stakeholder knowledge and dedicated empirical research.

The review of urban transport policies shows that urban freight transport is becoming an increasingly important element of sustainable mobility planning. The analysed documents and city practices make it possible to identify a catalogue of measures relevant to first- and last-mile delivery, including local consolidation centres and micro-hubs, dedicated parking and loading spaces for delivery vehicles, zero- and low-emission delivery vehicles, cargo bicycles, restrictions on heavy goods vehicle traffic, charging infrastructure, parcel locker location principles, rail freight facilities and soft governance measures based on cooperation with logistics operators.

The analysed city practices indicate that advanced urban logistics policies are not based on single isolated measures. Instead, they combine regulatory instruments, logistics infrastructure, digital tools, vehicle technologies, consolidation and stakeholder cooperation. This conclusion will be important for later scenario development, because realistic urban logistics scenarios should reflect combinations of measures rather than only individual technological substitutions. For example, the effectiveness of electric vehicles will depend on charging infrastructure and operational planning; the effectiveness of micro-hubs will depend on final delivery modes and spatial accessibility; and the effectiveness of parcel lockers will depend on user behaviour, pedestrian accessibility and servicing arrangements.

The work identifies several main groups of problems that should be considered in subsequent research:

- energy and environmental impacts – including energy consumption, emissions, carbon footprint, charging requirements and the relationship between logistics flows and energy infrastructure;
- operational efficiency – covering routing, delivery times, vehicle utilisation, service reliability, consolidation and the organisation of last-mile delivery processes;
- urban infrastructure and public space – relating to the availability and allocation of loading areas, charging points, micro-hubs, parcel lockers and access to dense urban areas;
- data and modelling limitations – including fragmented or incomplete data on demand, delivery flows, service times, user behaviour and operational constraints;
- social and behavioural aspects – covering user preferences, acceptance of alternative delivery forms, willingness to collect parcels and the role of different actors in reducing the energy and environmental impact of urban logistics;
- policy and governance – referring to access regulations, incentives, stakeholder cooperation and the need for decision-support tools for local authorities.

The findings of D0.1 will be used in D0.2 "Development of a set of attributes characterizing the scenario and the reference case". The identified problem groups, solution categories and analytical dimensions will support the definition of attributes describing reference cases, virtual reference cases, base scenarios and alternative scenarios. In particular, the results of the state-of-the-art analysis will justify the inclusion of attributes related to the urban area, transport network, logistics facilities, transport modes, demand, operational parameters, energy use, emissions, costs, user behaviour and KPI indicators. In this way, the qualitative diagnosis developed in D0.1 will be translated into a formal structure for scenario and case description.

The obtained results will also support D0.3 "Identified scenarios of logistics systems, inventory of reference cases with description". The review of literature, research projects and city policies will provide the basis for selecting logistics segments that are relevant, researchable and important from the perspective of urban impacts. These will include, in particular, ready-meal delivery, boxed meal delivery, parcel delivery to parcel lockers and direct parcel delivery to individual recipients. The scenario families defined later in WP0 will therefore be grounded in documented research trends, observed urban logistics practices and policy needs.

The outcomes of D0.1 will contribute to M0 "Repository of cases characterizing logistic system scenarios". By identifying relevant solution types, actor groups, infrastructure elements, transport modes, demand categories and assessment dimensions, the report will provide the conceptual input for structuring the repository of cases and scenarios. The repository will be able to organise information on reference cases, scenarios, variants, assumptions and data requirements in a way that supports subsequent modelling, what-if analyses and comparative assessment.

Therefore, the D0.1 will serve as the starting point for the entire analytical path of the project. The report first identifies the key trends, problems and solution categories in urban logistics, and these findings will then be progressively transformed into more operational elements: attributes, scenarios, data structures, models, simulations and recommendations.

The same logic will guide the preparation of empirical and simulation research in WP2. Since D0.1 shows that many key parameters of urban logistics cannot be obtained only from existing datasets, the next stages will have to supplement spatial, transport and operational data with information collected from users, operators, couriers and local authorities. This will be reflected in the assumptions for questionnaire and simulation research in D2.1, the analysis of user needs and preferences in D2.2, and the simulation-based assessment of distribution systems in D2.3. The identified barriers and policy-relevant issues will also support the work leading to M2, especially in selecting relevant sustainable urban logistics policies and recognising the main inhibitors of energy-efficient logistics systems.

The conclusions from D0.1 will also shape the technical and modelling parts of the project. Problems such as routing, charging availability, demand uncertainty, delivery times, service reliability and the interaction between logistics flows and infrastructure will provide the background for the development of operational and strategic planning models in WP3 and uncertainty-oriented algorithms in WP4.

In this way, D0.1 will create a coherent path from diagnosis to application: first by identifying the state of knowledge and the most important urban logistics challenges, then by supporting the definition of attributes and scenarios, next by guiding data collection and modelling, and finally by feeding into simulation, optimisation and policy-oriented recommendations.

2. Introduction

Most urban logistics studies focus on operational and technical solutions to reduce the negative impacts of urban freight transport. A substantial part of the literature is solution-oriented and concentrates on addressing practical urban logistics problems. In this context, research attention is more frequently directed towards technical, technological and managerial improvements than towards policy-oriented innovations [2], [3]. At the same time, previous studies indicate that the transition towards more sustainable logistics systems still requires mechanisms that encourage climate-responsible behaviour among multiple groups of actors, including public authorities, service providers and users [1], [4].

Despite the growing body of research, important environmental aspects remain insufficiently addressed. When the environmental impact of urban logistics is analysed, the focus is often limited to a specific service, spatial setting or technology. Broader impacts on the urban system as a whole, including indirect effects generated by new logistics services, are less frequently considered. This applies in particular to the consumption of urban space, energy and other resources required for the development and operation of new logistics solutions [5], [6]. Consequently, greater attention should be paid to energy-related aspects of urban logistics, especially in relation to the carbon footprint of logistics flows and their connection with the power grid, where energy becomes a common analytical denominator.

Current research and innovation activities also develop along several complementary directions related to different urban freight transport modes, including trucks, electric vehicles, cargo bikes and drones. More specific research areas include warehousing, vehicle routing [5], [6], freight planning [7], supply chains [8], shared mobility [9], social behaviour [10], sustainable development [11] and other related issues. Methodologically, these studies often combine mathematical programming, exact algorithms, metaheuristics and machine learning-based approaches to address complex logistics and routing problems [12], [13]. Within this field, particular importance is attached to methods capable of handling large-scale, real-time and uncertain decision-making problems [14], [15].

The above observations point to three major challenges: the need to assess the energy footprint of urban logistics flows, the need to account for the responsibility of actors operating at different levels of the system, and the need to integrate fragmented research outcomes into a coherent analytical framework. These challenges indicate the necessity of a more holistic approach.

Thus, the state of the art will be updated as follows:

- review of scientific publications - analysis of issues related to city logistics, modelling and optimisation in last-mile delivery, energy management for urban logistics, smart city, and social aspects in urban logistics.
- overview of research projects - analysis of projects funded within JPI Urban Europe, Horizon 2020, Horizon Europe and other international research funding instruments, and the possibility of using data developed in these projects.
- overview of solutions in the transport policies of cities - analysis of transport policies in the last mile deliveries perspective in selected EU cities.

3. Purpose and scope of the report

The aim of report D0.1 is to update the state of the art in the field of energy-efficient and sustainable urban logistics based on a review of scientific literature, research projects, reports and urban transport policy documents. The report provides the initial knowledge base for further work in the E-Laas project, in particular for the definition of scenarios, reference cases, modelling assumptions, data requirements and assessment indicators.

The scope of the report includes:

- reviewing scientific literature related to sustainable urban logistics, first- and last-mile delivery, vehicle routing, energy management, optimisation methods, decision-support tools and social aspects of urban freight transport,
- identifying key research trends, concepts and methodological approaches relevant to the E-Laas project,
- reviewing completed and ongoing research projects related to urban logistics, last-mile delivery, low- and zero-emission transport, smart loading zones and data-driven logistics,
- assessing the potential usefulness of existing project outcomes, reports and available data for subsequent E-Laas work packages,
- reviewing selected urban transport policies and city practices related to urban freight transport and last-mile delivery,
- identifying urban logistics measures relevant to scenario development,
- formulating conclusions for the further definition of attributes, scenarios, reference cases, modelling assumptions and data structures in WP0 and subsequent work packages.

4. Scientific literature review

A review of the scientific literature in relation to the issues addressed in E-Laas has produced scientific articles that document the work carried out. These include the following:

1) **Shaping the future of transit: Innovations and prospects of intelligent connected bus systems**

   Authors: Shijie Cong (TU), Wei Zhang (TU), Kai Wang (TU), Balaźs Kulcsár (CUT), Marianna Jacyna (WUT)

   Abstract:

   As urbanization progresses, traffic congestion has become an increasingly severe issue confronting metropolitan areas worldwide. Intelligent connected bus systems (ICBS) emerge as a transformative solution to address this challenge. This review synthesizes ICBS as a layered closed-loop transit system that links infrastructure, intelligent buses, and operation platforms through continuous vehicle-road-cloud coordination. We first summarize its system architecture, including centralized operation platforms, smart intersections, smart bus stops, and intelligent connected buses, and explain how connectivity is translated into operational control. We then review two technical pillars under real-world deployment constraints: safety-oriented advanced driver assistance systems, covering cooperative perception, speed-signal coordination, and bus-oriented motion planning; and reliability-oriented intelligent scheduling, covering electrified

fleet and charging management, automation-enabled dispatching, and fixed-flexible services. Finally, we discuss the transition toward precise public transit and highlight key challenges in system-level performance verification, robustness under uncertainty, infrastructure affordability and legacy integration, and bus-specific automated driving. Overall, ICBS should be understood as a service-oriented operational paradigm that enables more adaptive, reliable, and sustainable urban public transport.

Keywords:
intelligent connected bus systems, vehicle-to-infrastructure, connected vehicle cloud platform, autonomous driving, intelligent dispatching

2) **Learning for routing: A guided review of recent developments and future directions**

Authors: Fangting Zhou (CUT), Attila Lischka (CUT), Balázs Kulcsár (CUT), Jiaming Wu (CUT), Morteza Haghir Chehreghani (CUT), Gilbert Laporte (HEC Montréal, University of Bath)

Abstract:
This paper reviews the current progress in applying machine learning (ML) tools to solve NP-hard combinatorial optimization problems, with a focus on routing problems such as the traveling salesman problem (TSP) and the vehicle routing problem (VRP). Due to the inherent complexity of these problems, exact algorithms often require excessive computational time to find optimal solutions, while heuristics can only provide approximate solutions without guaranteeing optimality. With the recent success of machine learning models, there is a growing trend in proposing and implementing diverse ML techniques to enhance the resolution of these challenging routing problems. We propose a taxonomy categorizing ML-based routing methods into construction-based and improvement-based approaches, highlighting their applicability to various problem characteristics. This review aims to integrate traditional OR methods with state-of-the-art ML techniques, providing a structured framework to guide future research and address emerging VRP variants.

Keywords:
machine learning, reinforcement learning, routing problems, traveling salesman problem, vehicle routing problem, combinatorial optimization

3) **Advancements in Electric Vehicle Routing Problems: a systematic review of research trends**

Authors: Jakub Murawski (WUT), Emilian Szczepański (WUT), Marianna Jacyna (WUT), Jiaming Wu (CUT), Fangting Zhou (CUT), Kai Wang (TU), Wei Zhang (TU)

Abstract:
Electric vehicles offer substantial advantages over conventional vehicles, notably reduced emissions and lower noise levels. Combined with recent advancements in battery and charging technologies, these benefits have accelerated their adoption in urban logistics. Nevertheless, integrating EVs into cargo distribution systems introduces significant operational challenges related to energy management, charging infrastructure, and vehicle range limitations. Consequently, considerable research has emerged around the Electric Vehicle Routing Problem (EVRP), an extension of the

classical Vehicle Routing Problem, which explicitly incorporates EV-specific constraints such as charging strategies, energy consumption, and vehicle-to-grid interactions.

This paper systematically consolidates and structures existing EVRP literature through a comprehensive review conducted using the PRISMA methodology. Out of 584 initially identified studies, 272 were selected for detailed discussion. The review establishes a structured classification framework covering multiple EVRP dimensions: transport system configurations, vehicle fleet diversity, delivery system organization, customer demand uncertainty, energy replenishment technologies, charging processes, V2G and V2V technologies, and energy consumption modeling approaches. Furthermore, the paper examines emerging research areas, including the integration of renewable energy sources and related routing scenarios such as Electric Arc Routing and Location Routing Problems. The analysis identifies critical research gaps and highlights directions for future studies, particularly emphasizing the need for addressing real-world complexities and sustainability goals. This systematic synthesis not only organizes the fragmented research landscape but also serves as a comprehensive reference for scholars and practitioners focused on advancing sustainable urban logistics through electric vehicle routing.

These papers will be submitted for publication in international journals.

Main conclusions from above mentioned articles:

- **Shift toward integrated transport systems**
  Modern transport systems should be analysed at the system level. Intelligent connected buses, machine-learning-based routing, and electric vehicle routing all require coordination between vehicles, infrastructure, operational platforms, energy systems, and users. This means that future transport solutions should not be designed only around single vehicles or isolated routes, but around the functioning of the entire mobility and logistics ecosystem.
- **Growing importance of digitalisation and data-driven decision-making**
  All reviewed works highlight the increasing role of data, connectivity, and computational intelligence. In public transport, data exchange between vehicles, infrastructure, and cloud platforms enables real-time control and service adaptation. In routing problems, machine learning supports the search for efficient solutions in complex optimisation tasks. In electric vehicle logistics, data on energy consumption, charging availability, demand, and traffic conditions is essential for effective planning. Therefore, digitalisation becomes a key enabler of efficiency, reliability, and flexibility.
- **Need to combine classical optimisation with new intelligent methods**
  Traditional operations research remains important, but it is increasingly complemented by machine learning, automation, and real-time decision-support systems. Classical algorithms provide formal structure and optimisation rigour, while learning-based methods can improve adaptability in dynamic and uncertain environments. The most

promising direction is therefore not the replacement of established methods, but their integration with data-driven approaches.

- **Sustainability as a central objective of transport development**
  Sustainability is a major driver of innovation. Electric vehicles reduce local emissions and noise, while intelligent public transport can make collective mobility more attractive and efficient. Better routing and scheduling can reduce unnecessary vehicle kilometres, energy consumption, congestion, and operational costs. As a result, environmental goals should be incorporated directly into transport planning, not treated as secondary effects.

- **Electrification creates new operational and planning challenges**
  The transition to electric mobility is not limited to replacing conventional vehicles with electric ones. It introduces new constraints related to battery capacity, range limitations, charging duration, charging station location, grid interaction, and energy management. These constraints affect both logistics and public transport operations. Consequently, transport planning must increasingly consider the interaction between transport networks and energy infrastructure.

- **Robustness under uncertainty is a critical research and implementation issue**
  All areas discussed in the publications face uncertainty: traffic conditions, passenger demand, customer demand, charging station availability, energy consumption, vehicle delays, and infrastructure performance. Future models and systems must therefore be robust and adaptable, rather than optimised only for ideal or static conditions. This is particularly important for real-world deployment, where disruptions and incomplete information are common.

- **Real-world implementation remains a major challenge**
  Many concepts are technologically promising, but their practical deployment requires further validation. Intelligent bus systems must operate safely in mixed traffic and with legacy infrastructure. Machine-learning-based routing methods must prove scalability, reliability, and generalisability. Electric vehicle routing models must better reflect practical constraints such as heterogeneous fleets, charging congestion, uncertain demand, and dynamic operating conditions.

- **Infrastructure integration is as important as vehicle technology**
  Vehicles alone cannot deliver the expected benefits. Connected buses require smart intersections, smart stops, communication systems, and operation platforms. Electric logistics requires charging infrastructure, energy supply coordination, and sometimes integration with renewable energy sources. Routing optimisation also depends on high-quality network, demand, and operational data. Thus, infrastructure planning is a fundamental condition for effective intelligent and sustainable transport.

5. Research projects reviews

5.1. Assumptions for reviewing research projects in the area of E-Laas

The aim of this activity is to identify and assess research projects related thematically to the E-Laas project. The review is intended to identify completed or ongoing projects that may support work in E-Laas through the analysis of trends, achievements, and the definition of potential research scenarios in the context of urban logistics. The following assumptions have been adopted:

- The review covers research projects identified in selected databases and on websites such as:
  1) CORDIS - Community Research and Development Information Service,
  2) JPI Urban Europe,
  3) EIT Urban Mobility,
  4) Interreg,
  5) EUREKA,
  6) ERA-Learn,
  7) National Science Centre (NCN), Poland,
  8) National Centre For Research and Development (NCBR), Poland and Map of EU grants, Poland
- The analysis was conducted taking into account projects funded at the European level as well as projects carried out under national competitions in Poland, commencing on January 1, 2014, or later.
- The selection of projects is limited to those directly related to urban logistics and can be thematically linked to the ongoing project " Energy optimal urban Logistics As A Service" The main keywords adopted include urban logistics, last mile, urban freight transportation.

Based on subjective assessment, projects were selected that could bring added value to the ongoing E-Laas project. This assessment includes:

- Availability of open access data regarding the city's logistics system and its participants,
- Availability of project outcome descriptions in the form of concepts and trends in shaping urban logistics systems and energy management within these systems,
- The extent to which the project is useful for E-Laas.

Based on the review of projects, additional research scenarios will be defined within WP0 of the E-Laas project, as well as potential utilization of available data for the implementation of tasks in subsequent phases such as WP1-WP5.

5.2. Review of databases containing research projects in the EU

5.2.1. General characteristics of information sources and preliminary review results

CORDIS - https://cordis.europa.eu/search

In the CORDIS database, a list of projects implemented under EU programs and funds is available. This includes framework programs such as Horizon 2020, Horizon Europe, as well as others like ERC grants. In searching the project database, the keywords "((Urban OR City) AND Logistics)" and record type "project" were adopted, with the project start date >= 2014-01-01.

A total of 411 unique records related to urban logistics were identified in the database. Among them, 328 projects have been completed, while 83 projects are currently ongoing. The database includes projects funded by EU programs as well as additional programs aimed at financing research in their area through smaller grants (e.g., ERA-NET). Only projects that are typical research tasks were selected for analysis. Projects funded under additional initiatives are identified in subsequent points. **A total of 53 projects potentially related to E-Laas were identified.**

JPI Urban Europe - https://jpi-urbaneurope.eu/projects/
Established in 2010 as a project responding to the challenges facing urban development, JPI Urban Europe is an initiative aimed at promoting research in Europe on innovative solutions to improve the quality of urban functioning and their communities. Within JPI Urban Europe, research competitions are organized, mainly funded through ERA-NET projects financed by EU funds or joint projects with entities such as NSFC (an example of such a project is E-Laas). The JPI Urban Europe website does not have a search engine for funded projects, but there is a list of projects along with basic information. Based on this information, a review was conducted.
The list describes 153 projects, all related to urban areas. Many projects focus on PED (positive energy districts) and FEW (food-energy-water) issues; however, most of them are not related to freight transportation and the last mile. Another group of projects focuses on communities and their behaviors, migrations, as well as solutions in the area of urban spatial policy and city management. The review focused on projects related to last-mile deliveries and energy consumption in transportation. **A total of 9 projects potentially related to E-Laas were identified.**

EIT Urban Mobility - https://www.eiturbanmobility.eu/our-activities/
Established in 2019 by the European Institute of Innovation and Technology, this initiative aims to facilitate the transformation of cities to improve their functioning and enhance the quality of life. It organizes competitions for projects covering a wide range of areas related to urban functioning, including mobility and urban logistics. Projects may involve various activities such as training, startup accelerators, or purely research-oriented projects.
The database lists 184 different types of activities funded under EIT, with 72 being innovative research projects. **From these, 12 have been selected that may have a potential connection to E-Laas and will undergo further evaluation.**

Interreg - https://keep.eu/
Interreg programs are funded by the European Union budget. Their aim is to develop solutions to common problems across different areas and regions. Projects funded under these programs are implemented in international consortia. Examples of such programs include the Interreg South Baltic Programme and the Interreg Central Europe Programme.
In the database of projects funded under Interreg programs, 570 projects in the field of logistics were identified. **Out of these, 14 were selected for further analysis, as they may be useful for E-Laas.**

EUREKA - https://www.eurekanetwork.org/about-us/eureka-data
The EUREKA initiative was established to increase the competitiveness, modernization, and innovation of the European industry. Projects are funded under various programs such as Eurostars, Innowwide, Clusters, Network projects, Globalstars, and Investments readiness. These are projects that require international consortia. Based on a review of the database, 81

projects related to logistics were identified. These projects mainly focus on developing software or technical solutions, such as drones or autonomous robots. The developed solutions are intended to be implemented by the project executor(s) by default. **A total of 10 projects potentially related to E-Laas were identified.**

ERA-Learn - https://www.era-learn.eu/network-information/overview-projects

This is a portal supporting research funding institutions as well as potential project implementers. It provides information on ongoing projects and current calls for proposals. As part of its activities, it offers a database of projects and competitions. Based on this database, 9 records related to logistics were identified, with 3 related to E-Laas. **One overlaps with the EUREKA database, so 2 projects were selected for further evaluation.**

National Science Centre (NCN), Poland - https://projekty.ncn.gov.pl/

The National Science Centre is a funding agency for basic research through national and international competitions. Funding mainly covers research teams from research institutions and higher education institutions in the fields of humanities, social sciences and arts, exact sciences and engineering, as well as life sciences. The search engine available on the NCN website allows for searching projects funded under national competitions. Based on the query "logistics," 189 records were obtained. **However, after reviewing the thematic scope of the projects, 3 were selected that are related to E-Laas.**

National Centre For Research and Development (NCBR), Poland and Map of EU grants, Poland - https://polon.nauka.gov.pl/opi/aa/pn; https://mapadotacji.gov.pl/

The National Centre for Research and Development (NCBR) is an institution funding research, development, and implementation through national and international competitions, as well as projects financed by EU funds. It is the institution with the largest budget in Poland. Unfortunately, it does not provide a search engine for funded projects. Therefore, to conduct the review, platforms containing information about projects funded by NCBR were utilized. These platforms include the POL-on portal, an integrated database on science containing information about projects conducted by research units (if entered by these units), as well as the "EU Grants Map," which includes projects funded under EU funds. However, the Grants Map also includes infrastructure projects at the national and local levels.

Based on the review of the POL-on database, 62 records were identified based on the search term "logistics," **and only 1 of them was selected for further evaluation as thematically related to E-Laas and not repeated in other databases**. Based on the review of the "grants map" for the query "urban logistics," 5946 records were obtained. As mentioned, a large portion of the projects is not of a scientific and research nature. These are often infrastructure or training projects aimed at increasing competencies, developing education, or supporting enterprise development. Based on the conducted selection, **only 2 projects were chosen that could potentially be used in the implementation of the E-Laas project.**

5.2.2. Compilation of selected projects

Based on the conducted review of databases containing records of projects implemented and currently underway in the EU and in Poland, an assessment of available data and descriptions of results was conducted, which can be used in the E-Laas project. In total, initially 106 projects of potential added value for E-Laas were identified and compiled in **Table 1**.

Among the evaluated projects: 77 have been completed (as of January 1, 2024), 29 are in progress. Out of the 77 completed projects, 43 have documented outcomes that could potentially be utilized in E-Laas. Out of the 29 projects in progress, 17 have published partial results, while 12 have not yet published any results.

The columns of the table contain the following data:

- **LP** - ordinal number,
- **DBase** - database from which project information was obtained.
- **Title** - Project title.
- **Acronym** - Project acronym.
- **SDate** - Project start date.
- **EDate** - Project end date.
- **Pweb** - Is there a dedicated project website?
- **PAweb** - Is the project website active?
- **Fweb** - Project website in the funding institution.
- **Reports** - Are there reports, articles, and/or descriptions of outcomes?
- **Data** - Are data sets available?
- **AVELaaS** – value-adding for E-Laas:
  - **da** - difficult to assess (due to lack or partial data),
  - **yes** - data, articles, or outcome descriptions are available and can be utilized,
  - **no** - data or outcomes are available but not useful for E-Laas, or project description does not indicate usability.

Table 1. Compilation of selected projects

LP	DBase	Title	Acronim	SDate	EDate	Pweb	PAweb	Fweb	Reports	Data	AVELaaS
1	CORDIS	COoperative loGISTICS for sustainable mobility of goods	CO-GISTICS	01.01.2014	30.06.2017	www.cogistics.eu	0	https://cordis.europa.eu/project/id/621112	0	0	no
2	CORDIS	Galileo-based solutions for urban freight transport	GALENA	01.01.2015	31.03.2017	http://www.galenaproject.eu/	0	https://cordis.europa.eu/project/id/641515	0	0	no
3	CORDIS	New Electric Vehicle Chassis-Cab 10-14 for urban logistic	NEC14	01.04.2015	31.03.2017	no	0	https://cordis.europa.eu/project/id/666473	0	0	da
4	CORDIS	City Logistics in Living Laboratories	CITYLAB	01.05.2015	30.04.2018	https://www.citylab.soton.ac.uk/index.php	1	https://cordis.europa.eu/project/id/635898	1	0	**yes**
5	CORDIS	Rethinking Urban Transportation through advanced tools and supply chain collaboration	U-TURN	01.06.2015	31.05.2018	http://www.u-turn-project.eu/	0	https://cordis.europa.eu/project/id/635773	1	0	**yes**
6	CORDIS	New cooperative business models and guidance for sustainable city logistics	NOVELOG	01.06.2015	31.05.2018	http://www.novelog.eu/	0	https://cordis.europa.eu/project/id/636626	1	0	**yes**
7	CORDIS	Sharing Cities	Sharing Cities	01.01.2016	31.12.2021	https://sharingcities.eu/	1	https://cordis.europa.eu/project/id/691895	1	0	**yes**
8	CORDIS	DynaHUBs is a new application designed to kick start the development of the Physical Internet using a crowd-sourced approach	DynaHUBS	01.08.2016	31.07.2018	no	0	https://cordis.europa.eu/project/id/720657	0	0	da
9	CORDIS	Disrupting Logistics in Smart Cities and Regions through an Advanced Logistics Platform.	LOOP	01.09.2016	28.02.2017	no	0	https://cordis.europa.eu/project/id/735386	0	0	no
10	CORDIS	Towards a Shared European Logistics Intelligent Information Space	SELIS	01.09.2016	31.08.2019	https://selisproject.eu/	1	https://cordis.europa.eu/project/id/690588	1	0	no
11	CORDIS	Architecture for EurOpean Logistics Information eXchange	AEOLIX	01.09.2016	31.08.2019	https://aeolix.eu/	1	https://cordis.europa.eu/project/id/690797	1	0	no
12	CORDIS	Innovative solutions for sustainable mobility of people in suburban city districts and emission free freight logistics in urban centres.	ECCENTRIC	01.09.2016	30.11.2020	https://civitas.eu/projects/eccentric	1	https://cordis.europa.eu/project/id/690699	1	0	**yes**
13	CORDIS	Integrated mobility solutions for port cities	PORTIS	01.09.2016	30.11.2020	no	0	https://cordis.europa.eu/project/id/690713	1	0	**yes**
14	CORDIS	Logistics Emission Accounting and Reduction Network	LEARN	01.10.2016	31.03.2019	http://www.learnproject.net	0	https://cordis.europa.eu/project/id/723984	1	0	no
15	CORDIS	NeMo : Hyper-Network for electroMobility	NeMo	01.10.2016	30.09.2019	https://nemo-emobility.eu/	0	https://cordis.europa.eu/project/id/713794	1	0	no
16	CORDIS	Supporting Urban Integrated Transport Systems: Transferable tools for authorities	SUITS	01.12.2016	28.02.2021	https://www.suits-project.eu/project/	1	https://cordis.europa.eu/project/id/690650	1	1	**yes**
17	CORDIS	CARR·e: Lightweight and versatile electric vehicle applied to urban logistics	Carr-e	01.01.2017	31.03.2017	no	0	https://cordis.europa.eu/project/id/762975	0	0	da

18	CORDIS	PROXITRAK – next generation IoT tracking solution for a connected logistics – collect, analyse and visualise big data in a true real time	PROXITRAK	01.01.2017	31.03.2017	no	0	https://cordis.europa.eu/project/id/761931	0	0	no
19	CORDIS	Transforming Transport	TT	01.01.2017	31.07.2019	http://transformingtransport.eu/	1	https://cordis.europa.eu/project/id/731932	1	0	no
20	CORDIS	Promoting Sustainable Freight Transport in Urban Contexts: Policy and Decision-Making Approaches	PROSFET	01.01.2017	31.12.2019	http://www.prosfet.eu/PROSFET/	1	https://cordis.europa.eu/project/id/734909	1	0	**yes**
21	CORDIS	SensorToCloud Technologies for Loss Prevention and Smart "Last Mile" Logistics Operations	Logist-IoT	01.02.2017	30.04.2017	no	0	https://cordis.europa.eu/project/id/761863	0	0	no
22	CORDIS	HOLISTIC AND INTEGRATED URBAN MODEL FOR SMART CITIES	STARDUST	01.10.2017	31.03.2024	https://stardustproject.eu/	1	https://cordis.europa.eu/project/id/774094	1	0	no
23	CORDIS	Leveraging Big Data to Manage Transport Operations	LeMO	01.11.2017	31.10.2020	https://www.lemo-h2020.eu/	0	https://cordis.europa.eu/project/id/770038	1	0	no
24	CORDIS	Making CO2-free city logistics a reality	TiMMi Transport	01.02.2018	31.07.2018	no	0	https://cordis.europa.eu/project/id/808366	0	0	no
25	CORDIS	A novel robotic parcel locker platform for cheap, efficient & convenient last-mile delivery	TARDIS	01.06.2018	30.09.2018	no	0	https://cordis.europa.eu/project/id/827339	0	0	no
26	CORDIS	Disruptive Bike Logistic Smart Trailer for efficient, painless and zero nuisance last mile delivery in cities	Have a BLaST	01.06.2018	30.11.2018	no	0	https://cordis.europa.eu/project/id/816310	0	0	no
27	CORDIS	Enhanced data management techniques for real time logistics planning and scheduling	LOGISTAR	01.06.2018	30.09.2021	https://logistar-project.eu/	1	https://cordis.europa.eu/project/id/769142	1	1	**yes**
28	CORDIS	Optimizing Logistic Fleets with Machine Learning to Enable Sustainable On-Demand Deliveries in Cities	Airmee	01.08.2018	30.11.2018	no	0	https://cordis.europa.eu/project/id/827075	0	0	no
29	CORDIS	Integrated components, systems and architectures for efficient adaption and conversion of commercial vehicle platforms to 3rd generation battery electric vehicles for future CO2-free city logistics	SYS2WHEEL	01.01.2019	30.09.2022	https://sys2wheel.eu/	1	https://cordis.europa.eu/project/id/824244	1	0	no
30	CORDIS	Autonomous, self-loading and unloading ground-based robots	ELIPORT	01.02.2019	31.07.2019	no	0	https://cordis.europa.eu/project/id/856069	0	0	da
31	CORDIS	Full-equipped electric trailer to boost the implementation of efficient, eco-friendly and resilient last-mile delivery	FUTrailer	01.04.2019	30.06.2019	no	0	https://cordis.europa.eu/project/id/864695	0	0	no

32	CORDIS	Modelling Emerging Transport Solutions for Urban Mobility	MOMENTUM	01.05.2019	30.04.2022	https://h2020-momentum.eu/	1	https://cordis.europa.eu/project/id/815069	1	0	no
33	CORDIS	Holistic Approach for Providing Spatial & Transport Planning Tools and Evidence to Metropolitan and Regional Authorities to Lead a Sustainable Transition to a New Mobility Era	HARMONY	01.06.2019	28.02.2023	https://harmony-h2020.eu/	1	https://cordis.europa.eu/project/id/815269	1	0	**yes**
34	CORDIS	Regulating Vehicle Access for Improved Liveability	ReVeAL	01.06.2019	30.10.2022	https://civitas-reveal.eu/	1	https://cordis.europa.eu/project/id/815008	1	0	da
35	CORDIS	Sustainable Policy RespOnse to Urban mobility Transition	SPROUT	01.09.2019	28.02.2023	https://sprout-civitas.eu	1	https://cordis.europa.eu/project/id/814910	1	0	**yes**
36	CORDIS	Smart Loading Zones in EU and Global market to regulate, control and monitor City Logistics - Last Mile Delivery in dense urban areas, based on Bluetooth devices and mobile apps for commercial drivers	PARKUNLOAD	01.12.2019	30.04.2020	no	0	https://cordis.europa.eu/project/id/886990	0	0	**yes**
37	CORDIS	Low-Emission Adaptive last mile logistics supporting 'on Demand economy' through digital twins	LEAD	01.06.2020	30.09.2023	https://www.leadproject.eu/	1	https://cordis.europa.eu/project/id/861598	1	0	**yes**
38	CORDIS	Urban Logistics as an on Demand Service	ULaaDS	01.09.2020	29.02.2024	https://ulaads.eu/	1	https://cordis.europa.eu/project/id/861833	1	0	**yes**
39	CORDIS	Smart Network Operator Platform enabling Shared, Integrated and more Sustainable Urban Freight Logistics	SENATOR	01.09.2020	31.08.2024	https://www.senatorproject.eu/	1	https://cordis.europa.eu/project/id/861540	1	0	**yes**
40	CORDIS	Smart freight TranspOrt and logistics Research Methodologies	STORM	01.01.2021	31.08.2023	https://project-storm.eu/	1	https://cordis.europa.eu/project/id/101006700	1	1	**yes**
41	CORDIS	modUlaR and flexible solutions for urBAN-sIzed Zero-Emissions last-mile Delivery and services vehicles	URBANIZED	01.01.2021	30.06.2024	https://urbanized.eu/	1	https://cordis.europa.eu/project/id/101006943	1	0	**yes**
42	CORDIS	Multimodal and interconnected hubs for freight and passenger transport contributing to a zero emission 21st century	MOVE21	01.05.2021	30.04.2025	https://move21.eu/	1	https://cordis.europa.eu/project/id/953939	1	0	**yes**
43	CORDIS	Flexible, multi-mOdal and Robust FREIGHt Transport	FOR-FREIGHT	01.09.2022	31.12.2025	https://www.for-freight.eu/	1	https://cordis.europa.eu/project/id/101069731	1	0	da
44	CORDIS	UPSCALING INNOVATIVE GREEN URBAN LOGISTICS SOLUTIONS THROUGH MULTI-ACTOR COLLABORATION AND PI-INSPIRED LAST MILE DELIVERIES	URBANE	01.09.2022	28.02.2026	https://www.urbane-horizoneurope.eu/	1	https://cordis.europa.eu/project/id/101069782	1	0	da

45	CORDIS	Five pillars to DECARBOnize the last MILE logistics	DECARBOMILE	01.09.2022	31.08.2026	https://decarbomile.eu/	1	https://cordis.europa.eu/project/id/101069806	1	0	da
46	CORDIS	Fleet and traffic management systems for conducting future cooperative mobility	CONDUCTOR	01.11.2022	31.10.2025	https://conductor-project.eu/	1	https://cordis.europa.eu/project/id/101077049	1	0	da
47	CORDIS	Urban Planning and design ready for 2030	UP2030	01.01.2023	31.12.2025	https://up2030-he.eu/	1	https://cordis.europa.eu/project/id/101096405	1	0	no
48	CORDIS	Cooperative and Interconnected Green delivery solutions towards an era of optimized zero emission last-mile Logistics	GREEN-LOG	01.01.2023	30.06.2026	https://greenlog-project.eu/	1	https://cordis.europa.eu/project/id/101069892	1	0	da
49	CORDIS	A New Perspective on City Logistics: Concepts, Theory, and Models for Designing and Managing Logistics as a Service	GoodMobility	01.01.2023	31.12.2027	no	0	https://cordis.europa.eu/project/id/101076231	0	0	da
50	CORDIS	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 Living Labs	DISCO	01.05.2023	31.10.2026	no	0	https://cordis.europa.eu/project/id/101103954	0	0	da
51	CORDIS	Urban logistics and plaNning: AntiCipating urban freigHt generAtion and demand including dIgitalisation of urbaN freight	UNCHAIN	01.05.2023	31.10.2026	no	0	https://cordis.europa.eu/project/id/101103812	0	0	da
52	CORDIS	Integration and Harmonization of Logistics Operations	TRACE	01.06.2023	31.05.2026	https://trace-horizon.eu/	1	https://cordis.europa.eu/project/id/101104278	1	0	da
53	CORDIS	Smart Enforcement of Transport Operations	SETO	01.06.2023	31.05.2026	https://setoproject.eu/	1	https://cordis.europa.eu/project/id/101103695	0	0	no
54	JPI	Sustainable Operations in Urban Logistics	SOUL	2023	2026	no	0	https://jpi-urbaneurope.eu/project/soul/	0	0	da
55	JPI	Sustainable Innovative digitalized NEtwork of uRban loGIstics	SINERGI	2023	2026	https://sinergi-project.com/	1	https://jpi-urbaneurope.eu/project/sinergi/	0	0	da
56	JPI	Supporting innovative and ambitious cities and municipalities on their pathway to Positive Energy Districts	SIMPLY POSITIVE	2023	2024	http://simplypositive.eu/	1	https://jpi-urbaneurope.eu/project/simply-positive/	1	0	no
57	JPI	Integrated smart city mobility and energy platform	me2	2016	2018	http://me2-project.eu/	0	https://jpi-urbaneurope.eu/project/me2/	0	0	da
58	JPI	Decision-support environment for planning and integrating multi-energy networks and low-carbon resources in cities	IntegrCiTy	2016	2018	http://integrcity.epfl.ch/	0	https://jpi-urbaneurope.eu/project/interg-city/	1	0	no
59	JPI	Integrated systems and analysis of urban Mobility for climate-neutral and susTainable Cities in Europe and China	IMTECC	2023	2026	no	0	https://jpi-urbaneurope.eu/project/imtecc/	0	0	da

60	JPI	Smart decision support system for urban energy and transportation	DESENT	2016	2019	no	0	https://jpi-urbaneurope.eu/project/desent/	0	0	no
61	JPI	Construction in vicinities: innovative co-creation	CIVIC	2016	2018	http://civic-project.eu/	0	https://jpi-urbaneurope.eu/project/civic/	1	0	no
62	JPI	The Awaken Sleeping Assets Project	ASAP	2021	2024	http://www.smarturbanlogistics.eu/	1	https://jpi-urbaneurope.eu/project/asap/	1	0	**yes**
63	EITUrban	Implementation of Dynamic Curbside Management Solutions to Improve Sustainable City Logistics Operations	FlexCurb	01.01.2022	31.12.2022	https://urbanradar.io/flex-curb/	1	https://www.eiturbanmobility.eu/projects/flexcurb/	0	0	da
64	EITUrban	Coding the Curbs: Bookable Loading Zones	Coding the Curbs	01.01.2023	31.12.2023	https://www.codingthecurbs.com/	1	https://www.eiturbanmobility.eu/projects/coding-the-curbs/	1	0	**yes**
65	EITUrban	Tools for local commerce logistics	TACTIC	01.01.2023	30.06.2024	https://tacticlogistics.eu/	1	https://www.eiturbanmobility.eu/projects/tactic/	1	0	da
66	EITUrban	Innovative demand management strategies presents a seamless TDM tool to dynamically manage the use of roads infrastructure ecosystems	IMMENSE	26.01.2023	31.12.2023	no	0	https://www.eiturbanmobility.eu/projects/immense/	0	0	da
67	EITUrban	Last-mile logistics for autonomous goods delivery	LogiSmile	01.05.2023	30.04.2024	https://cdei.upc.edu/logismile-ing/	1	https://www.eiturbanmobility.eu/projects/last-mile-logistics-for-autonomous-goods-delivery/	1	0	da
68	EITUrban	Optimised urban logistics with LogiCYCLE	LogiCYCLE	01.01.2023	31.12.2023	https://www.powerhub.cz/portfolio/powered-projects/logicycle	1	https://www.eiturbanmobility.eu/projects/optimised-urban-logistics-with-logicycle/	0	0	da
69	EITUrban	Four-wheeled EV scooter to fast-track last-mile urban deliveries	GreenDash	01.01.2024	31.12.2024	no	0	https://www.eiturbanmobility.eu/projects/greendash/	0	0	da
70	EITUrban	NIMBLE	NIMBLE	01.01.2024	31.12.2024	no	0	https://www.eiturbanmobility.eu/projects/nimble/	0	0	da
71	EITUrban	Zero Emission off peak Urban distributionS	ZEUS	01.10.2019	30.11.2020	https://www.itrl.kth.se/research/completed-projects/zeus-1.992041	1	https://www.itrl.kth.se/research/completed-projects/zeus-1.992041	0	0	da
72	EITUrban	Hubs for Last Mile Delivery Solutions	HALLO	01.04.2021	31.03.2022	no	0	https://www.eiturbanmobility.eu/projects/hubs-for-last-mile-delivery-solutions/	0	0	da
73	EITUrban	Shared Micro depots for Urban pickup and Delivery	S.M.U.D.	01.01.2020	31.12.2020	no	0	https://www.eiturbanmobility.eu/projects/shared-micro-depots-for-urban-pickup-and-delivery/	1	0	da
74	EITUrban	Multi-sustainable digital loading and delivery zones for city logistics	S+LOADZ	01.01.2022	31.12.2022	https://sloadz.com/	1	https://www.eiturbanmobility.eu/projects/sloadz/	1	0	**yes**
75	Interreg	Transport and Logistics Stakeholders Network	TalkNET	01.06.2017	31.08.2020	https://programme2014-20.interreg-central.eu/Content.Node/TalkNET.html	1	https://keep.eu/projects/18268/Transport-and-Logistics-Sta-EN/	1	0	no
76	Interreg	Strengthening Combined Transport in the Baltic Sea Region	COMBINE	01.01.2019	30.06.2021	https://www.combine-project.com/en	1	https://keep.eu/projects/21621/Strengthening-Combined-Tran-EN/	1	0	no
77	Interreg	Fuel Cell Cargo Pedelecs	FCCP	07.03.2018	28.02.2023	https://fuelcellcargobike.eu/	1	https://keep.eu/projects/19475/Fuel-Cell-Cargo-Pedelecs-EN/	1	0	da

78	Interreg	Sustainable urban freight transport with autonomous zero-emission vessel>> modal shift from road to water	AVATAR	01.05.2020	30.06.2023	https://northsearegion.eu/avatar	1	https://keep.eu/projects/23462/Sustainable-urban-freight-t-EN/	1	0	da
79	Interreg	Greening Regional fReight Transport in fuAs	GRETA	01.04.2023	31.03.2026	https://www.interreg-central.eu/projects/greta/	1	https://keep.eu/projects/27737/Greening-Regional-fReight-T-EN/	0	0	da
80	Interreg	Revitalisation of Inner-Urban Freight Rail Hubs	UrbFRail	21.04.2023	30.04.2025	https://interreg-baltic.eu/project/urbfrail/	1	https://keep.eu/projects/28277/Revitalisation-of-Inner-Urba-EN/	0	0	da
81	Interreg	Increase of energy efficiency by Electric MOBIlity in the CITY	EMOBICITY	01.08.2019	31.07.2023	https://projects2014-2020.interregeurope.eu/emobicity/library/	1	https://keep.eu/projects/21482/Increase-of-energy-efficien-EN/	1	0	**yes**
82	Interreg	Green and socially responsible city logistics innovations	SPOTLOG	01.03.2023	31.05.2027	https://www.interregeurope.eu/spotlog	1	https://keep.eu/projects/28178/Green-and-socially-responsib-EN/	0	0	da
83	Interreg	Sustainable Urban Logistics PlannIng To Enhance Regional freight transport	SULPiTER	01.06.2016	31.05.2019	https://programme2014-20.interreg-central.eu/Content.Node/SULPiTER.html	1	https://keep.eu/projects/17680/Sustainable-Urban-Logistics-EN/	1	0	**yes**
84	Interreg	Smart Urban Freight Logistics Hubs	SURFLOGH	15.06.2017	30.04.2023	https://northsearegion.eu/surflogh/	1	https://keep.eu/projects/19102/Smart-Urban-Freight-Logisti-EN/	1	0	da
85	Interreg	Holistic Urban and Peri-urban Mobility	HUPMOBILE	01.01.2019	31.12.2021	https://www.hupmobile-project.eu/	1	https://keep.eu/projects/21619/Holistic-Urban-and-Peri-urb-EN/	1	0	yes
86	Interreg	Fostering e-mobility solutions in urban areas in the Baltic Sea Region	BSR electric	01.10.2017	30.09.2020	https://www.bsr-electric.eu/	1	https://keep.eu/projects/21636/Fostering-e-mobility-soluti-EN/	1	0	yes
87	Interreg	Cargo bikes in urban mobility	CoBiUM (seed)	01.03.2017	30.06.2017	https://energikontorsyd.se/en/cobium	1	https://keep.eu/projects/21927/Cargo-bikes-in-urban-mobili-EN/	1	0	no
88	Interreg	Delivering Tailored Approaches for Innovative Logistics Solutions	Freight TAILS	15.09.2015	03.05.2018	https://urbact.eu/networks/freight-tails	1	https://keep.eu/projects/22190/Delivering-Tailored-Approac-EN/	1	0	no
89	EUREKA	All Conditions Logistics Mobile Robot		01.08.2020	02.01.2022	no	0	no	0	0	da
90	EUREKA	Autonomous robotic deliveries for small logistics	RB-LOG	01.11.2017	30.04.2020	no	0	https://www.era-learn.eu/network-information/networks/eurostars-2/eurostars-cut-off-7/autonomous-robotic-deliveries-for-small-logistics	0	0	da
91	EUREKA	Central European Logistic Portal	CELP	06.10.2015	31.12.2017	https://starfos.tacr.cz/en/projekty/LF15010	1	no	0	0	da
92	EUREKA	Development of the Fuuzo platform for crowdsourcing of deliveries		01.06.2016	06.03.2018	no	0	no	0	0	da
93	EUREKA	European Portal of Logistics Services	EPLOS	01.01.2017	01.01.2021	no	0	no	0	0	no
94	EUREKA	Fast Inductive Charging System (FICS)		02.05.2016	05.02.2018	no	0	no	0	0	da
95	EUREKA	Integrated Software Platform for Planning, Optimizing and Monitoring Logistics Vehicle Fleets		01.02.2018	02.03.2020	no	0	no	0	0	da
96	EUREKA	Integrated Analytical Software Platform for Planning, Optimizing and Monitoring Logistics Vehicle Fleets	iRoute	01.04.2020	04.03.2023	https://iroute.eu/	1	no	1	0	**yes**
97	EUREKA	Portable Hydrogen refueling system for unmanned aerial	HUV2	05.11.2018	11.04.2021	no	0	https://www.era-learn.eu/network-information/networks/eurostars-2/eurostars-	0	0	da

		vehicles dedicated civilian applications						cut2013off-9/portable-hydrogen-refueling-system-for-unmanned-aerial-vehicles-dedicated-to-civilian-applications			
98	EUREKA	RECONFIGURABLE SMART LOCKERS - DISTributeurs INtelliGents recOnfigurables	DISTINGO	01.12.2019	31.03.2023	http://distingo.hi-iberia.es/	0	NO	0	0	da
99	ERA-LEARN	Logistics Network Technology	LogNetTech	01.09.2020	01.03.2022	no	0	https://www.era-learn.eu/network-information/networks/eurostars-2/eurostars-cut2013off-13/logistics-network-technology	0	0	da
100	ERA-LEARN	Electric Urban Freight and Logistics	EUFAL	01.01.2018	30.06.2020	https://www.eufal-project.eu/	1	https://www.era-learn.eu/network-information/networks/emeurope/emeurope-cofund-call/electric-urban-freight-and-logistics	1	1	**yes**
101	NCN	Logistics in city development strategies. Comparative analysis of the capitals of European cities (PL: Logistyka w strategiach rozwoju miast. Analiza porównawcza stolic miast europejskich)		18.02.2014	17.02.2018	no	0	https://projekty.ncn.gov.pl/index.php?projekt_id=220101	1	0	no
102	NCN	Probabilistic forecasting as a tool for optimizing decisions of electricity market participants (PL: Prognozowanie probabilistyczne jako narzędzie optymalizacji decyzji uczestników rynku energii elektrycznej)		25.06.2020	24.06.2023	no	0	https://projekty.ncn.gov.pl/index.php?projekt_id=460769	0	0	no
103	NCN	Sustainable last mile urban logistics and returns in the e-commerce market. The perspective of different stakeholder groups (PL: Zrównoważona logistyka miejska ostatniej mili i zwrotów na rynku e-commerce. Perspektywa różnych grup interesariuszy)		16.07.2019	15.06.2024	no	0	https://projekty.ncn.gov.pl/index.php?projekt_id=431417	1	0	**yes**
104	POL-on	Smart platform to integrate different freight transport means, manage and foster first and last mile in supply chains	S-mile	01.07.2016	30.06.2018	https://www.polsl.pl/rt4/en/smart-platform-to-integrate-different-freight-transport-means-manage-and-foster-first-and-last-mile-in-supply-chains/	1	no	1	0	da
105	MapaDotacji	Interoperable platform for an intelligent urban logistics infrastructure network, integrating networks of points and transmitting and receiving devices (PL: Interoperacyjna platforma inteligentnej sieci infrastruktury logistyki miejskiej, integrująca sieci punktów i urządzeń nadawczo-odbiorczych)		01.09.2018	31.12.2020	no	0	https://mapadotacji.gov.pl/projekty/785784/	0	0	da
106	MapaDotacji	Autonomous transport system based on mobile robots and learning planning and control algorithms for production processes and non-linear processes of internal warehouse Logistics (PL: Autonomiczny system transportu, oparty na robotach mobilnych oraz uczących się algorytmach planowania i sterowania, dla procesów produkcyjnych oraz nieliniowych procesów wewnętrznej logistyki magazynowej)		01.05.2016	30.04.2019	https://versabox.eu/pl/projekt-eu/	1	https://mapadotacji.gov.pl/projekty/743366/	0	0	da

5.3. Conclusions from the project review

The conducted review allowed for assessing projects thematically related to E-Laas, whose results and research data may be useful in the ongoing project. Based on the review of available resources, it was found that most projects provide information in the form of short popular science descriptions or abstracts and reports on completed tasks. In projects, the primary source of information is subpages dedicated to specific projects on the portals of funding institutions, e.g., CORDIS. Approximately 65% of projects have dedicated websites, but only about 55% have active pages. The reviewed projects have summaries on various websites, including those of the funding institution. However, 56% of the selected projects have detailed work results and/or datasets. Most projects do not provide source data. Only in 4 cases are source data provided, but not all. Source data are mainly available to consortium members implementing the project (as often indicated by available data management plans). Thus, mainly publications and result reports are provided. Reports or articles often contain fragmentary data that may be useful in other research projects.

Due to the growing interest in urban logistics, many projects potentially related to E-Laas (106) have been identified. The projects being implemented and initially selected concern various areas of urban logistics. Among the main assumptions of these projects, one should mention the development of guidelines for shaping transport policies, the development of platforms integrating various participants of the logistics system, the development of new concepts for organizing urban logistics (e.g., for a specific industry, using crowdsourcing), the development of new means of transport (bicycles, trailers, robots, drones), electric vehicles, and chargers. Often, projects include pilot studies or so-called Living Labs. Out of the selected projects, 28 were classified as having the potential to support E-Laas by examining the possibilities of applying certain concepts or utilizing data. 32 projects were excluded after detailed analysis, and the remaining 46 were deemed difficult to assess. This difficulty arises from a lack of sufficient information about the project or a lack of reports or research results. Projects that have started relatively recently, i.e., from 01.01.2023, and whose results have not yet been published or are only preliminary (17 projects), were also classified into this group. However, such projects should be monitored - some results may be useful for E-Laas.

Summarizing the conducted review, the projects selected as potentially useful for E-Laas were divided into 4 categories (the list of projects is presented in **Table *2***).

- Last-mile concepts - for the purpose of developing research scenarios, encompassing concepts of utilizing various means of transport, integration of multimodal branches, including the use of appropriate infrastructure such as consolidation centers or micro hubs. Reports contain fragmentary data that may be useful for simulation studies.
- Simulation and decision support - methodological assumptions for conducting research, simulations, or concepts of computational algorithms.
- Policy shaping guidelines - considering social, economic, and technical aspects in shaping urban logistics systems, which may be useful for developing research scenarios and detailing recommendations developed in E-Laas.
- Input data - datasets of logistics data or data on means of transportation.

Table 2. Classification of the projects

Field of Added Value	Project (numbering according to **Table 1**)
Last-mile concepts	4, 5, 6, 7, 12, 13, 16, 20, 35, 36, 37, 38, 39, 41, 42, 64, 74, 85, 86, 100, 103
Simulation and decision support	5, 27, 37, 39, 40, 62, 85, 96, 100
Policy shaping guidelines	4, 6, 33, 35, 42, 62, 83
Input data	16, 27, 40, 100

Regarding the goals and scope of the E-Laas project, particular attention is deserved by selected projects. From the above table, those were chosen which address diverse issues and complement each other in terms of achieved effects. In terms of concepts for developing scenarios, as well as assumptions for shaping urban logistics policies, the following projects propose interesting solutions:

- NOVELOG [6] project explores cooperative business models for urban logistics, aiming to address environmental, economic, and social challenges with a focus on sustainability and operational efficiency. The project’s insights into cooperative logistics models can bolster E-Laas by introducing strategies that promote energy efficiency and sustainability in urban freight systems, potentially enhancing the platform's approach to last-mile delivery through improved multimodality and integration.
- SPROUT [35] focuses on crafting city-led policies to navigate and capitalize on the shift towards new urban mobility paradigms, aiming for a sustainable future. The policy insights generated could guide E-Laas in aligning its logistics solutions with evolving urban policies, ensuring that recommendations for urban logistics systems are both innovative and policy-compliant, fostering sustainability.
- SULPiTER [83] is designed to enhance urban logistics planning to foster sustainable development, with an emphasis on strategic policy-making and planning. This project's policy-making and planning insights could enrich E-Laas’s approach to developing resilient and sustainable urban logistics strategies, aligning with goals for social, economic, and technical sustainability.
- Sustainable last mile urban logistics and returns [103] tackles the complexities of last-mile delivery and return processes in urban settings, aiming for sustainability and operational efficiency. The project's focus on last-mile efficiency and sustainability can provide E-Laas with valuable insights, particularly for enhancing the energy efficiency of delivery operations and integrating sustainable return logistics practices.

Among the projects that present interesting approaches from a methodological standpoint, but also provide certain concepts for shaping urban logistics systems, the following should be highlighted:

- LEAD [37] integrates low-emission transport modes and digital technologies to innovate last-mile delivery solutions, catering to the evolving needs of urban areas. The methodologies and data from LEAD can directly bolster E-Laas's objectives to minimize energy consumption and emissions in urban deliveries, offering valuable insights into the integration of digital solutions and low-emission transport modes.
- SENATOR [39] aims to create a cohesive logistics network, leveraging shared, sustainable solutions through innovative governance, to enhance urban logistics. Insights into

integrated logistics networks from SENATOR could enhance E-Laas's framework for energy-efficient logistics, especially by showcasing how shared and sustainable approaches can be implemented in last-mile concepts and multimodal deliveries.

- HUPMOBILE [85] strives for comprehensive mobility solutions that bridge urban and peri-urban areas, focusing on seamless integration and sustainability. The methodologies and findings could support E-Laas in exploring energy use across urban and peri-urban logistics networks, aiding in the creation of multimodal logistics solutions that are efficient and scalable.
- EUFAL [100] promotes the adoption of electric freight solutions in urban areas, providing a knowledge exchange platform to share best practices and innovations. Directly aligned with E-Laas's focus on electrification, EUFAL could offer critical input data on electric vehicles and operational insights, supporting the development of energy-efficient and zero-emission urban logistics models.

Additionally, in terms of utilizing dedicated parking areas, two key projects have been identified:

- PARKUNLOAD [36] initiative implements IoT solutions for smart loading zones, aiming to mitigate urban congestion and enhance the efficiency of delivery operations. By exploring the implementation of smart loading zones, this project could directly contribute to optimizing the operational aspects of E-Laas, especially in managing energy use in dense urban environments and improving the coordination of delivery platforms. It is also a project in which the participant is a partner in the E-Laas project.

- ASAP [62] seeks to mobilize underutilized urban assets for logistics through digitalization and innovative business models, enhancing urban logistics efficiency. The project's focus on leveraging urban assets can inform E-Laas's strategies for optimizing logistics infrastructure and usage of smart loading zones potentially offering insights for simulation studies and infrastructure planning.

In terms of parking, other projects can also provide some information, i.e. S+LOADZ [74], Coding the Curbs [64] and Freight TAILS [88], and also in consideration it was in the project already discussed - SPROUT [35].

As indicated, some projects were classified as difficult to assess due to being in an early stage. However, projects that should be monitored as they may provide certain information or data useful in E-Laas were selected. They are listed in **Table 3**.

Table 3. Ongoing projects – potentially useful for E-Laas

Field of Added Value	Project (numbering according to **Table 1**)
Last-mile concepts	48, 49, 50, 51, 54, 55, 59, 64, 65, 67, 68, 69, 70, 79, 80, 82
Simulation and decision support	48, 49, 50, 52
Policy shaping guidelines	51, 54, 79, 80
Input data	These projects do not make any source data available at this moment.

The conducted review allowed for identifying projects with similar themes, the results of which may be useful for E-Laas. Selected projects will be utilized to develop research scenarios and methodology to address urban areas' needs in urban logistics thoroughly. The main challenge in conducting research projects is the lack of source data. To some extent, these projects can support E-Laas precisely in terms of data. Reports, articles, and available data from previously conducted research will be thoroughly analyzed and may be used for machine learning and the development of econometric and forecasting models.

5.4. Lessons learned for E-Laas project

The following lessons can be formulated for further work on energy-efficient and sustainable urban logistics systems:

- **Urban logistics should be analysed as an integrated system rather than as a set of isolated technical solutions.** The reviewed projects cover a wide range of topics, including last-mile concepts, multimodal delivery systems, electric vehicles, chargers, cargo bikes, robots, drones, logistics platforms, smart loading zones, micro-hubs and policy guidelines. This confirms that contemporary urban logistics research is multidimensional and requires the integration of operational, infrastructural, technological, behavioural and policy-related aspects.
- **Research scenarios should be grounded in already tested or conceptually mature last-mile solutions.** A significant number of reviewed projects were classified as useful for developing last-mile concepts. These projects concern, among others, the use of different transport modes, multimodal integration, consolidation centres, micro-hubs and infrastructure supporting deliveries in dense urban areas. This indicates that further scenario development should be based on realistic solution families rather than purely theoretical assumptions.
- **The most relevant urban logistics concepts combine modal shift, consolidation and better use of urban space.** The project review shows that many initiatives focus on reducing the negative impacts of deliveries by reorganising the structure of the last mile. Particularly important directions include the use of consolidation points, micro-hubs, smart loading zones, alternative delivery vehicles and more efficient allocation of public space. These concepts should be treated as complementary, because their effectiveness often depends on how they are combined within a broader delivery system.
- **Simulation and decision-support methods are necessary to assess alternative logistics configurations.** Several reviewed projects were classified as relevant for simulation and decision support. This confirms that urban logistics solutions should not be assessed only descriptively. They require analytical tools capable of comparing alternative variants in terms of operational efficiency, energy consumption, emissions, costs, service quality and infrastructure use.
- **Data availability remains one of the main limitations in urban logistics research.** Although many projects provide descriptions, reports or summaries, access to detailed source data is limited. The review indicates that approximately 65% of selected projects have dedicated websites, around 55% have active websites, and 56% provide detailed results or datasets. However, only four projects provide source data, and even these data are not complete. This means that future analyses should combine available reports and

partial datasets with public data, partner data, surveys, expert assumptions and synthetic data.

- **Fragmentary project results can still be useful for defining assumptions and parameters.** Even when complete datasets are not available, reports and publications from previous projects may contain operational assumptions, case descriptions, methodological recommendations, pilot results, parameter ranges or KPI definitions. Such information can support the design of scenarios, the calibration of simulation models and the formulation of assumptions for comparative analyses.
- **Ongoing projects should be monitored as potential future sources of knowledge and data.** A considerable number of projects were classified as difficult to assess, mainly because they had started recently or had not yet published final results. Nevertheless, some of them may become useful at later stages, especially in relation to last-mile concepts, simulation methods, policy guidelines and digital logistics platforms. Therefore, the state-of-the-art review should be treated as a dynamic knowledge base rather than a closed inventory.
- **Policy-oriented research is essential for translating technical solutions into urban practice.** The review identified projects that develop guidelines for shaping transport policies and sustainable urban logistics strategies. This indicates that technical and operational analyses should be linked with institutional feasibility, stakeholder cooperation, regulatory instruments and the needs of local authorities. Without this link, even technically effective solutions may be difficult to implement in real urban environments.
- **Energy and environmental assessment should be connected with operational delivery structures.** The review shows that low-emission transport modes, electric vehicles, charging infrastructure and smart loading zones are frequently analysed together with last-mile organisation. This means that energy efficiency should not be assessed only at the level of individual vehicles. It should also take into account routing, consolidation, delivery density, vehicle utilisation, charging availability, delivery time windows and the spatial structure of demand.
- **The main research gap concerns the integration of dispersed project outcomes into one coherent analytical workflow.** Previous projects provide valuable knowledge, but their results are often dispersed across different thematic areas. Some focus on technologies, others on data platforms, policy tools, consolidation concepts, electric vehicles or stakeholder cooperation. The key lesson is that further research should combine these elements into a structured workflow linking scenario definition, data collection, modelling, simulation, energy assessment, behavioural analysis and policy recommendations.

6. Overview of solutions in the transport policies of cities

6.1. Introduction

In recent years, urban agglomerations have been implementing an increasing number of logistical solutions related to transport organization and the improvement of cargo deliveries within the first/last mile. The primary objective of implementing such initiatives is to enhance the residents' quality of life. This goal is achieved through:

- Reducing negative environmental impact;

- Decreasing adverse effects on the surroundings (e.g., noise and vibrations);
- Limiting congestion;
- Shortening delivery times;
- Increasing delivery flexibility (e.g., regarding possible timeframes);
- Organizing and better utilizing urban space.

To identify best practices in urban logistics, particularly in the context of first/last-mile deliveries, a review of transport policies in Polish urban agglomerations and urban functional areas was conducted. Currently, Polish cities have prepared strategic documents called Sustainable Urban Mobility Plans (SUMPs), which constitute comprehensive plans for developing the transportation system of a given area.
The initial concept of SUMPs was formulated by the European Commission in 2013 [16]. Building upon this concept, SUMPs are documents that indicate directions for the development of urban mobility, aligning with the principles of sustainable development and incorporating mobility-related actions into the overall strategy for urban development. The mentioned concept indicated that SUMPs should be formulated by all stakeholders of the urban transport system, including residents, businesses, service providers, local and central authorities. Moreover, the interdisciplinary nature of SUMPs was emphasized in the described concept, indicating that the preparation of such documents requires consideration of issues related to transportation, spatial planning, economic development, social policy, environmental protection, health, and road safety.
The current definition of SUMPs was established in 2023 [17]. According to this definition, a SUMP is a strategic plan developed to meet the mobility needs of city residents and businesses operating within the city and its surroundings. The main objective of creating SUMPs is to improve the quality of life for residents. These documents should, on one hand, be based on previously established best practices in planning while also considering the principles of active participation, integration, and evaluation of implemented actions.

6.2. Overview of solutions in the transport policies of Polish cities

6.2.1. Overall description

SUMPs are a valuable source of information on urban policies regarding first/last-mile deliveries and solutions in this area used in Polish cities. Currently, the Polish SUMP Competence Center, established by the Ministry of Infrastructure, maintains a SUMP repository [18], the ones that have been positively evaluated by the Center for EU Transport Projects (Poland). As of August 31, 2025, there were 46 SUMPs available in the repository developed for urban agglomerations and urban functional areas.
As a result of the analysis of SUMPs for the aforementioned urban areas, the following solutions and best practices related to urban freight transport were identified:

- establishment of local consolidation centers,
- creation of dedicated parking spaces for delivery vehicles,
- utilization of low-emission (zero-emission or low-emission) delivery vehicles,
- use of cargo bicycles,
- restriction of heavy-duty vehicle traffic,

- construction of publicly accessible charging stations for zero-emission or low-emission vehicles,
- development of recommendations for the location and operation of parcel lockers,
- utilization of rail transport,
- implementation of soft measures (e.g., collaboration with carriers to develop rational solutions),
- general approach (e.g. the necessity to develop a Sustainable Urban Logistics Plan).

In the following subsections, individual solutions in the field of urban logistics implemented or planned for implementation in Polish cities are described.

6.2.2. Overview of Urban Logistics Solutions Implemented in Polish Cities

1) Micro-hubs

Micro-hubs (also known as local consolidation centers) are logistic points located near the final recipients (senders), providing the opportunity for handling transfers and short-term storage. Considering the criterion of proximity to the final recipients, such points are typically located near places such as service/commercial concentration areas or large residential districts to ensure quick delivery to the destination point. As a rule, micro-hubs are owned by carriers who use them as a tool for organizing deliveries in urban agglomerations. Micro-hubs handle both deliveries made in business-to-business relationships (i.e., goods delivered to restaurants, service points, or retail stores) and in business-to-customer relationships (meaning parcels delivered to individual recipients).

The described transfer points allow, on one hand, an increase in the level of cargo consolidation delivered within the last-mile deliveries. On the other hand, it is a tool for organizing transfers from large delivery vehicles to smaller means of transportation. Since this solution supports sustainable development, deliveries between micro-hubs and end recipients are carried out using environmentally friendly transport modes, such as light zero- or low-emission delivery vehicles, cargo bikes, or walking couriers. In some cases, micro-hubs can also serve as points from which customers can pick up parcels themselves, resulting in shorter delivery times and greater flexibility (assuming that the end customer can collect the parcel at any time) [19][20].

The main advantages of organizing local consolidation centers include: reducing negative environmental impact, alleviating congestion, enabling efficient handling of transfer processes, limiting the movement of large trucks and delivery vehicles in city centers while simultaneously increasing the use of sustainable modes of transportation, enhancing the level of cargo consolidation within last-mile deliveries, and providing the opportunity for end recipients to collect parcels at these locations.

An example of a Polish city planning to implement the idea of local consolidation centers is Kraków. According to the "Sustainable Mobility Plan of the Kraków Metropolitan Area and its Functional Area," there are plans to establish local consolidation centers and introduce new solutions for delivery organization (Key Action 5.5, "Transfer Centers"). As part of this key action, Detailed Action 5.5.2 was formulated, which entails organizing transfers from vehicles to other sustainable means of transportation. Detailed Action 5.5.2 is to be implemented in Kraków as well as throughout the entire functional area. The mentioned plan prioritizes this action as medium [21]. Another example of an area planning to implement such solutions is the Koszalin-Kołobrzeg-Białogard Functional Area.

2) <u>Delivery vehicle parking spaces</u>

One of the most common problems associated with organizing cargo deliveries in urban agglomerations is the lack of parking spaces where delivery drivers can park their vehicles and deliver the cargo to the intended recipients. This issue is particularly challenging in densely populated areas, primarily in city centers. Despite the fact that the average delivery vehicle's time spent is only a few minutes, most parking spaces are usually occupied by residents or customers of service points. Delivery vehicles searching for available parking spaces generate numerous problems, such as prolonging the time and cost of deliveries, increasing environmental costs, and intensifying traffic congestion. Drivers who stop their vehicles in unauthorized places due to the lack of available parking spaces may cause traffic jams or block other vehicles attempting to exit parking spaces. This situation negatively affects road safety, especially for pedestrians.

As a result, in recent years, the idea of dedicated parking spaces for delivery vehicles has become widespread. It is assumed that such specially marked parking spaces are occupied for a few minutes by delivery drivers who need to make deliveries to nearby recipients. Subsequently, the parking space is vacated and can be used by another delivery driver. Typically, the allowable parking time in such spaces is 15 minutes, hence in some cities, these spaces are referred to as "15-minute envelopes."

Parking spaces for delivery drivers can be permanent or only applicable during designated hours when deliveries are most commonly made [22]. As mentioned earlier, proper signage of the parking space for delivery drivers is a crucial element of the described solution. In selected cases, it may be necessary to install physical barriers to prevent vehicles that are not making deliveries from blocking these spaces. Additionally, the described idea can be expanded by implementing reservation systems that allow the booking of parking spaces for specific hours. With such solutions in place, multiple delivery drivers do not attempt to use the same parking space at the same time [23].

It can be said that the organization of parking spaces for delivery drivers is a significant aspect of both urban logistics and city parking policies. There is no doubt that introducing dedicated parking spaces for delivery drivers has many benefits. These include streamlining and reducing traffic congestion, improving road safety, shortening delivery times, better planning of transportation processes, reducing delivery costs, and minimizing negative environmental impact. In summary, parking spaces for cargo deliveries are a vital element of urban planning and urban logistics, contributing to improving the efficiency, safety, and convenience of goods deliveries in cities.

From the analysis of SUMPs, it is evident that the introduction of parking spaces for cargo deliveries has been planned in Gorzów Wielkopolski, Kalisz and Ostrow Wielkopolski, Kraków, Lublin, Olsztyn, Opole, Siedlce, Warsaw, and Zielona Góra. It is worth noting that this is the most popular solution in the field of urban logistics, with implementation planned in Polish cities in the coming years.

In the case of the latter of the aforementioned cities, detailed plans were described in the Sustainable Urban Mobility Plan for the Zielona Góra-Nowa Sól Functional Area. Within

Operational Objective No. 6 "Calming and excluding traffic from city centers," an action was planned to apply solutions to organize goods deliveries in urban areas (Action 6.8). As indicated, the implementation of this action will involve designating parking spaces exclusively for delivery vehicles (no parking sign with the annotation "does not apply to supplies up to 15 minutes") in agreement with the owners of retail and service points located near the designated parking space. The plan assumes that one parking space should serve approximately 4-5 serviced points. According to the analysis conducted by the authors, the implementation of this solution in the cities of the Zielona Góra-Nowa Sól Functional Area will be associated with relatively low costs. The planned implementation horizon for this solution is the year 2025 [24]. The described solution has already been implemented in recent years, including in Gdynia and Poznań. In Gdynia, in 2018, as part of the Freight TAILS project (funded by the URACT III program), a pilot project was conducted, involving the designation of 11 parking spaces dedicated to delivery drivers in the city center. At these designated locations, vehicles were allowed to stop for a maximum of 15 minutes for unloading goods and completing deliveries.

3) Zero- / Low-emission delivery vehicles

The use of zero- and low-emission delivery vehicles in urban freight transport constitutes one of the key directions in the transformation of city logistics towards greater environmental sustainability. This measure responds directly to the negative externalities generated by conventional combustion-engine vehicles, including greenhouse gas emissions, air pollution, noise, and the excessive consumption of fossil fuels. In the context of urban agglomerations, where freight transport is concentrated in densely populated areas, the replacement of conventional delivery fleets with zero- or low-emission vehicles may significantly contribute to improving the environmental quality and liveability of cities.

Zero- and low-emission delivery vehicles include, in particular, battery electric vehicles, plug-in hybrid vehicles, hybrid vehicles, and other alternative-fuel vehicles characterized by reduced emissions during operation. Their deployment is especially relevant in last-mile logistics, where vehicles frequently operate over relatively short distances, make multiple stops, and move through areas with high population density. These operational characteristics make urban deliveries particularly suitable for electrification and for the broader introduction of alternative propulsion systems.

One of the most important benefits of this solution is the reduction of greenhouse gas emissions and local air pollutants. Conventional delivery vehicles contribute to the emission of carbon dioxide, nitrogen oxides, particulate matter, and other harmful substances. These pollutants negatively affect air quality and create health risks for urban residents, especially in city centres and along streets with intensive traffic. The introduction of zero-emission vehicles can eliminate exhaust emissions during vehicle operation, while low-emission vehicles can substantially reduce them. As a result, this measure supports both climate policy objectives and local environmental protection goals.

Another significant advantage is the reduction of noise generated by freight transport. Electric delivery vehicles are generally quieter than vehicles powered by internal combustion engines, particularly at low speeds and during frequent acceleration and braking. This feature is important in residential areas, historic city centres, and zones where deliveries are carried out early in the morning or late in the evening. Lower noise levels may improve the quality of life of residents and reduce conflicts between freight operations and other urban functions.

The implementation of zero- and low-emission delivery vehicles may also improve the operational efficiency of urban logistics. In many cases, such vehicles are associated with lower operating costs, especially due to reduced energy costs, fewer mechanical components, and lower maintenance requirements. Although initial purchase costs may remain relatively high, these can be offset over time by lower operating expenses, access to preferential regulatory conditions, and potential public support mechanisms. In addition, the development of charging infrastructure increases the practical feasibility of using electric vehicles for regular urban delivery operations.

From a policy perspective, zero- and low-emission delivery vehicles are closely linked to broader urban mobility and environmental strategies. Their use can be supported by regulatory instruments such as low-emission zones, preferential access to city centres, dedicated loading areas, tax incentives, subsidies, and public procurement requirements. These instruments may encourage logistics operators to modernize their fleets and accelerate the transition towards cleaner forms of urban freight transport.

The wider deployment of such vehicles also promotes technological innovation in the transport sector. The growing demand for zero- and low-emission delivery fleets stimulates the development of vehicle technologies, batteries, charging systems, fleet management tools, and energy-efficient logistics models. In this sense, the measure should not be understood solely as a vehicle replacement policy, but also as part of a broader innovation process aimed at restructuring urban freight systems.

In addition to environmental and operational benefits, zero- and low-emission delivery vehicles may increase the attractiveness of cities for residents, businesses, and visitors. Reduced air pollution and lower noise levels contribute to a more pleasant and healthier urban environment. This is particularly relevant in city centres, where freight transport must coexist with pedestrian activity, public transport, tourism, retail, and residential functions.

Overall, the introduction of zero- and low-emission delivery vehicles represents an important instrument for reducing the environmental burden of urban logistics. Its effectiveness depends not only on the availability of suitable vehicles, but also on complementary measures such as charging infrastructure, regulatory support, fleet management systems, and integration with broader sustainable urban mobility policies. When implemented as part of a coherent urban logistics strategy, this solution can contribute to cleaner, quieter, and more efficient goods distribution in cities.

4) Cargo bikes

The use of cargo bikes for urban deliveries has become increasingly popular in recent years due to the many benefits this solution offers. Cargo bikes are especially well suited to last-mile logistics in densely built-up urban areas, where conventional delivery vehicles often face operational difficulties related to congestion, limited accessibility, and parking shortages. As a result, cargo bikes are increasingly regarded as an effective and sustainable component of urban logistics systems.

One of the main advantages of cargo bikes is their environmental performance. Unlike conventional delivery vans, cargo bikes do not generate greenhouse gas emissions or other air pollutants during operation. This makes them an environmentally friendly means of transport and contributes to improving air quality in cities, while also reducing the negative environmental impacts associated with urban freight transport.

Cargo bikes also offer high mobility in urban areas. They can move efficiently through dense street networks and congested city centres, including locations that may be difficult to access for larger delivery vehicles. Thanks to their ability to avoid traffic congestion and reach destinations more directly, cargo bikes can reduce travel times and improve the reliability and speed of deliveries. This can significantly enhance the efficiency of the delivery process and increase customer satisfaction.

Another important benefit of cargo bikes is their flexibility. They can be adapted to different logistical needs and to the transport of different types of goods. Depending on the model and cargo capacity, they may be used for small parcels as well as for larger or heavier shipments. Their operation is also relatively inexpensive in comparison with conventional delivery vehicles. Lower operating costs, the absence of fuel expenses, and the lack of parking or road charges make cargo bikes an economically attractive option for logistics operators and delivery companies.

In addition to logistical and economic benefits, the use of cargo bikes may also support healthier and more active working conditions. Promoting cycle-based deliveries can contribute to a more active lifestyle among employees and reduce some of the negative effects associated with sedentary work. At the same time, wider use of cargo bikes in cities may help reduce congestion and improve the overall functioning of urban transport systems.

Overall, cargo bikes can be regarded as an important solution in the field of urban logistics. Their implementation may contribute to reducing traffic congestion, shortening delivery times, lowering operating costs, improving environmental performance, and increasing the accessibility and efficiency of urban deliveries.

5) Truck traffic restrictions

Truck traffic restrictions constitute one of the most frequently applied policy instruments in urban logistics and freight transport management. In the Polish context, this measure is particularly common in regional and local mobility policies, where it is used to limit the negative impacts of heavy goods vehicle traffic on city centres, residential areas, and sensitive sections of the urban road network. The main objective of such restrictions is not to eliminate freight transport from cities, but rather to regulate its spatial and temporal organization in a way that is compatible with road safety, environmental protection, infrastructure capacity, and the quality of urban life.

The scope of truck traffic restrictions may vary significantly depending on local conditions and policy objectives. In some cities, restrictions apply primarily to transit traffic, meaning that heavy goods vehicles which do not serve destinations within the city are redirected to alternative routes, such as ring roads or bypasses. In other cases, more extensive measures are considered, including a complete ban on heavy goods vehicle entry into inner-city areas. Restrictions may also be selective and apply only to specific categories of vehicles, for example vehicles exceeding a gross vehicle weight of 3.5 tonnes, or vehicles that do not meet particular emission or operational requirements.

Truck traffic restrictions can also be differentiated in time and space. They may apply only during selected hours, such as peak traffic periods, night-time hours, or specific delivery windows. In other cases, restrictions may be introduced on particular days of the week or on selected road sections where the presence of heavy vehicles generates the greatest negative impacts. This flexibility makes the measure adaptable to various urban contexts, from dense historic centres to residential districts and roads with limited technical capacity.

One of the principal arguments for introducing truck traffic restrictions is road safety. Heavy goods vehicles, due to their mass, dimensions, braking distance, and limited visibility, may pose a higher risk to vulnerable road users, especially pedestrians and cyclists. This risk is particularly significant in compact urban areas where freight traffic interacts with public transport, cycling infrastructure, pedestrian crossings, and high-intensity local traffic. Limiting the access of heavy vehicles to selected areas can therefore reduce the probability and severity of road accidents.

Another important rationale concerns the protection of road infrastructure. Intensive use of urban roads, bridges, and viaducts by heavy goods vehicles may accelerate pavement degradation and increase maintenance costs. In this sense, traffic restrictions can serve as an infrastructure management tool, helping to preserve the technical condition of road assets and reduce the need for frequent repairs. This is especially relevant on streets not originally designed for high volumes of heavy vehicle traffic.

Environmental considerations also play a significant role. Heavy goods vehicles are often associated with substantial emissions of nitrogen oxides, particulate matter, volatile organic compounds, and greenhouse gases. Their concentration in densely populated urban areas contributes to poor air quality and increases health risks for residents. Restricting truck traffic in selected areas can help reduce local exposure to harmful emissions, particularly where restrictions are combined with the promotion of cleaner delivery vehicles, consolidation schemes, or low-emission zones.

Truck traffic restrictions may also contribute to reducing urban noise. Heavy vehicles generate considerable noise during acceleration, braking, loading operations, and movement over uneven road surfaces. In residential districts and city centres, this noise can negatively affect the well-being of residents and reduce the attractiveness of public spaces. By limiting truck movements in sensitive areas or during specific time periods, cities can improve acoustic conditions and overall urban liveability.

The measure can additionally support traffic flow management. A high volume of heavy goods vehicles may contribute to congestion, particularly on narrow streets, intersections, and road sections with limited capacity. Trucks also require more space for manoeuvring and may slow down traffic in areas with high pedestrian activity or frequent stops. Properly designed restrictions can reduce conflicts between freight traffic and other road users, thereby improving accessibility and mobility for pedestrians, cyclists, public transport passengers, and private vehicles.

However, the effective implementation of truck traffic restrictions requires careful planning. Restrictions introduced without adequate alternative routes may simply transfer traffic problems to neighbouring areas or create operational difficulties for businesses that depend on regular deliveries. Therefore, such measures often require prior development of appropriate road infrastructure, including ring roads, bypasses, or designated freight corridors. This creates a need for close cooperation between local governments and road authorities, including national-level institutions responsible for major road infrastructure.

Truck-entry restrictions should also be coordinated with logistics support measures. If heavy goods vehicles are prevented from entering inner-city areas, alternative systems must be provided to ensure the continuity of deliveries. In this context, urban micro-hubs, consolidation centres, cargo bike logistics, and zero-emission last-mile vehicles may play an important complementary role. Such measures allow goods to be transferred from larger vehicles to smaller and cleaner modes of transport before entering restricted zones.

From a policy perspective, truck traffic restrictions should therefore be understood as part of an integrated urban logistics strategy rather than as an isolated regulatory measure. Their effectiveness depends on the clarity of regulations, appropriate signage, enforcement mechanisms, availability of alternative routes, consultation with logistics operators and local businesses, and the provision of complementary delivery solutions. When properly designed, truck traffic restrictions can improve road safety, protect infrastructure, reduce emissions and noise, limit congestion, and contribute to a more accessible and people-oriented urban environment.

6) <u>EV charging stations</u>

The development of publicly accessible charging stations for delivery vehicles is a fundamental infrastructural condition for the broader deployment of electromobility in urban logistics. While the electrification of delivery fleets is increasingly identified as a desirable direction in sustainable urban mobility policy, its practical implementation depends on the availability, reliability, and spatial distribution of charging infrastructure. In this sense, charging stations should not be treated as an auxiliary element of transport policy, but as a core component of the transition towards low- and zero-emission urban freight systems.

Publicly accessible charging infrastructure is particularly important for delivery vehicles because urban freight transport is characterized by strict time constraints, multiple stops, and the need to maintain operational continuity throughout the day. Unlike private passenger cars, delivery vehicles are part of business-critical transport chains, where vehicle downtime directly affects service reliability, delivery costs, and fleet productivity. Therefore, the availability of charging points in appropriate locations may determine whether electric delivery vehicles can be effectively integrated into everyday logistics operations.

A key planning issue concerns the location of charging stations. For delivery fleets, charging infrastructure should be situated not only in general public parking areas, but also in places directly connected with freight activity. These include logistics zones, distribution centres, urban consolidation facilities, delivery vehicle parking areas, retail clusters, and locations with high volumes of goods movement. In dense urban areas, charging points may also be integrated with loading bays or micro-hubs, enabling vehicles to recharge during unloading, consolidation, or operational breaks. Such spatial integration can significantly improve the functionality of the system and reduce unnecessary vehicle movements.

Another important dimension is the type and power of charging. Charging stations may offer different technological solutions, including alternating current charging and direct current fast charging. The choice of charging technology should reflect the operational profile of delivery fleets, including daily mileage, battery capacity, route length, delivery frequency, and available dwell time. Slow or standard charging may be sufficient for vehicles parked overnight or during longer operational breaks, whereas fast charging may be necessary for vehicles used intensively throughout the day. Therefore, an effective charging network for urban logistics should include a diversified charging offer adapted to different vehicle types and business models.

The power capacity of charging infrastructure is also a critical factor. Delivery fleets may include vehicles with different battery sizes, charging capabilities, and energy requirements. Charging stations should therefore be designed in a way that allows efficient service for a heterogeneous fleet, including small electric vans, larger delivery vehicles, and potentially specialized vehicles used for refrigerated transport or other energy-intensive operations. At the same time, the planning of charging infrastructure must take into account the capacity of the local electricity grid and the need for smart energy management systems, especially in areas where multiple vehicles may charge simultaneously.

Safety and reliability are essential requirements for publicly accessible charging stations. Infrastructure should be designed to protect users, vehicles, and equipment against technical failures, adverse weather conditions, vandalism, theft, and operational disruptions. This may include appropriate lighting, monitoring, emergency power disconnection systems, clear user instructions, and compliance with relevant technical standards. For logistics operators, reliability is particularly important, as unavailable or malfunctioning charging points may disturb delivery schedules and reduce confidence in electric fleet operations.

Charging stations should also be well integrated with the surrounding urban and transport infrastructure. This includes adequate signage, safe vehicle access, clearly marked parking or loading spaces, and convenient pedestrian access for users. Poorly designed charging points may create conflicts with pedestrians, cyclists, public transport, or other vehicles, particularly in dense city centres. For this reason, the design of charging infrastructure should be coordinated with parking policy, street management, traffic organization, and public space planning.

From an operational perspective, payment and management systems are also important. Public charging stations should provide transparent and user-friendly payment options, preferably based on electronic payment systems or fleet accounts. At the same time, infrastructure operators should be able to monitor energy consumption, charging duration, occupancy rates, technical performance, and user demand. Such data may support better planning of future infrastructure expansion and allow cities to identify locations where additional charging capacity is needed.

The environmental benefits of charging infrastructure depend not only on the use of electric vehicles, but also on the sources of electricity used to power them. Where possible, charging stations should be linked to renewable energy sources, such as solar or wind energy, or supported by energy storage systems. This can reduce the indirect environmental impact of electric freight transport and strengthen the contribution of electromobility to climate and air quality objectives. In this respect, charging infrastructure should be considered part of a broader urban energy and transport transition.

The design of charging infrastructure should also be future-oriented. The number of electric delivery vehicles is expected to increase as vehicle technology develops, regulatory requirements become stricter, and logistics operators modernize their fleets. Therefore, charging stations should be planned with scalability and flexibility in mind. This includes the possibility of increasing charging capacity, adding new charging points, adapting to future vehicle standards, and integrating smart charging solutions. Infrastructure that is not designed for future demand may quickly become insufficient and limit the pace of fleet electrification.

Overall, the construction of publicly accessible charging stations for delivery vehicles is a necessary condition for the effective electrification of urban freight transport. Properly planned charging infrastructure can improve the operational feasibility of electric delivery fleets, reduce range anxiety, support the transition to zero-emission logistics, and strengthen the environmental performance of urban transport systems. However, its effectiveness depends on strategic location, suitable charging technology, adequate power supply, safety, user-friendly management systems, integration with urban infrastructure, and long-term scalability.

7) <u>Parcel lockers</u>

Parcel lockers have become an increasingly important element of contemporary urban logistics systems, particularly in the context of the rapid growth of e-commerce and the rising demand for flexible parcel delivery services. They represent an automated form of out-of-home delivery, enabling parcels to be delivered to a shared pickup point rather than directly to individual recipients. From the perspective of urban freight transport, parcel lockers may contribute to the consolidation of deliveries, the reduction of failed delivery attempts, and the improvement of last-mile logistics efficiency. However, their impact on the urban environment depends strongly on their spatial distribution, accessibility, and integration with the surrounding public space.

One of the main advantages of parcel lockers is their potential to improve the efficiency of parcel distribution. By delivering multiple parcels to a single automated pickup point, courier companies can reduce the number of individual stops required during delivery rounds. This may shorten delivery routes, reduce operational time, and improve the productivity of logistics operators, especially in densely populated urban areas. In this respect, parcel lockers can serve as a form of micro-consolidation infrastructure, supporting more efficient organization of last-mile deliveries.

Parcel lockers may also reduce logistics costs. Direct home deliveries are often associated with high operational costs, particularly when recipients are absent and repeated delivery attempts are required. Parcel lockers help mitigate this problem by allowing parcels to be delivered to a secure location where recipients can collect them at a convenient time. This improves delivery reliability and enables courier companies to organize transport processes more efficiently. For customers, parcel lockers often provide greater temporal flexibility, as parcels can usually be collected outside standard business hours and without the need to wait for a courier at home.

The use of parcel lockers may also contribute to reducing traffic congestion and environmental impacts, provided that they are properly located and effectively integrated into delivery systems. Concentrating parcels in selected pickup points can reduce the number of delivery vehicles circulating through residential streets. However, this benefit is not automatic. If parcel lockers are located in places that are accessible mainly by car, or if their location encourages additional trips by users, they may generate new traffic rather than reduce it. Therefore, the environmental and transport benefits of parcel lockers depend on whether they are accessible on foot, by bicycle, or as part of existing everyday travel patterns.

The location of parcel lockers is consequently a critical planning issue. Poorly located parcel lockers may generate additional traffic in areas where such traffic is not acceptable, including residential streets, local access roads, or zones intended primarily for pedestrians. In some cases, delivery vehicles servicing parcel lockers may be forced to enter areas with restricted traffic, such as parks, pedestrian zones, or streets with limited access. This can undermine the objectives of urban mobility policy and create conflicts between logistics operations and other urban functions.

Parcel lockers may also affect spatial order and the quality of public space. If installed without adequate planning, they can disrupt pedestrian movement, reduce the functionality of pavements and squares, obstruct visibility, or negatively influence the aesthetic quality of streetscapes. This is particularly relevant in historic city centres, high-density neighbourhoods, and public spaces with limited available land. For this reason, parcel lockers should not be treated solely as private logistics infrastructure, but as elements of the urban environment requiring appropriate spatial governance.

Effective implementation of parcel lockers therefore requires dialogue between local authorities, logistics operators, property owners, and residents. Cities should define suitable location principles to ensure that parcel lockers support urban logistics objectives without creating additional burdens for residents or public space users. Such principles may concern minimum pavement width, distance from pedestrian crossings, accessibility for persons with reduced mobility, visual integration with the surroundings, servicing arrangements, and restrictions on locations where delivery vehicle access would be problematic.

Pedestrian accessibility should be one of the key criteria in planning parcel locker locations. Parcel lockers should be situated within convenient walking distance of residential areas, public transport stops, retail facilities, workplaces, or other frequently visited destinations. At the same time, their proximity to existing pickup points should be analysed to avoid oversupply in some locations and insufficient coverage in others. A balanced spatial distribution can reduce unnecessary delivery-related traffic and support more sustainable collection behaviour among users.

The management of parcel lockers also involves several operational challenges. Infrastructure operators must ensure regular maintenance, technical reliability, parcel security, and protection against theft or damage. In addition, systems should be accessible to all users, including older people, persons with disabilities, and individuals using different forms of payment or digital access. Poor accessibility or unreliable operation may limit the social benefits of parcel lockers and reduce user acceptance.

Overall, parcel lockers have considerable potential to improve the functioning of urban logistics, particularly by consolidating deliveries, reducing failed delivery attempts, lowering logistics costs, and increasing customer convenience. However, their positive impact depends on careful spatial planning and coordination with broader urban mobility objectives. Without appropriate location guidelines and consultation with logistics operators, parcel lockers may generate additional traffic, disturb public space, and create new conflicts in sensitive urban areas. Therefore, the development of parcel locker networks should be guided by accessibility analyses, spatial order principles, delivery servicing requirements, and the objective of minimizing unnecessary freight-related traffic.

8) <u>Railway freight facilities</u>

The use of rail freight facilities in urban logistics represents a strategic measure aimed at reducing the dependence of cities on road-based freight transport. Although urban freight distribution is currently dominated by trucks and vans, rail transport may play an important role in supplying cities, particularly where existing railway infrastructure can be reactivated, modernized, or integrated with last-mile delivery systems. In this context, rail freight facilities should be understood not only as railway tracks or sidings, but also as a broader logistics infrastructure that includes transshipment terminals, urban consolidation points, logistics centres, and connections with road-based or zero-emission distribution modes.

A key argument for the development of rail freight facilities is the environmental performance of rail transport. Compared with road freight transport, rail generally enables the movement of larger volumes of goods with lower emissions per unit of cargo. Its wider use in urban logistics may therefore contribute to reducing greenhouse gas emissions, air pollutants, and energy consumption associated with freight movement. This is particularly relevant in metropolitan areas, where freight transport contributes to congestion, noise, and deteriorating air quality.

Rail freight can also support the reduction of heavy goods vehicle traffic in cities. By shifting part of the freight flow from road to rail, cities may reduce the number of trucks entering inner-city areas or travelling through sensitive urban zones. This may contribute to lower congestion, reduced road wear, improved road safety, and lower noise levels. The measure is therefore closely connected with other urban logistics policies, such as truck traffic restrictions, low-emission zones, and the development of micro-hubs for last-mile delivery.

An important advantage of rail transport is its capacity and scalability. Trains can transport large quantities of goods in a single movement, which may be more efficient than relying on multiple road vehicles. This feature is particularly relevant for regular, high-volume freight flows, including supplies to retail chains, construction materials, waste logistics, industrial goods, or other cargo categories that can be consolidated. Where properly organized, rail-based deliveries may improve the efficiency of logistics systems and reduce the spatial pressure created by road freight operations.

The feasibility of this solution depends heavily on the availability and condition of railway infrastructure. In many cities, unused or underused railway lines, industrial sidings, and former freight facilities still exist. These assets may provide an opportunity to reintegrate rail transport into urban logistics without the need to construct entirely new infrastructure. Their reactivation may allow goods to be brought closer to urban markets by rail, after which they can be distributed by smaller vehicles, cargo bikes, or zero-emission vans.

Where existing infrastructure is insufficient, additional investment may be required. This may include the construction of short railway sections, modernization of sidings, development of transshipment ramps, and creation of dedicated urban logistics terminals. Such facilities can function as interfaces between long-distance freight transport and last-mile distribution. In some cases, they may also operate as micro-hubs, where goods are transferred from rail to smaller and cleaner vehicles for final delivery within the city.

However, the implementation of rail freight facilities in urban logistics is institutionally and operationally complex. It requires coordination between multiple stakeholders, including railway infrastructure managers, rail freight operators, logistics companies, terminal operators, local governments, road authorities, and businesses generating freight demand. Each of these actors has different objectives, operational constraints, and investment capacities. For this reason, the development of rail-based urban logistics requires not only physical infrastructure, but also governance mechanisms, contractual arrangements, and long-term cooperation models. Incentive systems may be necessary to increase the attractiveness of rail transport in city logistics. These may include financial support for infrastructure modernization, preferential access to logistics sites, integration of rail facilities into local spatial planning, reduced fees for rail-based freight operations, or regulatory measures limiting the use of heavy goods vehicles in selected urban areas. Without such incentives, logistics operators may continue to prefer road transport due to its flexibility, established service networks, and lower organizational complexity.

Rail freight facilities should also be integrated with other transport modes. Rail is rarely able to provide complete door-to-door delivery in urban areas without complementary distribution systems. Therefore, its effective use requires intermodal solutions linking rail with road transport, cargo bikes, electric vans, and urban consolidation centres. The success of the measure depends on the efficiency of transshipment operations, the reliability of schedules, and the ability to ensure timely deliveries to final recipients.

There are also several challenges associated with this solution. In some urban areas, rail infrastructure may be poorly located in relation to current logistics demand, physically degraded, or constrained by competing land uses. Former railway areas may have been redeveloped or may face pressure from residential and commercial development. In addition, urban rail networks are often primarily used for passenger transport, which may limit available capacity for freight operations. These factors must be carefully assessed before rail freight facilities are included in urban logistics strategies.

The example of the Koszalin–Kołobrzeg area illustrates a practical direction for this type of measure. Planned activities include the development of logistics centres near existing railway sidings and the modernization of rail infrastructure, including sidings and transshipment ramps. This approach reflects the idea of using existing rail assets as a basis for more sustainable freight distribution, while strengthening the connection between regional logistics flows and urban delivery systems.

Overall, rail freight facilities may play an important role in making urban logistics more sustainable, particularly by reducing road freight traffic, lowering emissions, improving safety, and increasing the efficiency of high-volume goods movement. Nevertheless, their implementation requires substantial infrastructure investment, careful spatial planning, intermodal integration, and strong cooperation between public and private stakeholders. Rail-based urban logistics should therefore be treated as a long-term strategic measure, most effective when combined with complementary policies such as micro-hubs, truck traffic restrictions, and zero-emission last-mile delivery systems.

9) **„Soft" policy measures**

"Soft" policy measures constitute an important, though often less visible, component of urban logistics policy. Unlike infrastructure-based or regulatory interventions, such as delivery vehicle parking spaces, truck restrictions, or charging stations, soft measures focus primarily on coordination, planning, knowledge development, stakeholder engagement, and institutional cooperation. Their purpose is to create the organizational and strategic conditions necessary for the effective implementation of more operational urban logistics solutions.

In the field of urban freight transport, soft measures are particularly relevant because logistics processes are usually shaped by many independent actors. These include local authorities, road infrastructure managers, logistics operators, courier companies, retailers, service providers, residents, and transport users. As a result, many urban logistics problems cannot be solved solely through physical infrastructure or legal restrictions. They require dialogue, negotiation, data collection, and the development of shared rules between public and private stakeholders.

One of the most common forms of soft policy measures is the preparation of strategic concepts and analytical studies. Such documents may define the desired model of freight transport organization in selected parts of the city, especially in inner-city areas where conflicts between delivery traffic, pedestrian movement, public transport, and public space functions are most visible. For example, the development of concepts for logistics services in city centres using sustainable urban mobility solutions has been planned in Kraków and in the Koszalin–Kołobrzeg area. These activities can provide a basis for later implementation of micro-hubs, cargo bikes, low-emission vehicles, or dedicated loading spaces.

Another important group of measures concerns cooperation with logistics operators and delivery companies. Dialogue with businesses makes it possible to identify practical barriers to efficient deliveries, define acceptable delivery rules, and adapt municipal policy to the operational realities of the freight sector. In Gorzów Wielkopolski, cooperation with delivery companies and their contractors has been indicated as a way to establish delivery rules. This type of action may be particularly useful where local authorities seek to regulate deliveries without creating excessive administrative burdens or disrupting commercial activity.

Soft policy measures may also involve the creation of working groups or permanent consultation platforms. These bodies can bring together representatives of local government, infrastructure managers, carriers, logistics operators, business associations, and other stakeholders. Their role may include diagnosing problems, discussing proposed regulations, assessing the feasibility of new solutions, and monitoring the effects of implemented measures. Such platforms are especially valuable in urban logistics because freight transport is often underrepresented in general mobility planning, despite its significant impact on congestion, emissions, and the functioning of local economies.

Detailed empirical studies of delivery traffic are another important element of this category. Urban freight transport is frequently characterized by limited data availability, as many deliveries are carried out by private operators and are not systematically monitored by cities. Studies of delivery traffic, combined with stakeholder consultations, can help identify delivery hotspots, parking problems, peak delivery periods, vehicle types, route patterns, and conflicts with other road users. In the Gdańsk-Sopot-Gdynia area, such studies and consultations have been indicated as a basis for improving the management of urban deliveries.

The main advantage of soft policy measures is their relatively high flexibility and comparatively low implementation cost. They can be introduced before major infrastructure investments or regulatory changes and may help reduce the risk of poorly designed interventions. By improving knowledge, trust, and coordination among stakeholders, they can increase the effectiveness of subsequent measures and facilitate their acceptance by businesses and residents.

However, soft measures also have limitations. Their effectiveness depends on the willingness of stakeholders to cooperate, the administrative capacity of local authorities, the availability of reliable data, and the extent to which consultation outcomes are translated into concrete actions. If not followed by implementation instruments, strategies, working groups, and dialogues may remain purely declarative. Therefore, soft measures should be linked to clear implementation pathways, responsibilities, timelines, and monitoring mechanisms.

10) <u>General approach</u>

A general approach refers to situations where urban logistics is recognised in the Sustainable Urban Mobility Plan as an important component of urban mobility, but the document does not define specific measures, implementation activities or management instruments dedicated to freight transport. In such cases, the SUMP acknowledges that goods movement, servicing traffic and first-/last-mile deliveries affect the functioning of the city, but it remains at a general strategic level.

This type of approach usually indicates that freight transport is treated as a relevant issue for sustainable mobility, especially in relation to congestion, emissions, road safety, public space use and accessibility of urban areas. However, the document does not specify concrete solutions such as delivery vehicle parking spaces, micro-hubs, urban consolidation centres, cargo bike schemes, parcel locker management, charging infrastructure for delivery vehicles, delivery time windows or restrictions for heavy goods vehicles.

In many cases, this general recognition leads to the recommendation that a separate Sustainable Urban Logistics Plan (SULP) should be developed. Such a document would allow the city or metropolitan area to analyse urban freight transport in more detail and to define targeted actions focused specifically on logistics, servicing traffic and first-/last-mile delivery processes. While a SUMP usually addresses the entire mobility system, a SULP can provide a dedicated framework for urban logistics, including delivery organisation, infrastructure needs, stakeholder cooperation, data collection, regulatory tools and implementation priorities.

An example of this approach is the GZM Metropolis, where the SUMP focuses primarily on passenger transport. As a result, freight transport and first-/last-mile delivery issues are not addressed through a detailed catalogue of logistics measures. This indicates the need for a complementary planning document dedicated specifically to sustainable urban logistics.

Table 4 presents a comparison of solutions and best practices in the field of urban logistics in various cities in Poland.

Table 4. A compilation of solutions and best practices in the field of urban logistics planned for implementation in various cities in Poland

City	Local consolidation centres	Dedicated parking spaces	Restrictions for heavy goods vehicles	Zero-/low-emission vehicles	Cargo bikes	Rail freight	Parcel lockers	EV charging stations	Soft measures	General approach (SULP)
Białystok			✓							✓
Bielsko-Biała										
Busko-Zdrój			✓							
Bydgoszcz										
Częstochowa										
Dębica										✓
Gdańsk, Gdynia, Sopot	✓	✓	✓		✓	✓	✓		✓	✓
Gorzów Wielkopolski	✓	✓			✓	✓	✓		✓	
Grudziądz										
GZM										
Kalisz Ostrów Wlkp.		✓	✓		✓			✓		
Kielce			✓							✓
Końskie, Skarżysko-Kamienna, Starachowice, Ostrowiec Świętokrzyski										✓
Koszalin, Kołobrzeg	✓	✓			✓	✓			✓	
Kraków	✓	✓	✓	✓	✓	✓				
Krasnystaw	✓	✓	✓	✓						✓
Kraśnik										
Lubaczów								✓		
Lublin Świdnik		✓	✓	✓	✓			✓		
Łódź		✓	✓			✓				
Łuków	✓	✓	✓					✓		
Myślenice										
Olsztyn	✓	✓	✓							
Opole		✓						✓		
Oświęcim			✓	✓				✓		✓
Płock								✓		✓
Polkowice										✓
Poznań										
Puławy								✓		
Radom			✓	✓						✓
Rybnik	✓	✓			✓			✓		✓
Ryki										✓
Rzeszów	✓	✓	✓		✓	✓				✓
Sanok										✓
Siedlce		✓	✓							
Staszów						✓				
Szczecin	✓	✓				✓		✓		
Tarnobrzeg										✓
Tomaszów Mazowiecki	✓	✓	✓			✓		✓		
Toruń		✓	✓		✓	✓		✓		
Wałbrzych, Świdnica										
Warszawa	✓	✓	✓	✓						
Włocławek		✓	✓		✓	✓	✓			
Wrocław					✓					
Zamość	✓	✓	✓	✓	✓			✓	✓	✓
Zielona Góra		✓	✓					✓		

✓ Measure present

6.3. Solutions implemented in other countries

Solutions aimed at improving the organisation of urban freight transport are widely implemented in European cities. They are increasingly treated as an integral component of sustainable urban mobility policy rather than as isolated technical measures. In recent years, many European cities have introduced dedicated urban logistics strategies, zero-emission freight policies, delivery access regulations, cargo bike schemes, parcel collection systems, and new forms of public-private cooperation with logistics operators.

At the European level, Sustainable Urban Logistics Plans are understood as strategic frameworks designed to optimise the movement of goods in urban areas, while reducing environmental impacts, improving transport efficiency, and enhancing quality of life. The European Commission's Expert Group on Urban Mobility also indicates that freight transport and logistics are increasingly being incorporated into urban mobility planning, partly because urban freight represents a significant share of city traffic and pollutant emissions.

The measures implemented in European cities are broadly similar to those identified in Polish Sustainable Urban Mobility Plans. They include local consolidation centres and micro-hubs, dedicated loading and unloading spaces, zero- and low-emission delivery vehicles, cargo bikes, truck access restrictions, charging infrastructure, parcel locker and pick-up point systems, the use of rail or inland waterways, and soft governance instruments such as urban logistics partnerships, charters, covenants and stakeholder working groups. However, in cities with more advanced urban logistics policies, these instruments are usually implemented as integrated packages rather than as single measures.

1) **<u>Rotterdam (The Netherlands)</u>**

Rotterdam is one of the most advanced European examples of integrated urban logistics policy. The city has developed a long-term approach focused on zero-emission city logistics, supported by cooperation with the logistics sector. The Zero Emission City Logistics Rotterdam defines a transition pathway towards emission-free urban logistics within the city's zero-emission logistics zone [25]. The document is explicitly linked to the city's wider mobility and clean air policies and aims to achieve zero emissions, fewer inefficient trips and reduced congestion.

The Rotterdam approach combines several types of measures. First, it includes the introduction of a zero-emission city logistics zone, which requires logistics operators to gradually shift towards cleaner vehicles. The city's strategy explicitly refers to battery-electric vehicles, hydrogen-electric vehicles and non-motorised vehicles, including cargo bikes. Second, Rotterdam promotes more efficient logistics through the use of hubs, micro-hubs and collection points. These facilities are intended to reduce the number of inefficient freight movements and support the transfer of goods to smaller zero-emission vehicles for last-mile delivery.

Parcel logistics also plays an important role in Rotterdam's policy framework. The covenant notes that parcel operators are already experimenting with micro-hubs, parcel lockers and light electric freight vehicles. One of the actions included in the document concerns the development of a mini-hub in the city to reduce the number of trips and enable deliveries by smaller emission-free vehicles. Another action concerns the placement of parcel lockers in Rotterdam in order to reduce delivery trips.

The Rotterdam case demonstrates that zero-emission delivery vehicles, micro-hubs, cargo bikes, parcel lockers and soft policy measures can be implemented as mutually reinforcing instruments. The city does not treat freight decarbonisation only as a matter of replacing vehicles. Instead, it combines vehicle regulation, spatial logistics infrastructure, cooperation with operators, and the reorganisation of delivery patterns.

2) <u>Amsterdam and other Dutch cities (The Netherlands)</u>

The Netherlands provides an important example of national and local coordination in the field of urban freight policy. Dutch cities have been preparing the implementation of zero-emission zones for logistics, with Amsterdam to introduce such zones in January 2025. C40 reports that 14 Dutch municipalities launched zero-emission freight zones in January 2025, while additional municipalities are preparing similar measures.

The Dutch model is based on the assumption that freight access regulations should stimulate the transition towards zero-emission vehicles and more efficient delivery models. These zones restrict access for polluting vans and trucks, thereby encouraging the use of electric vans, electric trucks, cargo bikes and other light electric freight vehicles. The introduction of these zones is also connected with the need for charging infrastructure, fleet transition support, data exchange and cooperation with logistics operators.

From the perspective of urban logistics planning, the Dutch approach is particularly relevant because it shows how truck restrictions and zero-emission vehicle policies can be combined. Rather than introducing a simple ban on heavy vehicles, cities create access rules that differentiate vehicles according to their environmental performance. This type of policy may simultaneously reduce emissions, stimulate fleet modernisation, and encourage the use of smaller and cleaner delivery modes in dense urban areas.

3) <u>Paris (France)</u>

Paris is one of the most frequently cited European examples of integrating logistics infrastructure into urban planning. The city and its metropolitan logistics stakeholders have promoted the concept of urban logistics facilities located within or close to dense urban areas. A particularly important example is Chapelle International, described by the International Transport Forum as a 42,000 m² mixed-use logistics facility in northern Paris. The facility can be connected to the freight rail network and serves multiple logistics operators with functions such as cold storage and cross-docking for urban distribution. It also includes offices, retail space, workspaces, an urban farm, a data centre and a sports centre, which improves its integration into the surrounding urban fabric.

Paris also provides examples of smaller-scale urban logistics hubs. The Grenier Saint-Lazare Urban Hub, located in the city centre, was created by converting a former automated car park into a service and storage facility. It combines micro-storage with services such as concierge functions, order preparation and inventory management, while limiting disruption to the urban heritage of the neighbourhood.

The Paris case is relevant because it demonstrates the importance of logistics real estate in sustainable urban freight policy. Instead of relocating logistics functions to the urban periphery, Paris has sought to reintroduce selected logistics facilities into the city in a controlled and spatially integrated way. This approach supports shorter delivery distances, the use of cargo bikes and low-emission vehicles, and the consolidation of freight flows close to final recipients.

Paris also illustrates the potential role of rail and multimodal logistics in urban freight systems. Although the rail connection at Chapelle International has not been fully operational for economic and organisational reasons, the facility was designed with the possibility of freight rail integration. This shows both the potential and the difficulty of using rail transport in dense urban logistics systems: the infrastructure may exist, but its effective use requires competitive costs, appropriate operators, reliable service models and coordination between public and private actors.

4) <u>Barcelona (Spain)</u>

Barcelona has developed a broad urban freight distribution policy based on the management of loading and unloading space, digital tools, low-emission regulation and support for sustainable last-mile delivery. One of the most visible instruments is the system of Urban Freight Distribution spaces, known as DUM spaces. These are dedicated areas on public streets intended to facilitate loading and unloading operations close to the destination point. In Barcelona, only vehicles used for goods distribution may park in these spaces, and parking requires prior validation through a telematic application. The maximum parking time is generally 30 minutes, while zero-emission vehicles may receive an additional 30 minutes. The city has approximately 8,710 DUM spaces in the regulated area.

Barcelona also uses digital curbside management. The city's urban freight strategy identifies the need to assist couriers in finding available loading and unloading spaces and treats digital registration of stops as an important source of information for managing urban freight activity. The strategy also shows that different delivery models generate different levels of demand for street space, which supports the case for data-based planning of freight infrastructure.

Another important element of Barcelona's policy is support for micro-distribution hubs and cargo bikes. Barcelona allocated funding to explore new concepts for reducing the impact of urban deliveries, including micro-distribution hubs and cargo bikes. The city also introduced a large low-emission zone covering the metropolitan area, which affects urban deliveries and encourages cleaner last-mile solutions.

The Barcelona example shows how several measures can be integrated: dedicated delivery parking spaces, digital control of loading and unloading, low-emission access regulation, micro-hubs and cargo bike logistics. The city's experience is particularly relevant for dense urban areas where competition for curb space is high and where delivery vehicles must coexist with pedestrians, cyclists, public transport and private cars.

5) <u>Brussels (Belgium)</u>

Brussels represents a governance-oriented model of sustainable urban logistics. The Brussels-Capital Region has implemented a Green Deal for Sustainable Urban Logistics, bringing together public and private stakeholders to make urban logistics less polluting, more efficient and more sustainable. The initiative is linked to the wider regional mobility and economic transition frameworks, including the Good Move plan and the Brussels Shifting Economy programme.

The Brussels approach is based on voluntary commitments and cooperation rather than only on regulation. Such a model is particularly useful in urban logistics because local authorities usually do not directly control most freight operations. Courier companies, retailers, logistics operators and service providers make many independent operational decisions that affect traffic, emissions and public space. A Green Deal creates a structured framework for aligning these private decisions with public objectives.

A similar Green Deal model was also implemented in Flanders. It is described as a declaration of commitment between companies, organisations and the Flemish government. Participants undertake self-selected actions, while receiving visibility and support; the government also examines whether regulatory barriers can be removed.
The Brussels and Flemish cases are important examples of soft measures that support more operational interventions. They may facilitate the introduction of cargo bikes, low-emission vehicles, consolidation models, delivery coordination, parcel collection networks and cleaner last-mile services. Their value lies in creating trust, shared objectives and implementation capacity before more restrictive or infrastructure-intensive measures are introduced.

6) <u>Stockholm (Sweden)</u>

Stockholm is another example of a city moving towards comprehensive urban freight planning. Stockholm published a Sustainable Urban Logistics Plan in 2024, focusing on charging infrastructure, the use of city regulation and public procurement, facilitation of cargo bikes and micro-hubs, and shifting freight from road to rail and water.
This approach is significant because it combines several intervention areas within a single policy framework. Charging infrastructure supports the electrification of delivery fleets. Public procurement can be used to influence the behaviour of suppliers and contractors working for the city. Cargo bikes and micro-hubs support cleaner last-mile logistics. The shift from road to rail and water addresses larger freight flows and reduces dependence on road-based transport.
The Stockholm case illustrates the direction in which more advanced European urban logistics policies are moving. Instead of treating city logistics as a narrow issue of courier deliveries, the city links freight transport with climate policy, energy infrastructure, procurement, modal shift and urban planning. This type of integrated approach may be particularly relevant for metropolitan areas that want to reduce road freight pressure while maintaining efficient goods distribution.

7) <u>Gothenburg (Sweden)</u>

Gothenburg is a relevant European example of a city that has treated urban freight transport as an important component of sustainable mobility and urban planning. The city's transport strategy explicitly recognises that accessibility for goods deliveries in dense urban areas should be ensured through a combination of efficient infrastructure, policy instruments and new transport systems. The strategy refers, among others, to walking-speed areas, local traffic regulations, delivery time windows, clean vehicles and innovative concepts.
One of the most important initiatives implemented in Gothenburg was Stadsleveransen, an urban consolidation and last-mile delivery system serving shops and offices in the city centre. The scheme was based on a common goods reception point and consolidation function, from which parcels were distributed in the inner city using small electric vehicles and electric cargo bikes. The system was developed in phases, starting with a concept and evaluation phase in 2012-2013, followed by a development phase in 2014-2016, during which the operational area and the number of participating businesses were expanded.
The operational model of Stadsleveransen combined several types of measures relevant to urban logistics policy. First, it functioned as a local consolidation centre, allowing goods from different carriers to be redirected to a common reception point before final delivery. Second, it supported the use of zero-emission last-mile vehicles, including electric vehicles and electric

cargo bikes. Third, it relied on cooperation between public authorities, property owners, trade associations, logistics operators and transport companies. In this sense, Gothenburg's approach combined infrastructural, operational and soft governance measures within one integrated scheme.

The results reported for Stadsleveransen indicate the potential benefits of this type of solution. According to Interreg Europe, after one year of operation the scheme contributed to a reduction of 68 tonnes of carbon dioxide emissions in the centre of Gothenburg. The same source reports that approximately 500 parcels per day were distributed from the terminal to shops and offices using small, quiet electric vehicles and bicycles adapted to limited street space and interaction with pedestrians and cyclists. A later presentation by the City of Gothenburg indicated that the system used a terminal function in Gullbergsvass, four electric vehicles with trailers and two electric cargo bikes, and handled on average more than 800 parcels per day.

Gothenburg is also relevant because its experience illustrates both the advantages and limitations of urban consolidation schemes. Research on Swedish city logistics notes that Stadsleveransen aimed to reduce the number of large vehicles in the inner city by replacing direct deliveries with consolidated deliveries performed by smaller electric vehicles. At its peak, the scheme became one of the larger consolidation initiatives in Europe in terms of goods flow and involved major carriers such as DHL, DB Schenker and PostNord. However, the same study also indicates that the project was eventually discontinued, partly reflecting the difficulty of developing financially sustainable business models for urban consolidation centres once public support is reduced.

In recent years, Gothenburg has continued to develop its approach to sustainable freight. A Strategic Urban Logistics Plan 2024-2030 was adopted in order to make the city's work on sustainable freight transport more effective. The plan is intended to facilitate freight flows and the accessibility of goods transport, secure land for freight-related functions, protect the urban living environment, support innovation and technological development, and create conditions for cooperation between public authorities, business and academia.

7. Conclusions

The report provided an updated and structured overview of the current state of knowledge in the field of urban logistics, with particular attention to first- and last-mile delivery systems, energy-related aspects of freight transport, and urban policy measures supporting sustainable freight distribution. The analysis combined three complementary perspectives: scientific literature, completed and ongoing research projects, and transport policy documents. This approach made it possible to identify both the main research trends and practical solutions already planned or implemented in urban areas.

The literature review confirmed that urban logistics is increasingly understood as a complex system that requires the integration of transport operations, energy infrastructure, digital tools, user behaviour and public policy. Sustainable urban freight transport cannot be reduced only to vehicle technology, route optimisation or individual operational improvements. Instead, it requires a systemic approach in which routing, fleet structure, charging infrastructure, delivery organisation, demand patterns, user preferences and environmental impacts are analysed jointly.

The review of research projects showed that European and national research programmes have generated a broad range of knowledge on last-mile delivery, digitalisation, electric mobility, shared logistics, dynamic curbside management, urban consolidation, parcel delivery systems and decision-support tools. At the same time, the analysis demonstrated that the outcomes of many projects remain fragmented. Individual initiatives often develop specific technological, operational or policy solutions, while fewer provide an integrated methodological framework connecting transport organisation, energy use, user behaviour, infrastructure and urban policy.

The analysis of city transport policies showed that urban freight transport is becoming an increasingly important component of sustainable mobility planning. The reviewed documents identified a catalogue of measures relevant to first- and last-mile deliveries, including local consolidation centres and micro-hubs, dedicated parking and loading spaces for delivery vehicles, zero- and low-emission delivery vehicles, cargo bicycles, truck traffic restrictions, publicly accessible charging infrastructure, parcel locker location guidelines, rail freight facilities and soft governance measures based on cooperation with logistics operators. These measures are consistent with solutions observed in more advanced European cities, although in many cases they are still formulated at the strategic or planning level rather than implemented as mature operational systems.

The European examples confirmed that the most advanced urban logistics policies are not based on isolated interventions. Instead, cities combine regulatory instruments, logistics infrastructure, digital tools, zero-emission vehicles, modal shift and stakeholder cooperation into integrated policy packages. This indicates that effective urban freight management requires the coordination of several mutually reinforcing measures. For instance, vehicle access regulations should be linked with low- and zero-emission delivery modes; micro-hubs should be connected with cargo bikes or electric vehicles; parcel locker networks should be planned with regard to accessibility and public space; and charging infrastructure should be coordinated with fleet electrification strategies.

The conducted analyses also showed that urban logistics policies pursue several recurring objectives. These include reducing environmental impacts, lowering energy consumption, limiting congestion, improving the use of urban space, increasing delivery efficiency, improving service flexibility and enhancing the quality of life for residents. These objectives define the main assessment dimensions for further research, including transport performance, energy consumption, emissions, costs, accessibility, service quality and user behaviour.

A key conclusion is that future analyses of urban logistics systems should be based on the interaction between logistics processes, urban infrastructure, transport modes, energy use and user choices. The reviewed literature and projects highlighted the importance of electric vehicles, cargo bikes, routing optimisation, charging infrastructure and energy-aware planning. The policy analysis added the urban governance perspective, showing that cities are increasingly interested in micro-hubs, delivery parking spaces, parcel lockers, truck restrictions, charging infrastructure and cooperation mechanisms with logistics stakeholders.

Another important conclusion is that every urban logistics scenario must be embedded in a specific spatial and infrastructural context. The relevant context includes the road network, transport analysis zones, land-use structure, logistics facilities, demand generators, delivery points, and access conditions. At the same time, alternative configurations of logistics systems should describe changes in the organisation of deliveries, such as modal shift, demand growth, consolidation, selection of delivery points, parcel pick-up behaviour, fleet electrification or the use of low-emission modes.

The state-of-the-art analysis also indicated which urban logistics segments are particularly relevant for further research. These include ready meal delivery, boxed meal delivery, parcel locker delivery and direct parcel delivery to individual recipients. These segments are characterised by dynamic growth, operational complexity, strong links with user behaviour and high relevance for energy, emission and service-quality assessment. They also correspond to the problems identified in the literature and to the measures observed in urban policies.

8. References

[1] M Haumann et al. Towards Sustainable Transport: A Strategic Decision Support System for Urban Logistics Operations, Springer LNISO, 2021.

[2] Guiliano G., O'Brien T., Dablanc L., Holiday K. (2013). Synthesis of freight research in urban transportation planning. Transportation Research Board, Vol. 23. http://onlinepubs.trb.org/onlinepubs/ncfrp/ncfrp_rpt_023.pdf.

[3] Leonardi, J., Browne, M., Allen, J., Bohne, S. and Ruesch, M. (2014). Best practice factory for freight transport in Europe: demonstrating how 'good'urban freight cases are improving business profit and public sectors benefits. *Procedia-Social and behavioral sciences*, 125, 84-98.

[4] Anderson, S., Allen, J. and Browne, M. (2005). Urban logistics—how can it meet policy makers' sustainability objectives?. *Journal of transport geography*, 13(1), 71-81.

[5] Basso, R., Kulcsár, B., Egardt, B., Lindroth, P. and Sanchez-Diaz, I. (2019). Energy consumption estimation integrated into the electric vehicle routing problem. *Transportation Research Part D: Transport and Environment*, 69, 141-167.

[6] Basso, R., Kulcsár, B. and Sanchez-Diaz, I. (2021). Electric vehicle routing problem with machine learning for energy prediction. *Transportation Research Part B: Methodological*, 145, 24-55.

[7] Zhen, L., Hu, Y., Wang, S., Laporte, G., & Wu, Y. (2019). Fleet deployment and demand fulfillment for container shipping liners. *Transportation Research Part B: Methodological*, *120*, 15-32.

[8] Zhen, L. (2017). A bi-objective model on multiperiod green supply chain network design. IEEE Transactions on Systems, Man, and Cybernetics: Systems, 50(3), 771-784.

[9] Zhen, L., Tan, Z., Wang, S., Yi, W., & Lyu, J. (2021). Shared mobility oriented open vehicle routing with order radius decision. Transportation Research Part A: Policy and Practice, 144, 19-33.

[10] Larsson, J., Keskin, M.F., Peng, B., Kulcsár, B. and Wymeersch, H. (2021). Pro-social control of connected automated vehicles in mixed-autonomy multi-lane highway traffic. *Communications in transportation research*, 1, 100019.

[11] Zhen, L., Wu, Y., Wang, S., & Laporte, G. (2020). Green technology adoption for fleet deployment in a shipping network. *Transportation Research Part B: Methodological*, *139*, 388-410.

[12] Zhen, L., Gao, J., Tan, Z., Wang, S., & Baldacci, R. (2022). Branch-price-and-cut for trucks and drones cooperative delivery. *IISE Transactions*, 1-17.

[13] Wang, K., Zhen, L., Xia, J., Baldacci, R., & Wang, S. (2022). Routing Optimization with Generalized Consistency Requirements. *Transportation Science*, *56*(1), 223-244.

[14] Tettamanti, T., Luspay, T., Kulcsar, B., Péni, T. and Varga, I. (2013). Robust control for urban road traffic networks. *IEEE Transactions on Intelligent Transportation System*s, 15(1), 385-398.

[15] Wang, K., & Jacquillat, A. (2020). A stochastic integer programming approach to air traffic scheduling and operations. *Operations Research*, *68*(5), 1375-1402.

[16] Komunikat Komisji Do Parlamentu Europejskiego, Rady, Europejskiego Komitetu Ekonomiczno-Społecznego I Komitetu Regionów „Wspólne dążenie do osiągnięcia konkurencyjnej i zasobooszczędnej mobilności w miastach" coM(2013) 913 z dnia 17 grudnia 2013 roku.

[17] Guidelines for developing and implementing a sustainable urban mobility plan – Second Edition, Rupprecht Consult - Forschung & Beratung GmbH 2019.

[18] Repozytorium SUMP. On-line: https://www.gov.pl/web/infrastruktura/repozytorium-sump

[19] Janjevic, M.; Ndiaye, A.B. Development and Application of a Transferability Framework for Micro-Consolidation Schemes in Urban Freight Transport. Procedia-Soc. Behav. Sci. 2014, 125, 284–296.

[20] Katsela, K.; Güneş, Ş.; Fried, T.; Goodchild, A.; Browne, M. Defining Urban Freight Microhubs: A Case Study Analysis. Sustainability 2022, 14, 532. https://doi.org/10.3390/su14010532

[21] Plan Zrównoważonej Mobilności Metropolii Krakowskiej i jej Obszaru Funkcjonalnego, Kraków, 2023. On-line: https://www.bip.krakow.pl/?bip_id=1&dok_id=183504

[22] Figliozzi, M.; Tipagornwong, Ch. Impact of last mile parking availability on commercial vehicle costs and operations, Supply Chain Forum: An International Journal 2017, 18, 60-68, https://doi.org/10.1080/16258312.2017.1333386

[23] Šarac, D.; Čačić, N.; Kopić, M.; Blagojević, M. Reserve Delivery Parking Spots in Urban Areas. Transportation Research Procedia 2022. 64. 138-148. https://doi.org/10.1016/j.trpro.2022.09.017

[24] Plan Zrównoważonej Mobilności Metropolii Krakowskiej i jej Obszaru Funkcjonalnego, Zielona Góra, 2023. On-line: https://www.zielona-gora.pl/PL/1776/8846/Ostateczna_wersja_Planu_Zrownowazonej_Mobilnosci_Miejskiej_dla_Zielonogorsko_____Nowosolskiego_Obszaru_Funkcjonalnego_przyjeta_przez_rady_wszystkich_gmin_z_obszaru_ZNOF_wraz_z_kompletem_dokumentow__w_tym_dotyczacych_SOOS/

[25] Zero Emission City Logistics Rotterdam. On-line: https://logistiek010.nl/app/uploads/2022/03/Covenant-Zero-Emission-City-Logistics-Rotterdam.pdf