URBAN LOGISTICS AS AN ON-DEMAND SERVICE

Futures scenarios for last-mile logistics in mid-size European cities

ULaaDS D2.4: Futures scenarios based on a Disaggregative

Policy Delphi

Date: 24/02/2022
Authors: Dr. P.A. Plazier, Dr. W.S. Rauws, R. Neef, Dr. P. Buijs (RUG)

Deliverable details

Project acronym	Project title
ULaaDs	Urban Logistics as an on-Demand Service

WP	Deliverable title
2	D2.4 Futures scenarios

Document history

Version	Date	Author(s)	Status*	Dissemination level**
1	04/02/2022	Paul Plazier, Ward Rauws	Draft	CO
1.1	18/02/2022	Paul Plazier, Ward Rauws	Draft update after input Günther Illek & Nacho Sarrio	CO
1.2	22/02/2022	Paul Plazier, Ward Rauws, Robin Neef, Paul Buijs	Draft update after input Paul Buijs, Robin Neef, Günther Illek & Nacho Sarrio	CO
2	24/02/2022	Paul Plazier, Ward Rauws, Robin Neef, Paul Buijs	Final	PU

*Status: Draft, Final, Approved, Submitted (to European Commission).
Dissemination Level: **PU: Public; **CO**: Confidential, only for members of the consortium (including the Commission Services); **EU-RES** Classified Information - restraint UE; **EU-CON**: Classified Information - confidential UE; **EU-SEC**: Classified Information - secret UE

Contractual delivery date	Actual delivery date	Deliverable type*
28-02-2022	..	R

*Deliverable type: **R**: Document, report; **DEM**: Demonstrator, pilot, prototype; **DEC**: Websites, patent fillings, videos, etc; **OTHER**; **ETHICS**: Ethics requirement; **ORDP**: Open Research Data Pilot.

Abstract

ULaaDS sets out to offer a new approach to system innovation in urban logistics. Its vision is to develop sustainable and liveable cities through re-localisation of logistics activities and re-configuration of freight flows at different scales. Specifically, ULaaDS will use a combination of innovative technology solutions (vehicles, equipment and infrastructure), new schemes for horizontal collaboration (driven by the sharing economy) and policy measures and interventions as catalysers of a systemic change in urban and peri-urban service infrastructure. This aims to support cities in the path of integrating sustainable and cooperative logistics systems into their sustainable urban mobility plans (SUMPs). ULaaDS will deliver a novel framework to support urban logistics planning that aligns industry, market and government needs, following an intensive multi-stakeholder collaboration process. This will create favourable conditions for the private sector to adopt sustainable principles for urban logistics, while enhancing cities' adaptive capacity to respond to rapidly changing needs. The project findings will be translated into open decision support tools and guidelines.

A consortium led by three municipalities (pilot cities) committed to zero emissions city logistics (Bremen, Mechelen, Groningen) has joined forces with logistics stakeholders, both established and newcomers, as well as leading academic institutions in EU to accelerate the deployment of novel, feasible, shared and ZE solutions addressing major upcoming challenges generated by the rising on- demand economy in future urban logistics. Since large-scale replication and transferability of results is one of the cornerstones of the project, ULaaDS also involves four satellite cities (Rome, Edinburgh, Alba Iulia and Bergen) which will also apply the novel toolkit created in ULaaDS, as well as the overall project methodology to co-create additional ULaaDS solutions relevant to their cities as well as outlines for potential research trials. ULaaDS is a project part of ETP ALICE Liaison program.

Keywords

Urban logistics, scenarios, cooperation, regulation, innovation, Disaggregative Policy Delphi

Executive summary

The number of last-mile deliveries is expected to grow by 78% worldwide by 2030 (World Economic Forum, 2020). This growth poses serious challenges to the last-mile sector with regard to logistics operations within dense urban areas, improving sustainability of the sector, and establishing cooperation between logistics stakeholders. In addressing these challenges scenarios are a powerful tool to inform future pathways as they aid last mile policy makers and other logistics stakeholders to rehearse the future.

This study aims to identify plausible future states in last-mile logistics for mid-size European cities. It presents six scenarios for last-mile logistics in the year 2035 and identifies key themes policy makers should consider in addressing the uncertain future of last-mile logistics.

The scenarios are developed using a Disaggregative Policy Delphi method. This method enables the identification of scenarios through a cluster analysis of quantitative and qualitative assessments of possible future developments in last mile city logistics by 26 participants in the expert panel. These expert are involved in last-mile logistics in the European cities Bremen, Groningen and Mechelen.

Six scenarios have been identified:

- **Old Wild West -** "No active government involvement and lack of incentives for innovation and cooperation."
- **New Wild West -** "Last-mile logistics is shaken up, with high levels of innovation but low regard for sustainability."
- **New Cool Collective -** "Shared beliefs and a shared course of action lead to sustainable last-mile logistics."
- **Revolution By Design -** "Sustainability in last-mile logistics is reached at the hand of local authorities."
- **Thriving, Individually -** "A mix of restrictive and facilitative policies spur technological innovation but result in limited cooperation between stakeholders."
- **Good Intentions Abound -** "High levels of government initiative amidst low stakeholder cooperation and low market innovation."

Comparing the scenarios results in three main overarching conclusions:

1) **Logistics remains an integral part of inner cities.** Despite changes in *where* and *how* logistics are operated, last-mile logistics processes themselves will remain "a fact of city life", omnipresent and closely interwoven with the urban.
2) **Local governments take a more active role in setting direction for last mile logistics development.** Their role is considered essential in foster cooperation and sustainability with help of legal standards, access restrictions, facilitation of experiments and partnerships with private initiatives. Logistics operations are still mostly up to the market.

3) **A transition towards more sustainable city logistics is not a given**. Substantial barriers are identified. Enabling pathways to sustainable last mile logistics requires a strong vision and policy implementation by local governments, societal pressure on reducing environmental impact and improving livability in order to foster cooperation between stakeholders, and the introduction of new technology and business models that embrace sustainability as their main principle.

Table of content

1. Introduction 8

1.1 Background 8

1.2 Objectives 9

1.3 Research Approach 9

1.4 Relation to other ULaaDS work packages 10

1.5 Reading guide 10

2. Three main pillars of last-mile logistics 11

2.1 Introduction 11

2.2 Stakeholder cooperation 11

2.3 Technological innovation 12

2.4 The role of local authorities 13

3. Methodology 15

3.1 Document analysis 15

3.2 Disaggregative Policy Delphi for constructing scenarios 16

3.2.1 Overall design of the Disaggregative Policy Delphi 17
3.2.2 Selection of participants 17
3.2.3 DPD round 1: interview and questionnaire 19
3.2.4 DPD round 2: questionnaire 20
3.2.5 Analysis of the quantitative results 20
3.2.6 Futures table 20

3.3 Ethical considerations 21

4. Results 22

4.1 Six scenarios for the future of last-mile logistics 22

4.2 Scenario 1 - The Old Wild West 24

4.3 Scenario 2 - The New Wild West 25

4.4 Scenario 3 – New Cool Collective 26

4.5 Scenario 4 - Revolution By Design 27

4.6 Scenario 5 - Thriving, Individually 28

4.7 Scenario 6 - Good Intentions Abound 29

5. Discussion 31

6. Conclusions 36

Acronyms 38

References **39**

List of figures

Figure 1 – Last-mile logistics stakeholders included in the study (blue) and their relation to part of the wider global logistics network (red). 18

Figure 2 - Participant flow 19

List of tables

Table 1 - Methods employed leading to future scenarios 15

Table 2 - Themes shaping last-mile logistics between 2020 and 2035 16

Table 3 - Overview of participants of the DPD, second round in bold, first round between brackets 19

Table 4 - Futures table 22

1. Introduction

City logistics systems organize the transportation of goods by and for commercial entities in urban areas. Due to their dynamic, complex and open nature, various developments are likely to fundamentally impact their functioning today and in the years to come. This report presents different futures scenarios for city logistics generally and last-mile logistics specifically. The scenarios are constructed using a Disaggregative Policy Delphi method together with a panel of logistics stakeholders in three European Lighthouse cities taking part in the ULaaDS (Urban Logistics as an On-Demand Service) research project.

1.1 Background

The number of last-mile deliveries is expected to grow by 78% worldwide by 2030 (World Economic Forum, 2020). This growth poses serious challenges to the last-mile sector for several reasons. For instance, last-mile logistics takes the stage in dense urban areas where logistics space is scarce (Cushman & Wakefield, 2017) and where local authorities increasingly choose to intensify policy measures (e.g. through SULPs, see Rupprecht (2019)). Furthermore, the sector comprises of a complex web of actors with varying and changing interests and interdependencies (CIVITAS, 2015). And as competition increases, so does the need of logistics players to equip themselves with the latest technologies to gain competitive advantage and adhere to possible new policy measures (McKinsey, 2018). Finally, the logistics growth forecasts, and looming pressures on logistics stakeholders and urban environments, have increased awareness and efforts to ensure that this growth evolves in a more sustainable way. Key challenge for this sustainability transition is to simultaneously reduce environmental impact, foster urban liveability and maintain profitability of operations for the logistics sector.

To inform policies and guidelines generally and last-mile logistics practices specifically, there is a need to better understand the different possible futures of last-mile logistics. Gaining insight in the future images of stakeholders is key as it contributes to individual strategic decision-making processes within the coalition of these actors. This, in turn, increases or decreases the collective potential of actors to anticipate a range of possible futures. Possible futures, as represented in scenarios, aid decision-makers in rehearsing the future, exploring predictability and uncertainty. Thus, scenarios reduce actors' risk of being unprepared.

Scenarios can add to quality of decision-making by contributing to organizational learning and consensus building, and by exploring both plausible developments themselves and how they fit in their *wider* environments while remaining a focused narrative. Importantly, scenarios provide a purposeful basis for further inquiry to actors: they are a powerful tool that can prevent actors from being narrow-sighted and from being locked into their *individual* decision-making approach. The latter is especially important for last-mile logistics: the increasing complexity posed by sustainability needs, urbanisation, and logistic activities requires actors to be aware of their mutual dependencies for urban logistics to contribute to

sustainable and liveable cities. In other words, scenarios can help "to improve the probability of desirable (futures), decrease the probability of undesirable (futures), and gear up to coping with the inconceivable sure to come" (Dror, 2006, p90).

1.2 Objectives

The aim of this report is to identify possible future developments in last-mile logistics for midsize European cities. More specifically, this study formulates a set of scenarios, and investigates the possible future states of last-mile logistics in the year 2035. Six scenarios for last-mile logistics future pathways are presented. By comparing and reflection upon these scenarios, the study also identifies several key developments on which local logistics stakeholders should keep an eye in addressing the uncertain future of last-mile logistics.

1.3 Research Approach

The scenarios were constructed through a Disaggregative Policy Delphi method held among an expert panel consisting of 26 logistics stakeholders in the three ULaaDS Lighthouse cities, in Groningen (NL), Mechelen (BE) and Bremen (DE). Using the Delphi method, we inquired the views and future estimates of the expert panel on three general themes: level of market innovation, level of stakeholder collaboration, and role of local authorities. We balanced the expert views across different stakeholder groups, namely logistics operators, business representatives, citizens, local authorities, and researchers and consultants. This provides unique insights in possible future directions for last-mile logistics in the cities and countries under study, and western European cities working to realize similar ambitions.

The three cities under study (from here on referred to as "Lighthouse cities") share several characteristics:

1. All three cities have set ambitious goals for realizing zero emissions last-mile logistics and are actively working towards realizing them.
2. There is active and ongoing dialogue and cooperation between the local governments and the logistics stakeholders active in the cities.
3. The cities have similar urban structures, such as historic inner-city centres and high population densities.
4. Their current modal split in last-mile delivery is characterized by high levels of non-motorized transportation.

A detailed characterization of the lighthouse cities is provided in ULaaDS deliverable 2.3 "Provisional trend report" (see Plazier & Rauws, 2021).

1.4 Relation to other ULaaDS work packages

This report is the second product of our wider efforts of futures scenario creation and assessment in collaboration with the lighthouse cities' logistics stakeholders, and presents the final results in the form of futures scenarios. The basis of the report-at-hand was laid out in ULaaDS Deliverable 2.3. "Provisional trend report". In this trend report, we identified broader themes that will shape last-mile urban logistics in cities in the years to come, and included the views from local logistics stakeholders active in the last-mile to identify relevant trends and likely developments.

Apart from serving as a source of information and knowledge for all project partners and potential interested readers, this deliverable-at-hand will also have a clear role in relation to other WPs in the ULaaDS project. Scenarios development will aid stakeholders in rehearsing the future, exploring predictability and uncertainty, and thus reducing their risk of being unprepared, serving as useful impact for WP3, WP4, WP5 and WP6. Moreover, the aim is to contribute to dissemination and outreach activities of ULaaDs WP7 by identifying potential futures and important changes to come from and across stakeholder's perspectives. Doing so, it complements other trend reports beyond ULaaDS, which are generally expert-driven and rather abstract in their level of analysis. As such, insights from this report will also inform the stakeholder engagement strategies that will be developed in local freight fora in Task 2.2.

Several dissemination activities will be undertaken to share and further discuss the outcome of this scenario report. These activities include sending out and presenting the report to local logistics stakeholders involved in the study and to ULaaDS partners, the organization of an interactive ULaaDS workshop, conference talks at Transport Research Arena 2022, AESOP Annual Congress 2022 and outreach activities via social media.

1.5 Reading guide

Section 2 provides a literature review on the most important topics discussed in this report. Section 3 provides an overview of the methodology, describing the research process, themes, participant selection and ethical considerations. Section 4 discusses the six scenarios. A discussion of results is presented in section 5, followed by a conclusion in section 6.

2. Three main pillars of last-mile logistics

2.1 Introduction

Based on a desk study of logistics trend reports and associated academic literature, we discern three main topics that are each likely to play a crucial role in shaping last-mile logistics at the local level in the years to come. These are:

1) the level of cooperation between last-mile logistics stakeholders;
2) the level of technological innovation applied in last-mile logistics;
3) the role of local authorities in shaping last-mile logistics.

These three topics have been the basis for developing the interactive questionnaire that is at the heart of the Delphi method for scenario development.

2.2 Stakeholder cooperation

Collaboration is considered key in advancing towards sustainable last-mile logistics, but important barriers still need to be overcome (ALICE-ETP & Polis, 2021; PWC, 2019; DHL, 2018). Below, we discuss various forms and aspects of logistics stakeholder cooperation.

Logistics stakeholders may have various motives to seek cooperation. Driving forces behind the formation of alliances can be each stakeholders' expectation of a net positive value of the expected alliance outcomes (Cruijssen et al, 2007, Parkhe, 1993), "pain and gain sharing" (Savelsbergh & Van Woensel 2016, p14), legal obligations, or the exchange of knowledge and information (Lindholm & Browne, 2013). For instance, cooperation between courier, express and parcel service players (CEPs) can lead to better consolidation of freight volumes, resulting in more efficient utilization of resources (Savelsbergh & Van Woensel, 2016).

Collaborative schemes can take on the form of vertical and horizontal cooperation. In vertical cooperation, logistics stakeholders such as CEP's, manufacturers, customers, and 3rd party logistics players (to which e-commerce activities are outsourced) form strategic alliances of partnerships in the same supply chains, leading to more effective operations and higher responsiveness to consumer demands (Savelsbergh & Van Woensel, 2016). Horizontal cooperation involves stakeholders operating at the same level in the supply chain. Here, envisioned benefits are optimization of vehicle capacity utilization, reduction of empty mileage, and cost reductions in non-core activities to increase competitiveness of logistics networks (Cruissen et al, 2007).

Cooperation can also take the form of public-private partnerships in which local authorities and private stakeholders involved in delivery, consolidation matching supply and demand for logistics operations work together. Due to the complexity of the logistics sector and the many intersecting and varying interests, a local authority cannot improve freight transport in cities

without cooperation with other stakeholders (Kiba-Janiak, 2017). Cooperation between private logistics players and local authorities facilitates the exchange of knowledge and information, and improves mutual understanding (Lindholm & Brown, 2013). As a result, transport infrastructure could be better attuned to private sector needs. For example, local authorities might free up land for logistics space on strategic locations, or increase the number of loading and drop-off zones in inner cities. Or stakeholders might cooperate in city wide management systems that supports carriers in defining optimized routes for their vehicles in specific time window periods, in line with local authorities' regulations (Quak, 2012). This type of cooperation would require data-sharing between stakeholders, which gives rise to new questions of data ownership, interoperability and trust (Dalmolen et al, 2018). Private actors further benefit from public actors' involvement in transport operations through "the latter's long-term planning horizon and social considerations" (Bergqvist & Pruth, 2006, p104). Overall, however, the implementation of measures to improve freight transport and to reach sustainability does not always mean an improved situation for all logistics stakeholders, but rather a "give and take" for overall improvement: "the objective is, or should be, to reduce the conflict between different stakeholders' requirements" (Muñuzuri et al., 2005; Lindholm & Brown, p23).

2.3 Technological innovation

The high pace of technology development in logistics is rapidly transforming last-mile delivery (McKinsey, 2018). Innovations can apply to many aspects of the last-mile, ranging from hub locations and infrastructure, to vehicle technology, platforms, and logistics operations and business models (Buijs & Ozyavas, 2021). They can contribute to sustainability of last-mile logistics in different ways. First, innovations can help lower emissions of current operations, from vehicles used for last-mile deliveries (Holguin-Veras et al, 2018) to the organization of last-mile deliveries (e.g. delivery-to-door or via unattended technology) (McKinsey, 2016; Allen et al, 2012). Alternatively, new logistics players can enter the market, introducing new business models that fundamentally change how goods are handled (McKinsey, 2018; Anderson & Lee, 2000). These types of innovations are further discussed below.

In last-mile transport, one of the main challenges is the decarbonization of the last-mile vehicle fleet (PWC, 2019). New engine solutions are pushed by European regulations and the establishment of low emission zones or environmental zones in cities by local authorities (Quak, 2012). In response, innovative vehicles take the streets, such as electric vehicles, hybrids, and fuel cell electric vehicles (McKinsey, 2018; Bosona, 2020). These vehicles reduce last-mile logistics' environmental impact. Innovations also concern non-motorized transport modes, such as (e-)cargo bikes and delivery on foot, potentially with a "follow-me helper" (Quak & Kin, 2020, p5). Cargo bikes' relative low costs, emission and health benefits and flexibility are important advantages over other delivery forms in dense and congested urban areas (see also Thoma & Gruber, 2020).

Automation of delivery is another technological innovation that may shape the future of last-mile logistics. Growing labor costs and decreasing relative costs of technology drive the transition to automation in logistics (McKinsey, 2018). From a technological standpoint, the last-mile services of the future could be widely carried out by unmanned vehicles, robots, and unmanned aerial vehicles (Bosona, 2020). In the meantime, such developments raise new issues around traffic safety, infrastructure and legal domains.

The organization of urban freight flows is also changing. Last-mile logistics players are experimenting with (new) methods in the organization of urban freight flows with aims of increasing sustainability and efficiency. New delivery models, such as collection and delivery points, are challenging last-mile logistics' business-as-usual and are increasingly important for parcel delivery companies (Zenezini et al., 2018). For instance, business-to-consumer delivery through parcel lockers is increasingly considered as a viable alternative to home delivery. Delivery companies place parcels in unmanned reception boxes that can be opened by the customer with a reference code or an application on their phone (Iwan et al., 2016). Cities are also increasingly experimenting with last-mile delivery through urban consolidation centres (UCCs) or hubs (Allen et al., 2012). Here, packages from all (national and local) carriers are centralized, and last-mile delivery is bundled and executed with sustainable modes. Such hubs or urban consolidation centres can help to make traditional door-to-door delivery, organised by individual couriers, express and parcel services, more sustainable.

Finally, the future of last-mile logistics is also shaped by new entrants in the market, which might introduce new business models and radically change modes of operations (McKinsey, 2018). Examples of new entrants in last-mile logistics range from innovative start-ups to big tech companies, community initiatives and public initiatives. Here, a central question is the extent to which new entrants will impact the operations of established players, gain market share, or lead to new mergers and acquisitions.

2.4 The role of local authorities

The European Commission's Sustainable and Smart Mobility Strategy[1] stresses the need for inter-urban and urban mobility to become more sustainable, smart and healthy. Large- and mid-sized cities are encouraged to work on this transition with the implementation of sustainable urban mobility plans and sustainable urban logistics plans.

Local authorities have a key role to play. They are able to set regulations and create opportunities for efficient city logistics transport in line with regional or state governments' legislature. Authorities' key concerns are to maintain attractive urban areas and increase quality of life, while attempting to attract businesses and visitors to the area (Ballantyne et al, 2013). The objective of local authorities can be to solve conflicts between urban logistics stakeholders. They can initiate, motivate and coordinate logistics solutions in order to improve the movement of people and goods within the city. City councils can work with other

[1] https://civitas.eu/news/european-commission-presents-landmark-sustainable-and-smart-mobility-strategy

stakeholders by involving them in the implementation of activities to improve city logistics (Witkowski & Kiba-Janiak, 2014).

Facing the growth of e-commerce, bold policy action is needed to reshape last-mile logistics and bring down CO2-emissions. Without action, however, city logistics emissions will continue to rise (ITF, 2021). According to the International Transport Forum, two actions need to be undertaken by local authorities: first, the decarbonisation of last-mile logistics transport needs to move higher up on policy agendas. And second, authorities must help create business cases for decarbonization of the last-mile, as the sector is profit-driven. As such, a long-term vision and associated policies can set regulatory frameworks that favour best practices (ITF, 2021).

3. Methodology

Our approach included a document analysis of policy and trend reports, and a Disaggregative Policy Delphi. First, the document analysis yielded three "building blocks", which were subdivided in themes likely to play a role in the future of last-mile logistics. The themes were operationalized in 36 questions. Second, the Disaggregative Policy Delphi employed expert consultation in two rounds. In the first round, experts gave their quantitative future estimates for each of the 36 questions, and they elaborated their estimates during an interview. In the second round, participants were able to adjust their answers based on the first-round group response. We analysed the quantitative results of these two rounds through a cluster analysis, and the qualitative data through a direct content analysis. We employed a futures table to construct six scenarios: *Old Wild West, New Wild West, New Cool Collective, Revolution By Design, Thriving Individually* and *Good Intentions*. The steps that have led to the contents of this report are outlined in Table 1.

Table 1 - Methods employed leading to future scenarios

METHOD	ANALYSIS	WHEN
1. Document analysis (3.1)	Coding of lighthouse cities policy documents and logistics trend reports.	October 2020 - February 2021
2. Disaggregative Policy Delphi round 1: interviews and surveys (3.2.3)	Coding of interview transcripts to match qualitative data to quantitative data and understand scenario story logic. Products: Individual feedback reports; ULaaDS deliverable 2.3 (see Plazier & Rauws, 2021)	February - June 2021
3. Disaggregative Policy Delphi round 2: surveys (3.2.4)	Run multivariate cluster analysis of 36 variables in 7 themes. Use Futures Table to construct scenarios.	September 2021

3.1 Document analysis

The document analysis first comprised a desk study of logistics policy documents of the three lighthouse cities and had the goal to obtain themes relevant to these cities. Next, we performed a desk study of recent global logistics trend reports authored by logistics operators and research and policy institutes. This revealed a wide range of themes possibly relevant to the study, which we compiled into a longlist. This longlist was subjected to a brainstorming session with other researchers at the University of Groningen and with transportation and logistics experts, in which the longlist was narrowed down to a shortlist. The shortlist was subjected to an external validation round, during which ULaaDS lighthouse cities' experts and ULaaDS work package task leaders were inquired on the relevance and completeness of the list. The shortlist was then subjected to a final internal validation round by the University of Groningen research team, and resulted in six themes.

The selected themes are shown in Table 2. They formed the basis for data collection through the questionnaire and interviews. We operationalized each theme in one or more questions. For instance, within the theme "mobility", we addressed the subthemes "types of motorized transport in the last-mile, "types of non-motorized transport in the last-mile" and "level of autonomy of vehicles in the last-mile". The identified themes then formed input for the Disaggregative Policy Delphi.

Table 2 - Themes shaping last-mile logistics between 2020 and 2035

BUILDING BLOCK	THEME	QUESTIONS
GOVERNMENT	REGULATION	Degree of active regulation by local authorities
		Types of last-mile policies issues by city authorities
		Authorities' role in new delivery models
INNOVATION	COMPETITION	Extent to which large CEP-logistics players will remain amidst stricter access regulations
		Share of last-mile deliveries handled by logistics newcomers
		Types of logistics newcomers to expect.
	DELIVERY	Future of business-to-consumer (B2C) deliveries
		Future of business-to-business (B2B) deliveries
		Role of different stakeholders in new delivery models
	MOBILITY	Types of motorized transport used in last-mile transport
		Types of non-motorized transport used in last-mile transport
		Level of autonomy in last-mile transport
COOPERATION	ORGANISATION	Degree of B2B cooperation in supply chain operations to achieve sustainability benefits
		Degree of business-to-government (B2G) cooperation in smart logistics management system to achieve sustainability benefits
		Degree of B2B and B2G data-sharing
	RESOURCES	Degree of B2B cooperation on storage space
		Degree of B2B cooperation on vehicles use
		Degree of B2B cooperation in unattended delivery technology

3.2 Disaggregative Policy Delphi for constructing scenarios

A Delphi study is one of the main methods employed in futures research. Futures research aims to contribute to better policy-making by early detection and analysis of information, the generation of insights, and providing support in development of policy options (Van Dorsser et al, 2018). Delphi studies specifically are suitable for generating future information for long-range planning in topics where changes in current trends are expected (Rikkonen & Tapio, 2009). Whereas Delphis originally seek participant consensus, Disaggregative Policy Delphis (hereafter referred to as "DPD") assumes that expert communication does not lead to consensus, but that it demonstrates distinctly different views on the future. Hence, a DPD explicitly explores alternative futures. Allowing for this diversity is especially important for last-mile logistics for three reasons: the complex and dynamic nature of the field makes that innovations move quickly on various frontiers (technology, policy, behaviour), which makes one coherent development pathway unrealistic; furthermore, due to the wide diversity of

stakeholders involved, a shared narrative on a common development course is largely absent. Finally, there is a desire amongst policy makers to prepare for multiple futures (Rauws & Plazier, 2021).

3.2.1 Overall design of the Disaggregative Policy Delphi

Upon conducting the DPD, we asked participants to reflect on probable and preferable developments between 2020 and 2035. This time horizon was chosen in order to inspire and encourage stakeholders to think beyond policy goals and action plans that have deadlines set for the years 2025 or 2030.

The DPD consisted of two rounds: in the first round, the survey and interview were conducted in a single session. One expert participated per session to maintain Delphi group anonymity. The questionnaire structure served as the interview guide. This way, both quantitative data (questionnaire) and qualitative data (interviews) were collected simultaneously, which has the added advantage of reduced inter-round attrition.

In the second round, participants were able to adjust their first-round answers based on how they interpreted the "group response" provided to them. This group response represented a summary of the qualitative data presented as a provisional trend report, and the quantitative data as anonymous survey answers of the other panel members. By collecting data in different rounds, the data foundation is built to identify true centres of consensus representing the mental modes of the stakeholders.

This set-up varies from more common DPD designs where, as a first step, one or more surveys are held, before conducting in-depth interviews as a second step. We deviated from this approach because commonly, attrition rates in Delphi's generally and DPDs specifically are high, which inhibits robustness of findings. Importantly, we expected that experts worked remotely and online due to the Covid-19 pandemic which was likely to further reduce experts' inclination to continue to participate. In order to reduce attrition rates and increase chances that study participants would complete both rounds of data collection, we decided to use the first round to build rapport with participants as to increase their commitment to the study. An hour-long face-to-face interview with each participant was deemed suitable to quickly bring them up to speed on the research objectives, familiarize them with the themes and research questions, and hear their questions and remarks. This thorough introduction to the research in the first round increased their willingness to participate in the second round of the research which was held months later.

3.2.2 Selection of participants

We inquired the views and future estimates of local authorities, logistics operators, citizens, business representatives and experts. The stakeholders and their relation to the wider global logistics network are shown in Figure 1. Study participants are shown in blue. Logistics

stakeholders in red were not included in the study, but the interdependencies between study participants and these other actors were discussed during the interviews.

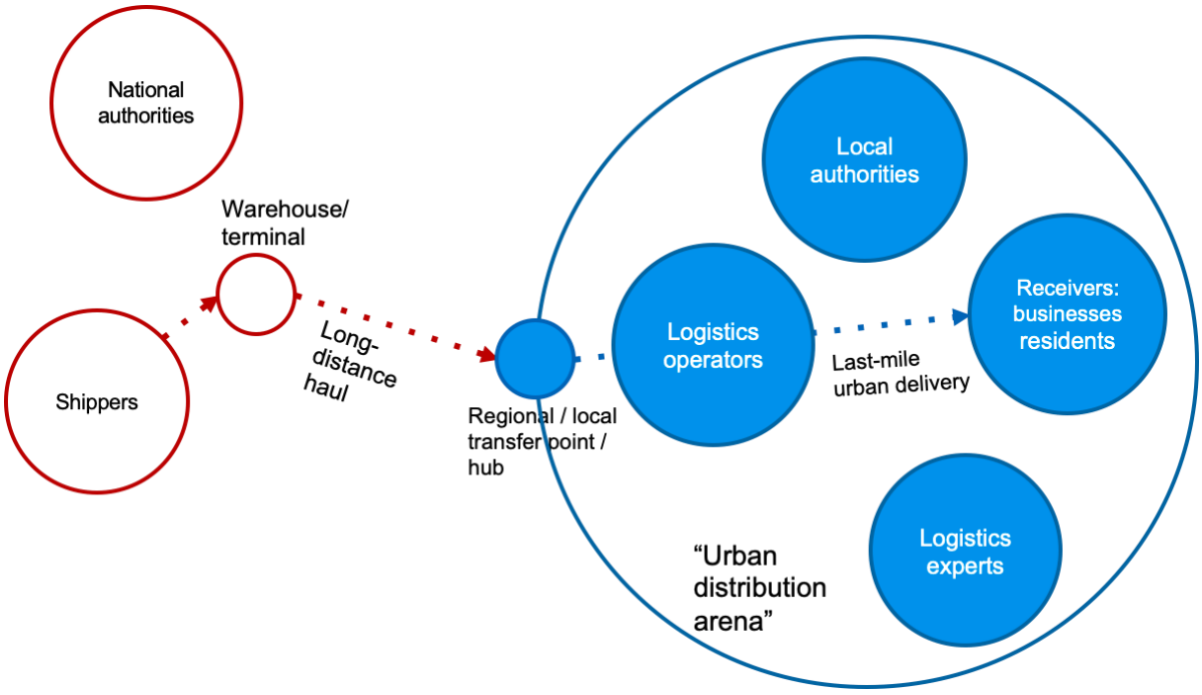

Figure 1 – Last-mile logistics stakeholders included in the study (blue) and their relation to part of the wider global logistics network (red).

Potential study participants were first approached by contact persons from the lighthouse cities, who have extensive networks of various logistic stakeholders within their respective cities (see Troppe & Illek, 2021). These potential participants were then asked by e-mail to participate in the study by the researchers. The logistics experts included in the study either worked on scientific and applied research in logistics or as logistics advisers, and were familiar with and active in the respective cities through their research programmes or advisory work. Study participants from local authorities were either policy makers or policy administrators in charge of mobility and logistics in their respective cities. The group of logistics operators consisted of both global logistics operators with local subdivisions in the respective cities and logistics operators that were only active locally. Finally, on the receiving end, representatives of residents and local businesses in the respective cities were included in the study.

Thirty-four logistics stakeholders were included in the first round to explore the possible states of last-mile logistics in 2035 (see Plazier & Rauws, 2021), and 26 participants also participated in the second round of the Delphi, thereby completing two rounds including two surveys and one in-depth interview. The data of these 26 participants was used to construct futures scenarios. The participant flow throughout the study is shown in Figure 2.

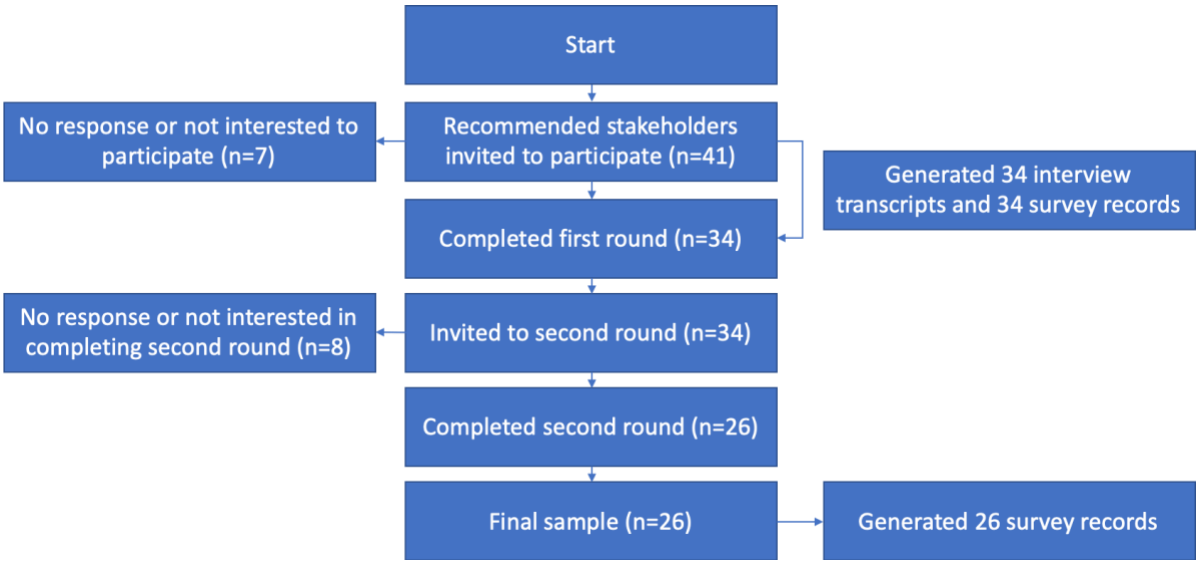

Figure 2 - Participant flow

The number of study participants per round from each logistics stakeholder category is shown in Table 3.

Table 3 - Overview of participants in the first and second round of the DPD

TYPE OF STAKEHOLDER	COMPLETED FIRST ROUND	COMPLETED SECOND ROUND
Local authorities	7	5
Logistics operators	15	10
Citizens	2	2
Business reps	6	5
Experts	4	4
Total	34	26

3.2.3 DPD round 1: interview and questionnaire

We designed the questionnaire based on the validated themes in Table 3. The survey was built using Qualtrics online survey software, and interviews were held using the video conferencing application Google Meet. During the interviews the researchers showed the survey by sharing the screen with the participants. They were asked to answer the questions verbally, and these were filled-out on the shared screen by the researcher. Participants were asked to elaborate on their motivations. Each of the interviews were between 60 and 90 minutes long. They were audio recorded and transcribed verbatim.

Following round 1, we compiled and shared individual feedback reports. At this stage, ULaaDS deliverable 2.3 “Provisional trend report” (Plazier & Rauws, 2021) was also shared with the participants, in order to provide them with a better understanding of the data collected during the first round. To construct the provisional trend report, we employed

qualitative directed content analysis to effectively assess the amount of qualitative data. The 34 interviews held in the first round resulted in 440 pages of transcripts, 78 interview codes and 1954 coded quotations. We grouped the qualitative arguments per theme and employed qualitative directed content analysis to target specifically determined categories of experts' transcripts as informed by the cluster analysis (Hsieh & Shannon, 2005; cf. Varho & Tapio, 2013).

3.2.4 DPD round 2: questionnaire

When sharing the individual feedback report and Provisional trend report, participants in round 1 were invited to participate in round 2 of the survey. This survey was identical to the round 1 survey, although this time no interview was held and participants were asked to fill-out the survey in their own time. Participants were able to adjust their first-round answers based on how they interpreted the "group response" of the first round provided to them while filling out the particular question in the second-round survey.

3.2.5 Analysis of the quantitative results

Using the data from the second survey, we used multivariate cluster analysis to analyse quantitative future estimates per theme. Since each respondent provided both probable and preferable future estimates, the total amount of future estimates was equal to the number of respondents multiplied by two. Variables were standardized on a scale of 0 to 1. We selected standardized Euclidean distance as dissimilarity measure, and agglomerative hierarchical clustering furthest neighbour (complete linkage) as clustering algorithm. We calculated the arithmetic means of the resulting clusters as cluster center. We limited the number of clusters to minimally four or maximally seven to ultimately ensure sufficient scenario diversity as well as to enhance the efficient use of the scenarios (Varho & Tapio, 2013). Final cluster selection was based on the mutual combination of quantitative and qualitative data (Tapio et al., 2011): we compared whether arithmetic means of all thematic variables between cluster options varied sufficiently for the available qualitative data to explain that variation, and used the hierarchical trees (dendrograms) to visually check for the structure of the responses – i.e., sub-clusters and outliers and formed our cluster judgement.

3.2.6 Futures table

Finally, we constructed scenarios using a futures table, in which the rows express the themes and variables, the columns represent the scenarios, and the cells comprise the cluster (centroid) value of a future state. The futures table is shown in Table 4. The quantitative values of the futures table result from the cluster analysis. Since we ran cluster analysis per theme, different themes can have different numbers of clusters. Initially, when any futures table is created with cluster values, columns do not yet represent a scenario. Therefore, we reorganized the cluster themes and connected one theme to another based on qualitative content analysis so that the columns represent a coherent storyline and to maximize internal

scenario consistency. Finally, we wrote storylines supported by the qualitative data and we named the scenarios.

3.3 Ethical considerations

As mentioned, the interviews held were based on the themes addressed in a pre-designed questionnaire. This questionnaire was filled-out by the stakeholders during the interview.

Oral and written instructions were provided by e-mail before the interview. Prior to the interview, participants were informed on their rights and data privacy. They were informed that there were no consequences if they decided not to participate in this study. They were free to stop participating at any moment without giving a reason for doing so. They were informed that data they provided in this research would be anonymized after the data analysis and could not be traced back to them as an individual, and that personal information would remain confidential and would not be shared. They were also informed that data would be analysed by the researchers that collected the information, and that completely anonymized data might be shared with other researchers or published in a scientific journal.

All participants gave their written informed consent to this approach prior to both the first and second time filling out the survey, and gave permission for their anonymized data to be used for research purposes both times.

4. Results

4.1 Six scenarios for the future of last-mile logistics

Using the DPD we constructed six scenarios, each depicting a different future state of last-mile logistics in the year 2035. The columns in Table 4 depict the scenarios quantitatively. The values are the result of the cluster analyses (section 3.2.5). For instance, in the *New Cool Collective* and *Revolution By Design* scenarios, 32% of last-mile parcel deliveries in 2035 will be handled by logistics newcomers (variable *Newcomer share)*. In both scenarios, 52% of these newcomers will consist of innovative start-ups (variable *Startups)*. In contrast, in the *Good Intentions Abound* scenario, 16,9% of all last-mile deliveries will be handled by logistics newcomers. Here, big (tech) companies represent 69% of newcomers whereas innovative start-ups account for 15% of newcomers.

The columns represent scenarios because the theme clusters are connected by the qualitative content analysis (section 3.2.5). For instance, the degree of regulation by local authorities corresponds with different types of regulations in the *New Cool Collective* scenario than in the *Revolution By Design* scenario. Next, we describe the six scenarios qualitatively by emphasizing their main themes and how they cohere.

Table 4 - Futures table

		Old Wild West	New Wild West	New Cool Collective	Revolution By Design	Thriving, Individually	Good Intentions Abound
Themes and variables	**Units**	**1**	**2**	**3**	**4**	**5**	**6**
GOVERNMENT							
Degree of regulation							
Transport modes	-2 passive, +2 active	0,0	0,0	1,1	1,1	1,6	1,5
Autonomous veh.	-2 passive, +2 active	0,2	0,2	0,7	0,7	1,7	1,4
Inner city access	-2 passive, +2 active	0,4	0,4	1,9	1,9	1,7	1,4
Logistics resources	-2 passive, +2 active	0,3	0,3	0,7	0,7	-0,3	1,4
Type of regulation							
Transport modes	-2 restr, +2 facilit	-1,0	-0,6	0,4	-1,0	1,4	0,6
Autonomous veh.	-2 restr, +2 facilit	1,3	-0,3	1,6	1,3	0,8	0,3

Inner city access	-2 restr, +2 facilit	-1,3	-0,1	2,0	-1,3	1,5	-0,8
Logistics resources	-2 restr, +2 facilit	0,8	0,4	1,0	0,8	1,0	0,5
INNOVATION							
Current CEPs with access to inner cities in 2035							
Small CEPs	%	44,1	20,8	70,0	10,0	100,0	85,0
Med/Large CEPs	%	53,6	73,9	83,0	10,0	100,0	18,6
Share and distribution of newcomers							
Newcomer share	0-100%	21,7	29,2	32,0	32,0	23,0	16,9
Startups	%	73,3	37,2	52,0	52,0	34,3	15,0
Big (tech) companies	%	15,8	45,0	0,0	0,0	13,3	63,1
Community initiatives	%	5,0	4,2	1,0	1,0	15,0	8,8
Public initiatives	%	3,3	5,3	9,0	9,0	26,0	6,9
Other	%	2,5	8,3	38,0	38,0	11,3	6,3
Types of delivery							
B2C	-2 traditional, +2 new delivery models	-0,1	0,7	0,8	2,0	1,1	0,7
B2B	-2 traditional, +2 new delivery models.	-0,2	1,0	2,0	1,4	-0,4	1,0
Motorized transport							
Fossil-fuel	%	54,4	24,0	3,3	10,9	1,1	0,0
Fuel-cell	%	13,9	30	76,7	12,5	36,1	37,5
Battery-electric	%	25,7	36,0	6,7	72,2	50,0	12,5
New solutions	%	6,0	10,0	13,3	4,4	12,8	50,0
Non-motorized transp.							
On-foot courriers	%	19,0	51,4	7,8	5,0	12,9	19,0
(E-)cargobikes	%	67,0	28,6	87,2	25,0	46,3	67,0
New solutions	%	14,0	20,0	5,0	70,0	40,8	14,0
Level of automations							
Small vehicles	Autom. level 1-5	2,0	2,0	4,5	2,0	3,4	2,0
Large vehicles	Autom. level 1-5	1,9	1,9	4,3	4,0	2,7	1,9
COOPERATION							
CEP cooperation							
Storage space	-2 low, +2 high	0,2	-1,2	1,0	1,8	-1,2	-1,2
Transportation	-2 low, +2 high	0,3	-1,8	-0,6	1,29	-1,8	-1,8
Unattended delivery	-2 low, +2 high	0,2	0,2	0,8	1,7	0,2	0,2

Supply chain cooperation							
B2B	-2 low, +2 high	0,4	-1,0	2,0	1,0	0,8	-1,0
B2G	-2 low, +2 high	0,4	-0,3	1,7	1,1	-1,0	-0,3
Datasharing							
B2B	-2 low, +2 high	-1,3	-1,1	1,6	0,7	-1,3	-1,1
B2G	-2 low, +2 high	0,4	-1,1	2,0	0,7	0,4	-1,1
Stakeholder roles in implem. of unattended tech							
Local authorities	-2 passive, +2 active	0,4	-1,0	1,7	1,7	1,5	1,3
CEPs	-2 passive, +2 active	1,6	1,6	1,3	1,3	1,5	-0,7
Consumers	-2 passive, +2 active	0,2	0,9	-2,0	-2,0	1,0	-0,7

4.2 Scenario 1 - The Old Wild West

"No active government involvement and lacking incentives for innovation and cooperation."

Synopsis

In this scenario, only little progress has been made in the last-mile logistics sector in 2035 as opposed to the early 2020s. In 2035, cooperation between stakeholders is largely non-existent, the number of innovations introduced is generally low, and local authorities are largely absent from the logistics playing field.

Policies issued by local authorities lack a clear vision and direction for the logistics sector. Some classic access restrictions and regulations on inner city transport are in place (e.g. time windows for last-mile deliveries or restrictions on certain types of vehicles), but no novel processes, tools or practices have been introduced. Local authorities' failure to respond to or embrace logistics innovations is apparent in the development of last-mile delivery models. Both logistics operators and consumers increasingly opt for unattended delivery, such as through parcel lockers or pick-up/drop-off points. Yet, decision-makers in charge of accommodating space for logistics lack a proactive approach to facilitate the development of a coherent network of parcel points. As a result, unattended delivery's potential is not fully realized, and an important share of goods is still delivered unconsolidated and door-to-door. The last-mile transport fleet presents a similar case, as the transition towards clean modes of transportation is not fully made. Cargo bikes are widely used, but swamp inner city streets, with negative effects for traffic safety.

Last-mile logistics is further characterized by low levels of innovation by private actors and low cooperation between stakeholders. In the absence of new policy measures, logistics operators have no need to innovate in response to stricter policies, and only act in response

to developing consumer preferences, as shown in the case of unattended delivery. Limited cooperation between stakeholders shows limited number of supply chain partnerships (vertical cooperation), and limited sharing of resources (horizontal cooperation) and low levels of data sharing.

Key arguments

- Local authorities are largely absent from the last-mile logistics playing field. This is due to a lack of knowledge, budgets and dedicated manpower, and a lack of felt urgency to bring about significant changes in the last-mile sector.
- In the absence of long-term goals set out by local authorities, private actors feel little urgency to innovate. As a result, by 2035, an important share of the established players from the early 2020s have failed to meet little access restrictions that have actually been put in place. Those that remain guard their positions heavily. New entrants only successfully gain a market share when able to disrupt the landscape of existing operators with new operational models.
- Private actors' operations are fully optimized based on their own customers, vehicles and facilities alone. Cooperation is seen as making matters unnecessarily complex. Results from pilot projects have insufficiently proven the added value of cooperation for business operations and societal benefit.

4.3 Scenario 2 - The New Wild West

"Last-mile logistics is shaken up, with high levels of innovation but low regard for sustainability."

Synopsis

In this scenario, the private sector leads the advancement of the last-mile logistics system. Local authorities leave the initiative in the last-mile to private actors, and aim to assist when asked and where they can. A clear example is the development of unattended delivery technology: authorities are asked to facilitate this development by accounting for the need for logistics space in zoning plans, and freeing up space for pick-up and drop-off points, but actual implementation is organized between private stakeholders.

High levels of innovation are seen in last-mile deliveries: a viable business model has been developed for better consolidation of business-to-business (B2B) deliveries. Consolidation of business-to-consumer (B2C) deliveries takes place in response to growing congestion in inner cities. The transition to clean fuels is made partially, with one fourth of the last-mile logistics fleet still accounted for by fossil fuel transport. Amidst these changes, there is renewed attention to deliveries by foot enhanced by autonomous mail carts following mailmen. Established logistics operators cement their dominance by acquiring smaller logistics operators, and a third of last-mile logistics is conducted by new big tech companies or innovative start-ups.

Despite the high levels of innovation, cooperation between logistics stakeholders is sparse and opportunistic, and only occasionally considered from a perspective of cost-reduction.

Private actors go the distance to preserve their individual reputations and client-bases, hindering more structural and intensive cooperation that might bring about sustainability benefits, such as supply chain partnerships or strategic alliances. In similar vein, data-sharing between private actors and between public and private actors is limited.

Key arguments

- Local authorities purposefully leave the initiative to the market, but this stance is largely the result of a lack of knowledge and expertise.
- Private companies innovate amidst severe competition and high numbers of new entrants. Innovations strictly serve to improve their companies' own business models and operations, but lack a broader societal purpose. Cooperation is equally seen as a quick fix to reduce costs, but seldomly as a structural solution with wider potential benefits.
- Low data sharing between local authorities and private actors is the result of a lack of trust of the government in its own capabilities to safely store and purposefully utilize the vast amounts of data involved.

4.4 Scenario 3 – New Cool Collective

"Shared beliefs and a shared course of action lead to sustainable last-mile logistics."

Synopsis

In this scenario, logistics stakeholders share the same objective and strategies: realizing sustainable last-mile logistics through high levels of innovation and cooperation. Local authorities follow suit, by taking on an active role in last-mile logistics, but with a facilitative stance. They formulate ground rules concerning city access restrictions and types of transport modes allowed in inner cities, but private initiative is encouraged to meet new demands. This also shows in the realization of unattended delivery technology: local authorities have a clear vision and action plan to create room for new delivery models in inner cities, and stimulate private actors to come up with fitting solutions to realize this vision.

Sustainability is notably realized in last-mile transport. In a joint effort involving all logistics stakeholders, the transition towards clean fuels is almost fully completed, with a strong orientation towards fuel cell vehicles, (e-) cargobikes and LEVs. Both deliveries to consumers and deliveries to businesses see a clear shift toward consolidation of parcel flows. The growth of e-commerce is accommodated through higher efficiency of logistics operators. Large and established CEPs cement their positions by acquiring smaller CEPs. Simultaneously, a large portion of last-mile logistics is carried out by new players, mostly innovative start-ups, who build their business models with sustainability as the premise.

To achieve higher efficiency, significant cooperation exists between logistics operators on storage space and delivery technology, although vehicle sharing remains limited. Strong cooperation is seen between logistics operators within supply chains and with local authorities in smart city management systems, which helps achieve significant sustainability

benefits. This is supported by high levels of data sharing between individual private actors and the government.

Key arguments

- Local authorities are highly knowledgeable and data-savvy. As such, they are seen as highly competent and taken seriously by private actors and other logistics stakeholders. This gives local authorities confidence that laying out the ground rules is more effective in reaching policy goals than implementing restrictive measures or micromanaging last-mile logistics operations.
- In B2B, consolidation of parcels is developed into a viable business model. Consolidation of B2C deliveries happens in response to public pressure and decreased acceptance of congestion in inner cities.
- Cooperation serves multiple purposes, and motivations to do so are both intrinsic and extrinsic. First off, logistics space in inner cities is scarce, and sharing assets, such as storage space and delivery points, facilitates business operations of a wide variety of logistics operators active in last-mile space. Furthermore, cooperation is cost-effective and contributes to local policy objectives, such as sustainability and liveability, to which both authorities as private actors are held accountable by the public.

4.5 Scenario 4 - Revolution By Design

"Sustainability in last-mile logistics is reached at the guiding hand of local authorities."

Synopsis

Last-mile logistics is characterized by dynamism and transition towards sustainable modes of operating as a result of active government intervention. Local authorities have laid out a clear vision on last-mile logistics in their inner cities and guide developments, while focusing on designing and implementing restrictive measures. Classic restrictions, such as on inner-city access and transport mode use, are in place, but authorities have also implemented more innovative measures: for instance, to operate in inner-city areas carriers now have to show they can do so efficiently, for example by showing their delivery density is high or that they enter a city with a consolidated load. In that regard, authorities experiment with concessions, leaving one logistics operator winning the contract in charge of deliveries in dedicated city districts. As a result of these efforts, the transition to zero emission vehicles is almost fully made. Inner cities are dominated by BEVs, resulting from decades of focus on this technology by local authorities and the wider last-mile logistics sector as a whole.

Restrictive measures induce high innovation and drastic changes in the way parcels are delivered. Mandated by local authorities, B2B deliveries are almost fully consolidated, although logistics operators have yet to develop a profitable business model. B2C deliveries are done entirely through unattended delivery and pick-up points. Restrictive measures also drastically change the composition of the sector: only a fraction of the logistics operators that were incumbent in the 2020s are still active in 2035, whereas a large share of last-mile

parcel deliveries is now handled by newcomers. These newcomers also cater to a renewed interest in alternative logistics concepts, such as niche services, combined and reverse logistics, and shorter (locally-oriented) supply chains.
Active involvement of authorities spurs high levels of cooperation across logistics operators, who are forced to cooperate to get their deliveries through to their customers in inner cities amidst tight restrictions. This is supported by data sharing between logistics operators and operators and government, although the prime motive is to adhere to higher standards over an intrinsic motivation to realize full transparency.

Key arguments

- Authorities take on an active role in last-mile logistics to force change upon the private sector. Strong guidance coupled with restrictive measures is seen as indispensable to reach sustainability in logistics.
- High levels of innovation and cooperation among logistics operators are needed to meet the high requirements set to last-mile distribution by local authorities
- New last-mile operators are successful as they are able to incorporate the innovations needed to comply with higher standards into their business models from the start, giving them competitive advantage over traditional operators who have had more difficulty making the transition.

4.6 Scenario 5 - Thriving, Individually

"A mix of restrictive and facilitative policies spur technological innovation but result in limited cooperation between stakeholders."

Synopsis
After an emphasis on restrictive measures in the early 2020s, local authorities focus on facilitative measures to stimulate innovation and cooperation in last-mile logistics. These early restrictions on mode use and inner-city access have triggered a mix of innovations in transport modes and business models. The logistics sector has expanded rapidly and consumer preferences have changed: for instance, the majority of residents now prefer delivery at unattended pick-up points. Developing such unattended pick-up points is also essential for logistics providers to process the growing volumes of parcels. For B2B-deliveries, door-to-door remains the standard as consolidation is difficult to organize.
A similar result of early restrictions, the last-mile transport fleet is almost completely zero emission, and includes a mix of (e-)cargo bikes, LEV's, and fuel cell vehicles for large deliveries. Also, automation in the form of autonomous mail carts following mailmen is part of the fleet. Micro hubs support a further increase of capacity and efficiency. The growth of e-commerce creates room for a wide range of new operators including big tech companies, start-ups and community initiatives, which together account for a quarter of the deliveries.
Taken altogether, the mix of innovations and the increase in number of logistics providers is sufficient to keep up with the growing demand and increase delivery capacity within the constraints of crowded inner-city areas. However, cooperation between private actors is

rare. Most private operators choose to operate independently. In an attempt to create synergies, the local authorities set up publicly funded initiatives. Where operators do work together, this is done to increase efficiency and reduce costs, but enhancing sustainability is not a motive. This shows in resource cooperation, where operators deliver parcels through joint parcel lockers, but work with their own distribution centres and vehicle fleet. Also, data sharing across logistics operators does not take place, as data is seen as a major asset for creating competitive advantage. Sharing data with local authorities is however considered somewhat more acceptable.

Key arguments

- Government learning curve: after the initial implementation of restrictive policies, which spurred the need for innovation among logistics operators, local authorities received many inquiries for support from private actors to facilitate the required changes. In response, the focus changed to facilitative policies to let innovations of private actors reach their full potential
- The innovations' 'arms race' between individual companies induced by the initial restrictive policies has swamped the attention to stakeholder cooperation, which is limited in this scenario. Technological innovations have fully optimized operations, but for each stakeholder individually.

4.7 Scenario 6 - Good Intentions Abound

"High levels of government initiative amidst low stakeholder cooperation and mixed levels of innovation."

Synopsis

In this scenario, local authorities take on an active role to aim to realize sustainable last-mile logistics: they regulate inner city access using restrictive measures, and actively develop policies addressing last-mile transportation and logistics resources and services such as storage, transportation and distribution. As a result of access restrictions, the transition to clean fuels has fully been made, and BEV, fuel cell and a range of new vehicle technologies dominate the scene in inner cities.

Local authorities are critical towards the necessity of different logistics flows and associated resources in inner cities. For instance, new large-scale developments in inner cities that are likely to entrain a significant flow of logistics goods are critically considered, and mitigation strategies and implementation plans to deal with potential negative effects require approval by authorities beforehand. Parcels are cross-docked from large to smaller carriers at city borders through a system of hubs, initiated and exploited by the city. Local authorities also actively acquire logistics real estate. As such, they are an active player in the logistics process. Amidst high government activity, however, cooperation between logistics stakeholders remains low. Aside from the need to cross-dock goods at inner city borders, cooperation in supply chains and in logistics resources is sparse, and as a result, potential sustainability gains from closer cooperation between operators are not fully realized. Where possible, CEPs

operate from their own distribution centres and use their own vehicle fleets. This is underpinned by low levels of data-sharing between logistics players, but also between private operators and governments.
Innovation rates are mixed. Whereas regulations have forced innovation upon the last-mile transport fleet, a large share of established players from the early 2020s have failed to meet new demands and disappeared from the last-mile. Amidst strict government policies, the entry of new players is lowest compared to other scenarios, leaving smaller CEPs to handle most of last-mile deliveries in fierce competition and with limited inflow of new and innovative players.

Key arguments

- Local authorities have concluded that private actors are not going to solve last-mile logistics' complex issues by themselves, and in response have taken on an active role with a restrictive focus. Progress in 'greening' the last-mile has been made through government intervention, but private initiative falls behind on policy ambitions.
- Amidst government activity, the logistics operators that still remain are eager to maintain little of their dominant positions they have left. They shy away from cooperating with each other and with local authorities. Strict requirements to operate in the last-mile, and fierce competition between remaining parties, lead to a limited inflow of new players.
- Significant changes in how last-mile logistics are operated have impacted profit margins. As a result, large logistics players from the 2020s have largely reoriented their focus to activities outside of last-mile logistics. Those that remain in the last-mile guard their positions heavily. Significant investments are needed by new entrants to gain market share. Their success is limited.

5. Discussion

The scenarios were constructed to explore possible future developments in last-mile logistics. The scenarios demonstrate a diversity of disruptive changes that follow from a growing demand for logistics, more attention to sustainability and liveability in cities, changing stakeholder interests and interdependencies, new technologies and the inflow of new players in the logistics sector. This means that the future of city logistics is open to different interpretations of how logistics operations are organised, how logistics contribute to sustainability and liveability, and what role and actions actors may, could, or should fulfil. In this section, we will address what major differences and similarities exist between the scenarios, and how policy-makers may act based on these scenarios.

Logistics remains an integral part of inner cities

Despite changes in *where* and *how* logistics are operated, the scenarios leave no doubt that logistics processes themselves will remain "a fact of city life", omnipresent and closely interwoven with the urban.

The growth of e-commerce is likely to increase the need for logistics space in inner cities. Not in one scenario does e-commerce show signs of slowing its growth, or are logistics activities relocated outside of the gates of inner cities. How the growth of city logistics takes shape differs per scenario. In the *Good Intentions Abound* scenario, the acquisition of logistics space is government-led. Local authorities actively acquire logistics real estate and operate logistics hubs in their attempt to foster sustainability. In the *Thriving, Individually* scenario, the initiative is with the operators, whose micro hubs constitute the missing link in their last-mile activities. In the *New Cool Collective* scenario, local authorities and logistics operators work closely together to jointly optimize the use of public space for logistics.

Innovations change *how* goods are handled, with solutions ranging from shared storage spaces on strategic locations, deliveries through unattended delivery points, or consolidated transportation in light-weight or automated vehicles. Again, it may vary how such innovations take shape: in the *New Wild West* scenario, the few pick up/drop-off points that exist result from private partnerships to reduce costs. Here, implementation is led by private parties, for whom those solutions present a profitable business model. In contrast, in the *Revolution By Design* scenario, widespread implementation of pick-up/drop-off points is strongly mandated by local authorities. For private operators, the argument to follow authorities' lead and work on implementation is retention of last-mile market share rather than expected profitability of these services. In sum, the wide array of expected changes and possible future outcomes require stakeholders' full attention and a proactive stance now and in the years to come.

Technology as a leverage

The scenarios are generally characterized by a strong focus on technology. Technological innovations are considered an integral part of the future of last-mile logistics. It is also seen

as an important tool for local authorities to reach policy goals, for instance by implementing smart city management solutions. Two broad views can be discerned on the role of technology in logistics' futures: one is the techno-optimist stance, which sees technology as the solution to most of last-mile logistics' problems. These solutions often already exist, but other forces prevent them from realizing their full potential (such as a lack of public acceptance or legal embeddedness in the case of autonomous vehicles). The other sees future technological innovation as the wild card, offering a way out of problems for which no solution has yet been found. For instance, in the *Good Intentions Abound* scenario, battery-electric and fuel-cell vehicles prove inadequate long-term solutions, resulting in high shares of new, yet unknown, transport modes used in the last-mile. Sharing data is often viewed as an important precondition to fully utilize technology's potential. However, low levels of data-sharing among stakeholders in most scenarios warn against too much optimism.

Harnessing the full potential of data and technology is important to successfully transition to sustainable last-mile logistics. But lots of learning has still to be done according to study participants, especially by local authorities, who have to become data savvy and highly knowledgeable in the field. Only then will they be able to fully understand the interests of the sector, and be seen as competent conversation partners by other logistics stakeholders.

Active local governments are a precondition to cooperation

In 2035, the network of last-mile logistics stakeholders is expected to be strongly interwoven, and stakeholder actions have direct and indirect effects on other players. The scenarios explicate these interdependencies. For instance, in the *New Cool Collective* scenario, increasing the number of parcel pick-up points helps logistics operators work more efficiently and simultaneously assists local authorities to meet congestion and emissions reductions. If such a scenario unfolds, both types of stakeholders need to be on board to harness the mutual benefits.

Across all scenarios, an active role of local governments in the organization of city logistics shows to be a pre-condition for enhancing cooperation between logistic actors and between public and private actors. But such an active role can be fulfilled in different ways. In the *New Cool Collective* scenario, authorities stimulate stakeholder cooperation in storage space or unattended delivery technology, for instance by identifying those players receptive to cooperation and actively helping them find and realize shared logistics space. For last-mile logistics players, this has the added benefit of reducing costs. In the *Revolution By Design* scenario, however, stakeholder cooperation to consolidate loads is imperative, as local authorities monitor delivery densities and can exclude actors from inner cities when targets are not met.

However, an active role of local governments is not necessarily a guarantee for stakeholder cooperation. In the *Thriving, Individually* scenario, the introduction of restrictions by local authorities has triggered sector innovations, with individually optimized business operations as a result. In the *Good Intentions Abound* scenario, strong government intervention has led to low trust between public and private actors, and the many new entrants have caused

fierce competition between private players, both resulting in a general reluctance to cooperate.

Scenarios show that the role of local authorities in last-mile logistics is likely to grow more active in the future. Local authorities are wise to invest in a continuous dialogue with other logistics stakeholders. As government intervention triggers different responses, authorities need to be sensible to the incentives that are likely to stimulate cooperation between stakeholders as well as the possible unintended effects of policy interventions.

Various drivers for innovation

Innovations are triggered by competitive pressures, government regulations, and aided by new technologies and clear long-term policy strategies. An active role by local governments shows to be an important driver for logistics innovations in three out of six scenarios. In the *New Cool Collective* scenario, local authorities formulate a clear vision on last-mile transport but leave operations to the market. In the *Revolution By Design* scenario, local authorities control the last-mile by monitoring delivery density and granting concessions, forcing logistics operators to come up with new methods of operation. In the *Thriving, Individually* scenario, innovations take place in response to classic access and mode use restrictions.
The *New Wild West* scenario however shows that market innovations can also take place without active government involvement. Here, technological innovation happens in response to competitive pressures, resulting from large numbers of new market entrants and the need to reduce costs of operations.
The value of the scenarios is not so much identifying one trigger for innovation over another, but in highlighting that is most likely requires a mix of drivers to innovate city logistics. Innovation requires a productive mix of drivers that fits with the specific characteristics of a city, the processes prevalent in the respective time period and the opportunities provided by contextual developments.

Logistics systems operations are still mostly up to the market

Despite the more prominent role of local authorities in the scenarios, last-mile logistics systems operations are still very much the domain of the logistics operators. They maintain a key role in the realization of sustainable last-mile logistics and livable inner cities in most of the scenarios. Compared to the present, local authorities take more control, their actions varying from setting the right conditions (*New Cool Collective*) to actively partaking in the development of logistics resources and services (*Good Intentions Abound*). But wider societal goals can't be reached without the sector. This is especially visible in the *Good Intentions Abound* scenario: authorities have some success in greening the last-mile through transport mode restrictions, but absence of cooperation between stakeholders means supply chain and resource inefficiencies remain.

Sustainability on the horizon? A reality check

The analysis of the future images of the stakeholder panel indicates that a transition towards more sustainable city logistics is far from a given. This is only achieved in the *Revolution By Design* and *New Cool Collective* scenarios. The latter scenario is unique as local authorities and logistics operators share the same goals and motives in their collective pursuit of

sustainability. In other scenarios, stakeholder motives to contribute to a transition may vary, from appealing to changing consumer preferences, the need to reduce costs, to introducing new operational schemes to comply with local regulations.
The *Old Wild West* scenario however indicates that 'business as usual' is a viable state for the last-mile 2035, even when considering the urge to reduce environmental impact already felt today. This scenario is characterized by limited progress all around. Local authorities are largely absent from the logistics playing field due to a lack of knowledge, capacity and budgets. In the absence of long-term goals set out by local authorities, private actors feel little urgency to innovate, and cooperation is seen as making matters unnecessarily complex.

Barriers for sustainable city logistics

Across the scenarios a number of barriers for establishing more sustainable futures can be identified. Limited trust between private actors and between private actors and the local government hamper initiatives for cooperation, as seen in *Good Intentions Abound*.
As noted earlier, a lack of knowledge, capacity and budgets within local governments is identified as another barrier. An active role of governments is considered essential for making city logistics more sustainable, but the expert panel is inconclusive on whether sufficient knowledge, capacity and budgets will be available within local governments.
The competition for market shares between logistics can also be a barrier. In some scenarios a volatile market comes with a strong focus on cost reduction rather than sustainability, as existing players are in fierce competition with each other and with newcomers. In other scenarios the growth of e-commerce and limited priority for sustainability at the side of consumers hampers sustainability.

Pathways for sustainable city logistics

Two scenarios assume city logistics to be much more sustainable in 2035. Sustainability in these scenarios concerns zero-emission transport, efficient use of urban space for logistics transportation and consolidation, and effective cooperation in supply chains for sustainability benefits.

These scenarios are instrumental for identifying pathways towards sustainable city logistics. The *New Cool Collective* scenario envisions far-reaching efforts of coordination and cooperation between public and private stakeholders in a collective pursuit for more sustainability. In contrast, *Revolution by Design* scenario depicts a successful government-led transformation of the logistics systems, realized through a combination of access and operations restrictions and promoting cooperation between logistics providers. In this scenario, public and private stakeholders have varying motivations to work together, innovate and share data. But the end result, i.e. more efficient logistics for livable and urban environments, is the same as in *New Cool Collective*. Comparing these scenarios, a number of enabling factors for sustainable city logistics can be identified.

Enablers for sustainable city logistics

Local governments are pivotal, in partnership with private actors or as transition-leaders. Both the *New Cool Collective* scenario and *Revolution by Design* scenario indicate that local governments need to have a strong vision, to set legal standards for operators, access

restrictions, and to be a knowable actor in the interaction with other stakeholders. Societal pressure to accelerate sustainability efforts is also enabler, specifically for the successful establishment of public private collaborations. A distinct feature of the *New Cool Collective* and *Revolution by Design* scenarios is that expected new logistics operators are oriented at cooperation and sustainability. Hence, CEPs that consider cooperation and sustainability at the heart of their business operations can be an enabler. The same holds for technological innovations, as the *Thriving, Individually* scenario shows that technological innovations are not automatically paired with sustainable performance. In the *New Cool Collective* and *Revolution by Design* scenarios innovations are used to increase efficiency, reduce transportation flows, increase collaboration with the aim to make city logistics sustainable.

Complexity all around

The scenarios demonstrate that city logistics developments are shaped through a complex interplay between stakeholders, their ambitions, capacity and actions, and contextual changes (see also Rauws & Plazier, 2021). This complexity implies per definition that multiple futures are plausible and that uncertainty about which future is more likely than others can only be reduced to some extent.

In the pursuit of sustainable city logistics, it is therefore essential to ensure an ongoing dialogue between the involved stakeholders. This is especially true for the coordination and cooperation between private and public actors, as all scenarios beyond business as usual indicate that they interplay is very influential in shaping the future of last-mile logistics. The analysis of the expert panel shows many assumptions and expectations exist about the intentions and behaviors of others. An ongoing dialogue may help actors to become more aware of the positions and ideas of others, which in turn can help in identifying feasible pathways for change.

In addition, systematic monitoring of city logistics developments is crucial to update expectations about plausible futures on time. This allows actors to deploy actions that mitigates undesirable developments and further embrace desirable ones.

Finally, the scenarios indicate that a structural investment in capacity building at local authorities is needed. For a long time, city logistics has been seen as a sector that worked best when governed based on a free market principle. As such, capacity of and attention from policy makers have been minimal. However, the analysis shows that a more active stance by local governments is expected in all scenarios that go beyond business as usual. Thus, improving public policy capacity is deemed necessary.

6. Conclusions

"The future belongs to those who prepare for it today." - Malcolm X

This study aims to identify plausible futures for last-mile logistics by formulating a set of scenarios for the year 2035. Scenarios are a powerful tool in informing future pathways as they aid last mile logistics stakeholders to rehearse the future. They are not meant to predict the future, but to prepare for which range of potential future development is considered plausible. The presented scenarios provide insights in the expectations of stakeholders and their arguments, thus allowing for better informed decision-making of individual and collective in anticipating certain future pathways. Additionally, an analysis across scenarios allows which values and beliefs are underlying future images, and which developments are expected to be necessary building blocks for specific futures. This then allows to identified expected barriers and enables for more sustainable last-mile logistics which in turn can support stakeholders, and especially local policy makers, navigating the uncertain future of last-mile logistics.

The presented scenarios are based on a specific urban context, as all 26 participants in the Delphi expert panel are involved in last-mile logistics in the European cities Bremen, Groningen and Mechelen. These cities are characterized by a compact urban form, with historical centers and high levels of non-motorized transportation in last-mile delivery (Plazier & Rauws 2021). Moreover, all three cities can be considered front-runners in transitioning towards sustainable urban logistics.

Using a Disaggregative Policy Delphi method, which explicitly explores alternative futures, six scenarios have been identified:

- **Old Wild West -** "No active government involvement and lack of incentives for innovation and cooperation."
- **New Wild West -** "Last-mile logistics is shaken up, with high levels of innovation but low regard for sustainability."
- **New Cool Collective -** "Shared beliefs and a shared course of action lead to sustainable last-mile logistics."
- **Revolution By Design -** "Sustainability in last-mile logistics is reached at the hand of local authorities."
- **Thriving, Individually -** "A mix of restrictive and facilitative policies spur technological innovation but result in limited cooperation between stakeholders."
- **Good Intentions Abound -** "High levels of government initiative amidst low stakeholder cooperation and low market innovation."

The analysis of the scenarios shows that in all identified futures it is expected that last-mile logistics remains an integral part of inner cities. This is to say that logistics flows and functions will be at the heart of cities in 2035, as much as it is today. Interestingly, a more active role

by local governments is part of all scenarios. This indicates that the actor arena will be fundamentally different from today, as presently local governments are mostly absent. Across the active role of government takes various forms, including legal standards, access restrictions, facilitation of experiments and partnerships with private initiatives. However, despite this expected active role of local governments the actual changes in the organization and operation of last-mile logistics are attributed to private stakeholder actions. In doing so, much is expected from technological innovations, including shared data platforms, automate vehicles and unattended pick-up points. These expected are driven by both a confidence in technological solutions and a hope that technology will bring desired change. Finally, the analysis of the scenarios indicate disbalance between public and private action can hamper further development of the last-mile sector, meaning that last-mile logistic systems will get stuck in more of the same (*New Wild West*), or that efforts of local government are not met with investments of private stakeholders and new types of operators (*Good Intentions Abound*).

The analysis of the future images of the stakeholder panel indicates that a transition towards more sustainable city logistics is not a given. Innovations in modes of transport, consolidation and cooperation can be substantial, but these can be more technology-driven or based on changing consumer preferences, rather than sustainability-driven. Moreover, limited trust between stakeholders, a lack of knowledge, capacity and budgets within local government, and a fierce competition between operators are identified as potential barriers for transitioning towards sustainable last-mile logistics.

A transition towards sustainable last-mile logistics is envisioned in two distinct futures. One in which public and private actors join forces to fundamentally re-organise logistics transportation, delivery modes, consolidation, data management (*New Cool Collective*). The other one is based on the conviction that local public government have set a comprehensive set of conditions and requirements that enforce the development of a more sustainable logistics systems (*Revolution by Design*). Regardless of which future one would embrace, the analysis points out that enabling pathways to sustainable last mile logistics requires a strong vision and policy implementation by local governments, societal pressure on reducing environmental impact and improving livability, and the introduction of new technology and business models that embrace sustainability as their main principle.

Acronyms

Acronym	Meaning
AI	Artificial Intelligence
AV	Autonomous Vehicles
B2B	Business-to-business
B2C	Business-to-consumer
B2G	Business-to-government
CEP	Courrier-, express- and parcel services
D	Deliverable
EC	European Commission
GA	Grant Agreement
ICT	Information and Communication Technology
LF	Load Factor
LSP	Logistics Service Provider
O	Objective
ODD	On-demand Delivery
P	Product
PPP	Public Private Partnership
PM	Person Month
SUMP	Sustainable Urban Mobility Plan
SULP	Sustainable Urban Logistics Plan
T	Task
UC	Use Case
UCC	Urban Consolidation centre
UFT	Urban Freight Transport
ULaaDS	Urban Logistics as an on-Demand Service
WBS	Work Breakdown Structure
WP	Work Package
VUR	Vehicle Utilisation Rate
ZE	Zero Emissions
ZEV	Zero Emission Vehicle

References

Academic literature

Anderson D.L. & Lee, H.L. (2000) The internet-enabled supply chain: From the “first click” to the “last mile”. Achieving supply chain excellence through technology. San Francisco (CA): Montgomery Research; 2002. p16.

Allen, J., Browne, M., Woodburn, A., & Leonardi, J. (2012) The role of urban consolidation centres in sustainable freight transport. Transport Reviews, 32(4), p473-490.

Ballantyne, E.E.F., Lindholm, M. and Whiteing, A. (2013) A comparative study of urban freight transport planning: addressing stakeholder needs. Journal of Transport Geography, Vol. 32, p93–101.

Bergqvist, R. and M. Pruth (2006) Public/Private Collaboration in Logistics: An Exploratory Case Study, Supply Chain Forum: an International Journal 7,(1), 106-116.

Bosona, T. (2020) Urban Freight Last Mile Logistics—Challenges and Opportunities to Improve Sustainability: A Literature Review. Sustainability, 12, no. 218769.

Cruijssen, F., Cools, M., and Dullaert, W. (2007) Horizontal cooperation in logistics: Opportunities and impediments. Transportation Research Part E, 43, p129–142.

Dalmolen, S., Bastiaansen, H., Moonen, H., Hofman, W., Punter, M., and Cornelisse, E. (2018) Trust in a multi-tenant, logistics, data sharing infrastructure: Opportunities for blockchain technology. Proc. 5th Int. Physical Internet Conf. (IPIC), 2018, p299–309

Dror, Y. (2006) Training for policymakers. In : M. Moran, M. Rein, R.E. Goodin (Eds.).The Oxford handbook of public policy, Oxford University Press (2006), p80-108

Hsieh, H.F & Shannon, S.E. (2005) Three approaches to qualitative content analysis, Qualitative Health Research, 15(9), p1277–1288

Iwan S. (2016) Implementation of telematics-based good practices to support urban freight transport systems, applying a city’s adaptability level. International Journal of Shipping and Transport Logistics, 8(5), p531–551

Van Dorsser, C., Walker, W. E., Taneja, P., and Marchau, V. A. (2018) Improving the Link Between the Futures Field and Policymaking. Futures, 104, p75-84

Holguin-Veras, J., Amaya Leal, J., Sanchez-Diaz, I., Browne, M., Wojtowicz, J. (2018) State of the art and practice of urban freight management: Part I: Infrastructure, vehicle-related, and traffic operations. Transportation Research Part A: Policy and Practice, 137, p360–382 Contents

Kiba-Janiak (2017) Opportunities and threats for city logistics development from a local authority perspective. Journal of Economics and Management, 28-2, p23-39

Lachapelle, U., Burke, M., Brotherton, A., & Leung, A. (2018) Parcel locker systems in a car dominant city: Location, characterisation and potential impacts on city planning and consumer travel access. Journal of Transport Geography, 71, p1-14.

Lindholm, M. & Browne, M. (2013) Local authority cooperation with urban freight stakeholders: A comparison of partnership approaches. European Journal of Transport and Infrastructure Research, 13 (1), p20-38.

Muñuzuri, J., Larrañeta, J., Onieva, L. and Cortés, P. (2005) Solutions applicable by local administrations for urban logistics improvement. Cities, 22(1), p15-28.

Parkhe, A. (1993) Strategic alliance structuring: A game theoretic and transaction cost examination of interfirm cooperation. Academy of Management Journal, 36, p794–829

Quak, H. (2012) Improving urban freight transport sustainability by carriers – Best practices from The Netherlands and the EU project CityLog. Procedia - Social and Behavioral Sciences 39, p158 – 171

Quak, H., Kok, R., & den Boer, E. (2018) The Future of City Logistics–Trends and Developments Leading toward a Smart and Zero- Emission System. City Logistics 1: New Opportunities and Challenges, p125-146.

Quak, H. & Kin, B. (2020) The impact of future delivery models in last-mile home deliveries. 4th International Conference Green Cities 2020 – Green Logistics for Greener Cities, 3-5 June 2020, Szczecin, Poland

Rudolph, C., & Gruber, J. (2017) Cargo cycles in commercial transport: Potentials, constraints, and recommendations. Research in transportation business & management, 24, 26-36.

Rikkonen, P. & Tapio, P. (2009) Future prospects of alternative agro-based bioenergy use in Finland-constructing scenarios with quantitative and qualitative Delphi data. Technological Forecasting and Social Change, 76, p978–990.

Savelsbergh, M. & Van Woensel, T (2016) City logistics: Challenges and opportunities. Transportation Science 50(2) 579–590.

Tapio, P., Paloniemi, R., Varho, V., & Vinnari, M. (2011). The unholy marriage? Integrating qualitative and quantitative information in Delphi processes. Technological Forecasting and Social Change, 78(9), p1616–1628.

Thoma, L., & Gruber, J. (2020) Drivers and barriers for the adoption of cargo cycles: an exploratory factor analysis. Transportation Research Procedia, 46, p197-203.

Varho, V. & Tapio, P. (2013) Combining the qualitative and quantitative with the Q2 scenario technique—the case of transport and climate. Technological Forcasting and Social Change, 80 (4), p611–630

Witkowski, J & Kiba-Janiak, M. (2014) The Role of Local Governments in the Development of City Logistics. Procedia - Social and Behavioral Sciences, 125, p373-385

Zenezini, G., Lagorio, A., Pinto, R., De Marco, A., & Golini, R. (2018). The collection-and-delivery points implementation process from the courier, express and parcel operator's perspective. IFAC-PapersOnLine, 51(11), p594-599.

Reports

ALICE-ETP & POLIS (2021). "Cities-Regions and companies working together. Guide for advancing towards zero-emission urban logistics by 2030". Report. https://www.etp-logistics.eu/wp-content/uploads/2021/12/POLIS_ALICE_Guide-Zero-Emission-Urban-Logistics_Dec2021-low.pdf

Buijs, P. & Ozyavas, P. (2021) "Benchmarking & state-of-the-art". ULaaDS D3.1: Benchmarking business/operating models and best practices. Report. https://ulaads.eu/wp-content/uploads/2021/07/D3.1_Benchmark.pdf

CiViTAS (2015) "Policy note: Smart choices for cities. Making urban freight logistics more sustainable". Report. https://civitas.eu/sites/default/files/civ_pol-an5_urban_web.pdf

Cushman Wakefield (2017) "Urban Logistics Space: the urban real estate challenge?" Report. https://www.cushmanwakefield.com/-/media/cw/emea/united-kingdom/insights/download-pdfs/2017-cushman-wakefield-urban-logistics-report.pdf

DHL (2018) "Logistics Trend Radar", 5th edition. Report. https://www.dhl.com/content/dam/dhl/global/core/documents/pdf/glo-core-logistics-trend-radar-5thedition.pdf

ELTIS (2018) "Planning sustainable urban logistics" Website. https://www.eltis.org/resources/tools/planning-sustainable-urban-logistics

European Commission (2019) “Topic guide: Sustainable urban logistics planning”. Report. https://www.eltis.org/sites/default/files/sustainable_urban_logistics_planning_0.pdf

ITF (2021) “Transport Outlook 2021”. International Transport Forum. Report. https://www.oecd-ilibrary.org/sites/0c13b23d-en/index.html?itemId=/content-/component/0c13b23d-en

McKinsey (2016) “Parcel delivery: the future of last mile”. McKinsey & Company: Transport and Logistics, September 2016.

McKinsey (2018) “Fast forwarding last-mile delivery – implications for the ecosystem”. McKinsey & Company: Transport and Logistics, 2018.

Plazier, P.A. & Rauws, W.S. (2021) “What’s in store in last-mile logistics?” ULaaDS D2.3: Provisional trend report - based on a stakeholder perspective on trends shaping urban logistics in Western Europe between 2020 and 2035. https://ulaads.eu/wp-content/uploads/2021/10/D2.3_Provisional_trend_report.pdf

PWC (2019) “Five forces shaping last-mile logistics”. PwC CEE Transport & Logistics Trend Book 2019. https://www.pwc.com/m1/en/industries/documents/transport-logistics-trendbook-2019-en.pdf

Rauws, W.S. & Plazier, P.A. (2021) “Getting uncertainties on the radar in urban logistics policies”. ULaaDS D6.1: Typology of uncertainties in policy making and urban planning for sustainable urban logistics. https://ulaads.eu/wp-content/uploads/2021/10/D6.1-Getting-uncertainties-on-the-radar-in-urban-logistics-policies-.pdf

Roland Berger (November 2018) “Stronger together: Keep the Wild West scenario at bay with cooperation – Urban logistics 2030 in Germany. Report. https://www.rolandberger.com/publications/publication_pdf/roland_berger_urban_logistics.pdf

Ruppert Consult (2019) “Guidelines for Developing and Implementing a Sustainable Urban Mobility Plan”, Second Edition. Online: https://www.eltis.org/sites/default/files/sump_guidelines_2019_interactive_document_1.pdf

Troppe, M & Illek, G (2021) “The implementation of a multi-stakeholder approach in urban logistics”. ULaaDS D2.2: Local ecosystem stakeholders` needs and requirements & prioritization of use cases. https://ulaads.eu/wp-content/uploads/2022/01/D2.2-Local-ecosystem-stakeholders-needs-and-requirements-priorisation-of-use-cases-first-version.pdf

World Economic Forum (2020) “The Future of the Last-Mile Ecosystem”. Report. https://www3.weforum.org/docs/WEF_Future_of_the_last_mile_ecosystem.pdf