Ref. Ares(2021)2406165 - 08/04/2021

D1.5

Reference LEAD Strategies

Deliverable number: (D.1.5)
Author(s): B.Groothedde, B.Schultz, M.de Jong
Author’(s’) affiliation (Partner short name): ARG

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 861598

THE CIVITAS INITIATIVE IS CO-FINANCED BY THE EUROPEAN UNION

Deliverable No.		1.5	
Work package No.	1	Work package Title	Adaptative city logistics Framework and Value Cases
Task No.	1.5	Task Title	LEAD Strategies
Date of preparation of this version:		6/03/2021	
Authors:		B.Groothedde B.Schultz M.de Jong	
Status (F: final; D: draft; RD: revised draft):		D	
File Name:		LEAD – Deliverable 1.5 LEAD Strategies_vf.docx	
Version:		4.0	
Task start date and duration		01/06/2020 – 15/03/2021	

This document is issued within the frame and for the purpose of the LEAD project. This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 861598.

The views represented in this document only reflect the views of the authors and not the views of the European Commission. The dissemination of this document reflects only the author's view and the European Commission is not responsible for any use that may be made of the information it contains.

Revision History

Version No.	Date	Details
0.1	23/07/2020	1st draft version
0.2	05/11/2020	First review: UPM, MOLDE (informal)
0.5	04/12/2020	Informal review structure (internal)
0.9	15/2/2021	First draft review
1.0	15/2/2021	Updated version based on ZLM review
2.0	17/2/2021	Updated version based on UPM review
3.0	19/2/2021	Final version

Reviewers List

Name	Company	Date	Signature
Beatriz Royo	ZLC	11.03.2021	
Carolina Cipres	ZLC	13.03.2021	
Laura Garrido	UPM	16.03.2021	

Contents

1 Introduction 13

1.1 Overall scope and objectives LEAD 13

1.2 Objectives and scope of this deliverable 1.5 15

1.3 How does this deliverable relate to other deliverables? 17

1.4 Structure of the document 18

2 Methodological approach 20

2.1 Setting the stage: Definitions 20

2.1.1 City typology 22

2.1.2 Morphology / Size of the zone 23

2.1.3 Logistics profile 24

2.1.4 LEAD City Typology 25

2.2 Stakeholders analysis & role of the public sector 25

2.3 The urban freight transport market 26

2.4 Review of existing measures & practices 29

2.5 From Measures to Value case scenarios and policies 32

2.5.1 Public policy issues generated by UFT 33

2.5.2 Impacts and challenges 35

3 City logistics in the era of on-demand economy 36

3.1 Some dominant trends 36

3.1.1 E-commerce 37

3.1.2 On-demand economy 38

3.1.3 Urban Distribution Innovations 38

3.1.4 On-demand logistics and DTs 39

3.2 Factors influencing UFT: a survey 40

3.2.1 General Information 40

3.2.2 Influencing factors 41

3.2.3 The most influencing factors 43

4 Innovations agile storage & last-mile distribution 45

4.1 Delivery locations 46

4.1.1 Parcel Lockers 46

4.1.2 Pick-up points 48

4.1.3 Door to Car 49

4.2 Delivery mode 50

4.2.1 Click & Collect and Try & Buy 50
4.2.2 Crowdshipping 51
4.2.3 Instant delivery 52
4.3 Delivery times 53
4.3.1 Night deliveries 53
4.4 Management of loading and unloading areas 54
4.5 Consolidation 55
4.5.1 Urban Consolidation Centres 55
4.5.2 Micro-hubs 57
4.5.3 Mobile Depot and small EVs 59
4.6 New technologies 60
4.6.1 Automated and Autonomous delivery systems 60
4.6.2 Cloud Computing, AI and Data Collection through the Internet of Things 63
5 Towards a LEAD Strategy Longlist 65
5.1 LEAD Strategy Longlist 65
5.2 The link between Sustainability and the LEAD Strategy Longlist 69
5.3 Value case scenarios 73
5.3.1 LL1 Madrid value case 74
5.3.2 LL2 Hague value case 75
5.3.3 LL3 Lyon Value case 76
5.3.4 LL4 Budapest Value case 77
5.3.5 LL5 Oslo Value case 78
5.3.6 LL6 Porto Value case 79
6 Feasible combinations: LEAD Policies 81
6.1 Policy impact modelling and evaluation 81
6.1.1 Outputs 81
6.1.2 Measures 82
6.2 Synthesis of the results: Example policies 84
6.2.1 Focus on regulation 85
6.2.2 Efficient deliveries 86
6.2.3 Low emission vehicles 86
7 Conclusions and next steps 88
8 References 90
Annex 1 : Zoning 107
Annex 2 : Value case examples in Europe 110

Annex 3 : List of logistics measures 111
Annex 4 : Logistics Profile Characteristics 114
Annex 5 : Sustainability impact analysis 116

List of tables

Table 2: Deliverable's adherence to LEAD objectives and Work Plan. 17
Table 3: LEAD City Typology 25
Table 4: Distribution innovations. Adapted from He&Haasis, (2019) 38
Table 5: LEAD Strategy Longlist (1) 66
Table 6: LEAD Strategy Longlist (2) 67
Table 7: LEAD Strategy Longlist (3) 68
Table 8: LEAD Strategy & Sustainability dimensions overview (1) 70
Table 9: LEAD Strategy & Sustainability dimensions overview (2) 71
Table 10: LEAD Strategy & Sustainability dimensions overview (3) 72
Table 11: LL1 Madrid Value case overview of measures for scenario 4 75
Table 12: LL2 The Hague Value case overview of measures for scenario 4. 76
Table 13: LL3 Lyon Value case overview of measures for scenario 4 77
Table 14: LL4 Budapest Value case overview of measures for scenario 4 78
Table 15: LL5 Oslo Value case overview of measures for scenario 4 79
Table 16: LL6 Porto Value case overview of measures for scenario 4 80
Table 17: Relationship between measure and Output-category 84
Table 18: Regulation Policy Focus 85
Table 19: Efficient Deliveries Policy 86
Table 20: Low Emission Policy 87
Table 21: Overview of Value cases 110
Table 22: LEAD Urban freight logistics measures 111
Table 23: LEAD Urban freight logistics measures: delivery mode 111
Table 24: Type of vehicles charging stations 111
Table 25: Type of vehicle entering in the LEZ 112
Table 26: LEAD Urban freight logistics measures: others 112
Table 27: Logistics Profile overview 114

Table 28: Economic dimension: Cost consequence indicators description. 116

Table 29: Economic dimension: urban space needs consequence indicators description. 116

Table 30: Economic dimension: idle time consequence indicators description 117

Table 31: Economic dimension: urban freight transport service level indicators description 117

Table 32: Economic dimension: willingness to collaborate 117

Table 33: Environmental dimension: Climate change consequence indicators. 118

Table 34: Environmental dimension: air quality consequence indicators 118

Table 35: Environmental dimension: noise consequence indicators. 118

Table 36: Environmental dimension: energy consumption indicators. 118

Table 37: Social dimension: Employment consequence indicators description. 119

Table 38: Social dimension: Data privacy and cybersecurity concerns consequence indicators. ... 119

Table 39: Social dimension: Social acceptance consequence indicators. 119

Table 40: Environmental dimension: CIs continuum performance. 120

Table 41: Social dimension: CIs continuum performance. 121

Table 42: Economic dimension: CIs continuum performance. 122

List of figures

Figure 1: Overview of the LEAD measures categories....12
Figure 2: LEAD Strategies and Innovation Drivers. LEAD (2018). 14
Figure 3: Overall relations between Work Packages....18
Figure 4: Sectors/Industries in the Urban Area 27
Figure 5: Overview of the LEAD measures categories....31
Figure 6: Main components of the consequence analysis....35
Figure 7: Results survey Deliverable 1.1 [LEAD, (2021a)]. 42
Figure 8: Overview of UFT value case scenarios....73
Figure 9: zoning in Urban Environment. Based on Rodrigue (2020) 107

Abbreviations

Abbreviation	Explanation
AI	Artificial Intelligence
ABM	Agent Based Model
B2B	Business to business
B2C	Business to consumers
C2C	Consumers to consumers
CID	Central Innovation District
CNG	Compressed Natural Gas
CoP	Community of Practice
EDV	Electric delivery vehicles
EV	Electric Vehicle
GHG	Greenhouse gases
GPS	Global Positioning System
HGV	Heavy good vehicles
IoT	Internet of Things
KPI	Key performance indicator
LEAD	Low-Emission Adaptive last-mile logistics supporting 'on Demand economy' through digital twins
LEZ	Low Emission Zone
LGV	Light good vehicles
LL	Living Lab
LNG	Liquified Natural Gas
PI	Physical Internet
PM	Particular matter
PPP	Public-private partnership
SPROUT	Sustainable Policy RespOnse to Urban mobility Transition
TEN-T	Trans European Transport Network
UCC	Urban consolidation centre
UFT	Urban freight transport

Executive Summary

City logistics is one of the essential elements of urban mobility planning. Also, the growth of e-commerce activities is a trend that has been reinforced by COVID-19 pandemic. The consequence is that last-mile flows are increasing with a high impact on cities. In this report, the results are presented of Work Package 1 (WP1) of the LEAD project. WP1 covered the first objective of the project providing the relevant contextual framework for the LEAD project. The background and expected developments of city logistics in Europe were listed and relevant strategies from the longlists of experiences and plans that are available were evaluated, depending on the specific city contexts when needed. These strategies, technologies and logistics concepts were organized and structured into a LEAD typology (captured and clustered in the LEAD Strategy Longlist) for urban distribution settings that can be tested in the LLs.

The results presented in Deliverables 1.1 to 1.4 form the basis of this document and will be often referred to. Based on the review of existing measures & practices a longlist of strategies is derived and presented in this work package. The majority of the strategies were already presented in Deliverable 1.1 and were complemented in this document with additional measures to come up with the complete longlist of LEAD strategies. In Chapter 3 the results of the Survey that was presented at length in Deliverable 1.1 on the dominant trends in Urban Freight Transport (UFT) is summarised.

The LEAD Strategy Longlist

Key deliverable of this work package is presented below. In this graph, the nine LEAD Strategy Categories are presented. In total 68 LEAD Strategies are clustered in the 9 categories that cover the important sustainability dimensions (Economy, Social, Environment). In this deliverable a review of measures and practices that are employed is provided, mainly at a local level, to redress the balance between social cost and social benefit from UFT.

Next step will be to validate, test and apply these strategies and policies in the LLs and DTs. Based on the work in WP1 and strategies presented in this deliverable it is concluded that there now is a comprehensive set of strategies, clustered into 9 LEAD Strategy categories that will help to develop feasible and comprehensive scenarios and policies. This set of strategies will support the stakeholders in the LLs and DTs to develop feasible scenarios.

It provides the combination of innovations in logistics (consolidation, delivery, vehicle technology) but also provides stakeholders with strategies that focus on new business models and technology. For example, *Try&Buy*, *Click&Collect* and *Crowd Sourcing*. It also consists of concepts like *Block chain*, *Cloud computing* and *Logistics Market Places*.

Next to these innovations, a range of supporting strategies is presented on Regulation, Land-use, infrastructure and market-based measures because it is important the support the LEAD Specific strategies with the proper context and supporting measures to fully harvest their

potential. It is the combination of the different LEAD strategies from the nine categories that make up for a successful scenario or policy to tackle a specific challenge in UFT. This was experienced in the LLs through the value case and the additional policy examples in Chapter 6. In order to help the different stakeholder in the LLs and in a later stage other EU cities, the LEAD strategies were linked to specific CIs and city types and logistics profiles.

Figure 1: Overview of the LEAD measures category

1 Introduction

1.1 Overall scope and objectives LEAD

In this report, the results are presented of Work Package 1 (WP1) of the LEAD project that aims to develop a range of logistics solutions for shared, connected and low-emission logistics operations, empowered by an adaptive modelling approach and DT models.

With the rise of on-demand logistics serious pressure is put on last-mile delivery systems. And although these activities have continually contributed to the economic growth of cities, they also have caused the majority of environmental externalities within urban areas. These negative externalities primarily consist of air pollution, congestion, noise, etc. [Anderson, *et al.*, (2005); Wittlöv, (2012)]. Therefore, considerable research has focused on promoting sustainable urban freight transport alternatives [Zhangyuan&Haasis, (2020); Cui, *et al.*, (2015); Browne, *et al.*, (2019)].

Market pressure dictates responsive logistics systems that deliver customised products at low cost and transportation is a key driver behind economic development [Rassafi&Vaziri, (2005)]. Urban Freight Transport (UFT) has been defined as a process and a system to collect, transport, and distribute goods within urban areas and is the key focal point of this project.

The last-mile delivery market is developing fast through both large and small-scale consumer platforms, however economic incentives to create sustainable systems are weak. Cities, therefore, are confronted with possible negative consequences. As there is much uncertainty about the actual market developments and course taken by leading companies, such as parcel network integrators and major retailers, one cannot reliably predict the most likely developments for the next 20 years and propose feasible policies on that basis.

The LEAD project will create DTs of urban logistics networks in six cities (TEN-T urban nodes), to support experimentation and decision making with on-demand logistics operations in a public-private urban setting. City logistics solutions will be represented by a set of value case scenarios that address the requirements of the on-demand economy and the pressures caused by the increase of parcel deliveries, while aligning competing interests and creating value for all different stakeholders.

Each value case will combine a number of measures - referred hereafter as LEAD Strategies: a) *Innovative Business Models*, b) *Agile urban freight storage and last-mile distribution schemes*, c) *low emission, automated, electric or hybrid delivery vehicles*, and d) *smart data-driven logistics solutions* (Figure 1).

A balanced scenario will most likely have combinations of these strategies in place to cover the complete dynamics and complexity of a city's logistics challenges. The value case scenarios will incorporate opportunities for shared, connected and low-emission logistics

operations by considering four innovation drivers: Sustainability - Zero Emission Logistics, the Sharing Economy, Technology Advancements and the emerging Physical Internet (PI) paradigm (Figure 1).

PI concepts applied to urban logistics, integrating low-emission, connected (automated) delivery vehicles are especially pertinent, as this will ultimately lead to an optimised specification for the location and capabilities of 'city PI eco-hubs' and will automate routing, optimising the use of transport resources and storage facilities towards zero emissions solutions, while catering for the needs and wishes of contemporary consumers.

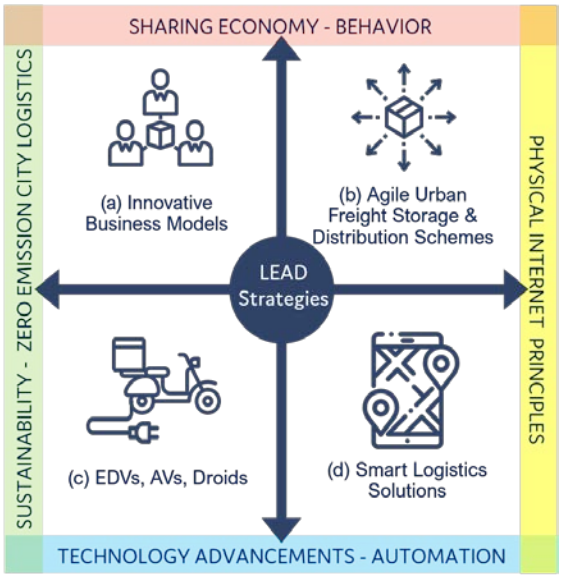

Figure 2: LEAD Strategies and Innovation Drivers. LEAD (2018).

Cost, environmental and operational efficiencies impact of the value case scenarios will be evaluated in our six intervention areas - from here onwards referred to as *Living Labs* (LLs) - with different logistics profiles, aimed at reaching a good representation of European cities. The long-term vision of LEAD is to design an open PI-inspired framework for smart city logistics that incorporates the six LL DTs created in the project, thus setting the foundations for the development of large-scale city DTs[1]. Cost, environmental and operational efficiencies will be achieved through **a combination of measures**, referred to as LEAD Strategies (Figure 1), including:

[1] *LEAD contributes to the LC-MG-1-10-2019 topic scope by "Developing value cases for integrated systems of logistics/ freight operations in urban, metropolitan and peri-urban areas, such as TEN-T urban nodes and consolidation centres in urban areas (Objectives 1 and 3)"*

(a) Innovative business models: Crowdshipping, space and transport capacity sharing schemes, collaborative urban logistics, Public-Private Partnerships (PPPs), consumer incentives to more sustainable behaviours.

(b) Agile urban freight storage and last-mile distribution schemes: New consolidation solutions i.e. mobile depots or Urban Consolidation Centres (UCC), alternative delivery drop-off options like secure lockers or local stores; modelling of the proximity of stations or the location of hubs on the basis of PI concepts and optimising routes.

(c) Low emission, automated, electric or hybrid delivery vehicles like cargo-bikes, delivery robots, AVs, droids and walkers.

(d) Smart logistics solutions for transport management and optimisation of routing, route planners, freight/space matching platforms, dynamic pricing systems.

Experimentation with what-if scenarios will allow making informed decisions and choosing the optimal set of measures for each case (involved city), for example promoting the re-design of a parking area as a transhipment hub to shorten the last-mile instead of installing lockers in the city centre. Other factors that influence last-mile logistics operations will be explored through simulation (higher occupancy rates of vehicles, encouraging consumers to adopt more sustainable behaviours - even including gamification experiments when applicable, implementing the right economic incentives for businesses), to name a few examples.

1.2 Objectives and scope of this deliverable 1.5

With the overall context of the LEAD project in mind, the objectives and scope of the projects' first deliverables are presented below. Work Package 1 (WP1) covered the first objective of the project providing the relevant contextual framework for the LEAD project. The background was framed and expected developments of city logistics in Europe were listed. The most relevant strategies are included on the longlists. These strategies, technologies and logistics concepts are organized and structured into a LEAD typology (captured and clustered in the LEAD Strategies Longlist) for urban distribution settings that can be tested in the LLs.

Three sub-objectives are defined for WP1:

1. Set up the LLs in 6 cities engaging stakeholders across the supply chain for local last-mile solutions co-creation. This objective is covered at length in Deliverable 1.4 [LEAD, (2021d)]. Multi-stakeholder communities of practice in six cities (LLs) were established to contribute to the co-development of sustainable on-demand freight mobility systems and analysed the factors (strategic, regulatory, business, technology, environmental) influencing complex city logistics systems through a consolidated survey of the current needs, trends and challenges of last-mile logistics.

2. Create a library of reference models to be used as the baseline for the development of DTs which can be found in Deliverable 1.2 [LEAD, (2021b)].

3. Investigate the factors influencing complex city logistics systems in the era of on-demand economy and evaluate innovative delivery vehicles and enablers/barriers for their integration in urban logistics. In addition, typologies of agile urban freight storage and distribution schemes, including PI enabled approaches. All these activities were presented in Deliverable 1.1 [LEAD, (2021a)].
    -
4. Innovative business models, relevant for last-mile logistics and the on-demand economy are included in Deliverable 1.3 [LEAD, 2021c)], including the analysis of regulatory and collaboration barriers, data sharing and privacy concerns and PPP incentives from different stakeholder perspectives.

In this Deliverable 1.5 the results are presented of the final task of this work package in which the results of the other WP1 tasks are synthesised. Build upon the work that was done in the previous four Deliverables the results found in detail in Deliverables 1.1 - 1.4 were summarised and combined. This resulted in a set of more than 68 so-called LEAD strategies.[2]

The overall deliverable consisted of several subtasks*:*

1) Longlist of city logistics measures for all stakeholders (*ST1.5.1*): In this task, all the insights are taken together, structured and enriched to arrive at a set of LEAD Strategy Longlist that will be candidate strategies to be applied in first the six LLs in the LEAD project, and going forward also for cities in general.

Based on an extensive review, relevant literature is carefully evaluated and used to describe the proposed measures as part of this deliverable and to construct a longlist.

2) Develop a LEAD Categorization/Typology of city logistics measures (*ST1.5.2*): As a next step, the selected LEAD strategies were categorized based on the four innovation drivers: a) innovative business models, b) agile urban freight storage and last-mile distribution schemes, c) low emission, automated, electric or hybrid delivery vehicles, and d) smart logistics solutions.

The longlist consists of strategies that comprise of single measures that can be taken by either commercial or public stakeholders. In most real-life city logistics situations, there will be no single silver bullet solution to the multi-faceted city logistics policy challenges. Therefore, a selection of LEAD policies, that are logical combinations of various LEAD strategies (Chapter 6) is presented to apply the list of strategies.

[2] *See Section 2.1 for the definitions on some key concepts we use in the LEAD project.*

3) Describe LEAD policies using city logistics profiles (*ST1.5.3*). The right policy depends on a city's characteristics. A city typology was developed that was used to illustrated typical policies using the longlist and typology.

Deliverable 1.5 adherence to LEAD Objectives		
LEAD GA requirements	**Section(s) of present deliverable addressing LEAD GA**	**Description**
Longlist of city logistics measures (ST1.5.1)	In Chapter 2, 3 and Chapter 5 the innovations on agile storage and last-mile distribution are gathered and complemented with additional measures to derive a Long-List of city logistics measures.	In this deliverable, all the insights are taken together, structured and enriched to arrive at a set of LEAD Strategy Longlist that will be candidate strategies to be applied in first the six LLs in the LEAD project, and going forward also for cities in general.
LEAD Categorization / Typology of city logistics measures (*ST1.5.2)*	Based on the longlist the measures were clustered into 9 main LEAD Strategy categories. Chapter 2, Chapter 5 present the typology and categorization.	Based on the four innovation drivers: a) innovative business models, b) agile urban freight storage and last-mile distribution schemes, c) low emission, automated, electric or hybrid delivery vehicles, and d) smart logistics solutions the strategies were clustered.
LEAD policies/strategies using city logistics profiles (*ST1.5.3*)	Chapter 2 focuses on logistics profiles in city logistics and the LEAD City Typology that is linked to the individual LEAD Strategies. In Chapter 5 and Chapter 6 the combinations of LEAD Strategies (policies) are presented.	We used a Logistics Profile typology to characterise urban land use and logistics and delivery requirements. The concept was based on the hypothesis that it is possible to identify, for some well-defined areas inside a city, reasonably homogenous groups of logistics needs.

Table 1: Deliverable's adherence to LEAD objectives and Work Plan.

1.3 How does this deliverable relate to other deliverables?

This deliverable synthesises all the WP1 insights to arrive at the LEAD strategies that will be a candidate to be applied in first in the six LLs. In the figure below, the overall structure of the LEAD project is presented and relations between the Work Packages are depicted. Denoted in green are the tasks covered in WP1.

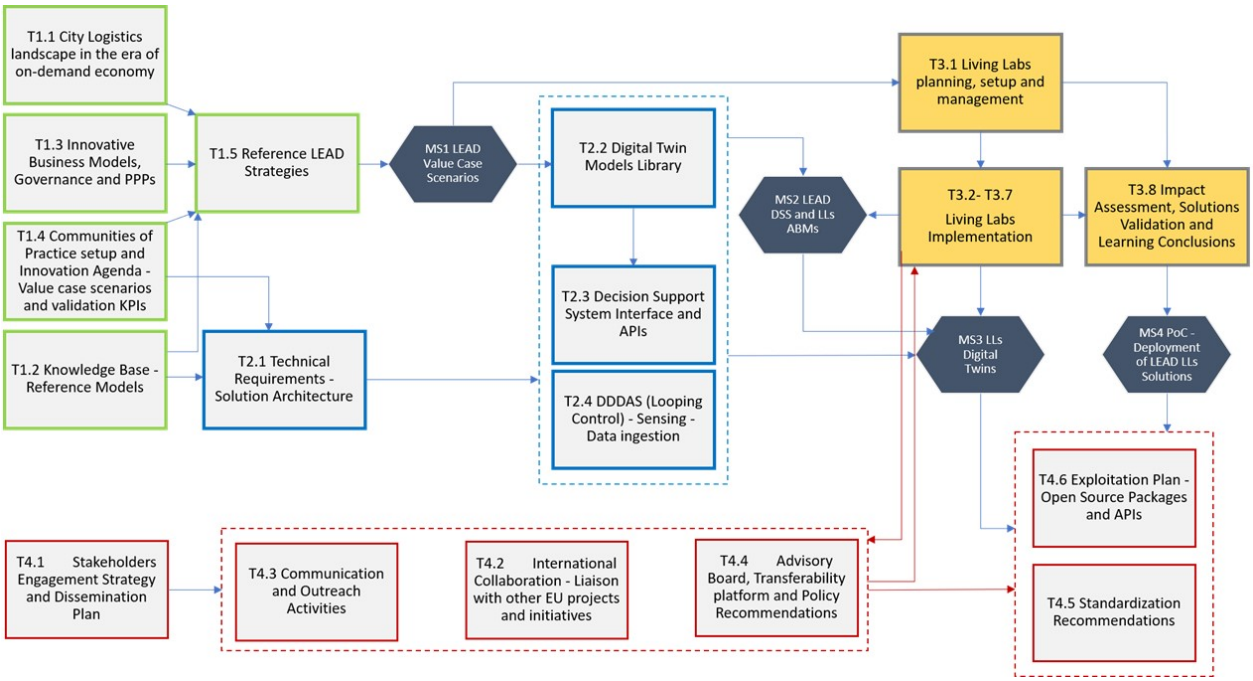

Figure 3: Overall relations between Work Packages

1.4 Structure of the document

The structure of this document is as follows: first, an overview of the methodology that is used to derive the longlist of strategies and present our definitions is presented.

The basis for this deliverable is formed by:

LEAD, (2021a). Deliverable 1.1: City Logistics landscape in the era of on-demand economy. Main challenges, trends and factors influencing city logistics. E.Marcucci (MOLDE), V.Gatta (MOLDE), and G. Lozzi (POLIS).

LEAD, (2021b). Deliverable 1.2: Knowledge Base – Reference Models. R.Tapia, and I. Kourounioti (TUDelft)

LEAD, (2021c). Deliverable 1.3: Innovative Business Models, Governance and Public-Private Partnerships, Knowledge for innovative actions, measures and business models in the LEAD Living Labs. E.Marcucci (MOLDE), V.Gatta (MOLDE), and G.Lozzi (POLIS).

LEAD, (2021d). Deliverable 1.4: Innovation Agenda - Value case scenarios and validation KPIs. B. Royo (ZLC), C. Ciprés (ZLC), S.Lekkakos (ZLC), S. Fernández (EMT), D.Latorre (CITYLOGIN), J.M.Vasallo(UPM), N. Sobrino (UPM), R. Tapia (TUDELF), Y. Brian (IRT SYSTEMS), J. Miczki (BKK), S. Bràthen (MOLDE), and N. Goveia (SONAE)

In Chapter 2 the stakeholders, urban environment are discussed and a short summary of the work is provided that was conducted and presented in Deliverable 1.4 on the impacts and challenges: *Sustainability Dimensions*.

In Section *2.4* the methodology that was used to derive the longlist of strategies is discussed. The majority of the strategies were listed in Deliverable 1.1 and in this document complemented with additional measures to come up with the complete list of LEAD strategies.

In Chapter 3 the results of the survey that was presented at length in Deliverable 1.1 on the dominant trends in UFT are summarised.

Chapter 4 provides an overview of the results of Deliverable 1.1 on innovations that form the backbone of the longlist of LEAD strategies.

Chapter 5 is dedicated to the Longlist itself and the categories that were used to classify the individual LEAD strategies. In addition, the individual strategies are linked to the Sustainability Dimensions and an illustration is provided of how the longlist can be used through some examples from the LLs.

Chapter 6 summarises the results of Deliverable 1.3 where the link between design questions and models is made. In addition, we present a few relevant typical UFT policies that make a logical combination of LEAD strategies to tackle specific UFT challenges.

2 Methodological approach

The analysis included in this work package is primarily based on the cited deliverable in Section 1.4 and the work done by the authors and contributors of WP1 is greatly acknowledged: E.Marcucci (MOLDE), V.Gatta (MOLDE), G. Lozzi (POLIS), R.Tapia (TUDelft), I. Kourounioti (TUDelft), B. Royo (ZLC), C. Ciprés (ZLC), S.Lekkakos (ZLC), S. Fernández (EMT), D.Latorre (CITYLOGIN), J.M.Vasallo (UPM), N. Sobrino (UPM), Y. Brian (IRT SYSTEMS), J. Miczki (BKK), S. Bràthen (MOLDE), and N. Goveia (SONAE).

Surveys
An important approach that was used in WP1. A number of surveys were carried out to consult the relevant stakeholders and gain insight into the main challenges, trends and factors influencing city logistics and assess the anticipated impact of specific value case scenarios.

Literature review
Another important step in WP1 was the review of the large body of literature in UFT. Our review consisted of the review surveys of books, scholarly articles, and any other sources relevant to UFT.

Secondary research
Research on, and analysis of, practices and measures in Europe, particularly at a local level, that aims to secure sustainable urban distribution. Our team carried out desk research into practices and measures that have been used in specific cities. The value cases have generally been reviewed at the city level, rather than considering individual measures, to show how a mix of measures and practices were employed.

Consultation: As well as the workshops and interviews that were completed, further evidence was obtained from meetings with subject matter experts.

2.1 Setting the stage: Definitions

Before the results of WP1 are presented, first some context and definitions of UFT are provided, City logistics and other relevant concepts in the urban environment. UFT accounts for about 10-15% of kilometres travelled and emits approximately 6% of all transport-related GHG emissions [Civitas, (2014)]. It accounts for between 2% and 5% of the total workforce employed in urban areas and it is estimated that between 3% and 5% of urban land is reserved for logistics activities [Macario, (2012)].

As cities have multiple functions people not only reside in them; they are also workplaces and places for education, leisure, production, administrations, shopping and health care which turns them into dominant centres of production and consumption. More and more people live in cities. In 2012, 200 million Europeans lived in densely populated areas [EU, (2014)]. More than 80% of global domestic product is created in cities [World Bank, (2013)]. Without frequent and reliable UFT both urban production and consumption would come to a stop and

the city would lose a part of its attractiveness and competitiveness [Browne, (1999); Allen *et al.*, (2000); Rodrigue, *et al.*, (2006); Lindholm&Behrends, (2012)].

And with the rise of on-demand logistics serious pressure is put on last-mile delivery systems and although these activities have continually contributed to the economic growth of cities, they also have caused the majority of environmental externalities within urban areas. These negative externalities primarily consist of air pollution, congestion, noise, etc. [Anderson, *et al.*, (2005); Wittlöv, (2012)]. Therefore, considerable research has focused on promoting sustainable UFT alternatives [Zhangyuan & Haasis, (2020); Cui, *et al.*, (2015); Browne, *et al.*, 2019]. A common, but controversial, definition of sustainable development was provided by Brundtland Commission (1987): "*it meets the needs of the present without compromising the ability of future generations to meet their own needs*".

Many different terms are used to refer to the transport of goods within, into, through or out of a city or urban area. There are no common definitions. In literature various terms are used to refer to the general concept of the transportation of goods and waste in urban areas; *Urban Goods Movement* [Ogden, (1992)], *City Logistics* [Tanaguchi, *et al.*, (2001)], *UFT* [Allen, *et al*., (2000); and Urban Distribution [Lindholm, (2012)].

A simple definition [Alice, (2014)] of freight transport in cities is: *all movements of goods in to, out from, through or within the urban area made by light or heavy vehicles, including service transport and demolition traffic as well as waste and reverse logistics*.

Although the definition is simple, it includes a huge variety of very different transport operations and logistics activities and requirements. What most definitions have in common is that they touch upon three aspects: Transportation, Geography and Commodity.

As presented by Verlinde (2015), there are various definitions of UFT, but for the purposes of this study it is defined as:

The movement of freight vehicles whose primary purpose is to carry goods into, out of and within urban areas and includes the system to collect, transport, and distribute goods within urban areas.

In recent years, the concept of the *Smart City* has increasingly become a popular topic in the academic field. This concept has arisen as a solution for improving the sustainability and liveability of cities through the effective urban management of governance, energy, and transportation [Hammad *et al*., (2019); Ferraris *et al.*, (2018)]. Since 2018, some research has focused on the topic of sustainable transport for smart cities, which primarily surround smart mobility. See for example Al-Thani *et al*. (2018); Freudendal-Pedersen, *et al.* (2019); and Zhangyuan&Haasis, (2020) on the impacts of mobility on smart cities, particularly on the aspects of automation and sustainability. Tobey *et al.* (2019) presented a conceptual framework for planning smart communities to take account of sustainable transport. Hammad *et al.* (2019) proposed a mathematical optimization framework to optimise zoning, land-use

allocation, the location of novel constructions, and investment decision-making related to infrastructure projects in smart cities. Bamwesigye and Hlavackova (2019) discussed sustainable transport and smart cities. Behrendt (2019) analysed the focus in European policy discussions on the topic of smart cities.

These works have discussed the application of innovative sustainable transport modes in future smart cities. However, much less research has paid attention to the impacts of these innovative transport modes on future sustainable UFT. Additionally, these papers specifically focused on the notion of smart cities based on information and communications technology (ICT) or the internet of things (IoT).

The usage of emerging transport modes is an efficient solution for logistics providers. An example is the utilization of electric vehicles (EVs) to deliver goods to customers within urban areas, which can reduce air pollution. Notwithstanding this, various distribution innovations operate together as a system that radically influences the conventional urban freight network [He, (2019); LEAD, (2021a)].

An aspect that needs careful consideration when looking at different measures and strategies to tackle the current day challenges in the city is that there are differences between types of urban area. In general terms, most of these public policy issues are more of a concern in metropolitan and large urban areas because there are significant concentrations of receivers of freight in relatively limited geographic areas and there are high concentrations of movements by freight vehicles and private cars during peak hours. The combination of these factors means that these larger urban areas are more likely to suffer from road traffic congestion and poor air quality.

In addition, the need to protect the culturally and physically sensitive historical centres and small heritage sites from traffic congestion, physical damage from larger freight vehicles and air pollution means that issues relating to freight movements are regarded as being a significant policy issue.

2.1.1 City typology

In spatial research, typology-approaches are used to describe, model, analyse, benchmark, and monitor the built environment with respect to buildings, (transport) infrastructure, and the urban structure [Rodrigue (2020); Blum & Gruhler, (2011)]. In addition, our typology is aligned with the research and development done in Novelog (2018a,b) and BESTFACT (2013, 2015a, 2015b). The objective of that study was to develop a city logistics typology that was pragmatic, based on UFT research, the database collected from all previous R&I work, and existing typologies.

From the research, it is determined that in UFT research and innovation at the European Union (EU) and local level, typologies have been both single and multi-tiered, often with a

variety of parameters making up an overall typology, and each parameter having attributes that define them. In some cases, the attributes are subdivided into sub clusters.

Typologies of the urban environment offer a consistent set of (pre-) defined representative buildings, blocks of buildings, street layouts and urban structures that have specific properties regarding issues such as embodied resources, energy demands, typical land coverage, and infrastructure demands, as well as the consumption of resources. Urban structure types classify basic urban spatial units that have a morphological and functionally homogenous character, which is defined by characteristics structures and development patterns of buildings, infrastructures, and open space (see Annex 1 for some additional background and resources on zoning).

The basis for the LEAD typology is formed by the study DG Move: Study on Urban Freight Transport, MDS Transmodal (2012) that came up with 4 zones, based on functions and morphology. First, they defined an urban area based on the definition of the United Nations and used by a number of EU member states: *Areas that have urban (i.e. built-up) land of 20 or more hectares that are less than 200 metres apart and linked to form a continuous built-up area.*

This also provides a reasonable definition for the purposes of the LEAD study, but it still includes a very wide range of towns and cities with different freight transport issues at varying levels of intensity.

2.1.2 Morphology / Size of the zone

The relevance of these impacts and issues discussed in the introduction and Annex 1 varies according to city size, and there are differences between large conurbations and small- or medium-sized cities. The latter are particularly affected by UFT. Narrow roads and a lack of loading and unloading areas within city centres combined with inefficient logistics processes produce negative effects that are attributable to the small scale of these cities. In addition, small- or medium-sized cities usually have a lower financial investment capacity and, due to their dimension, the critical mass for innovation is more difficult to reach. However, small- or medium-sized cities have some conditions that are favourable in relation to urban freight logistics. Citizens' perception of, and involvement in, city life is different, and citizens are generally more active in medium-size urban contexts as compared to larger ones.

The size of the city or urban area is evident and that is why this dimension is used as the basis for the LEAD typology. To facilitate the analysis of the Lead Strategies and to provide more practical conclusions from our review of measures and practices at a local level we will use a typology based on the DG move project, with a slightly altered boundary. The following zones are distinguished:

Metropolitan Area (Z1) - the very largest urban areas in Europe with over 1 million inhabitants that are likely to experience very significant road congestion and air quality issues.

Large Urban Zones (Z2) - urban areas with more than 500,000 inhabitants (excluding the Metropolitan Areas) that are also likely to experience road congestion and air quality issues.

Heritage Urban Areas (Z3) – smaller urban areas that are sensitive environments because of the importance of the town or city in cultural or heritage terms.

Smaller Urban Areas (Z4) – all other urban areas, probably with less significant road congestion and air quality issues.

2.1.3 Logistics profile

In addition to the size of the urban area, different labels were added to a zone in line with work done in TURBLOG (2011a;2011b), one of the EU city logistics projects that introduced a set of urban freight characteristics. The typology was named '*Logistics Profile*' and was used to characterise urban land use and logistics and delivery requirements. The concept was based on the hypothesis that it was possible to identify, for some well-defined areas inside a city, reasonably homogenous groups of logistics needs, based on three key points: 1) The urban characteristics of the area; 2) The requirements of the logistics agents (i.e. the requirements concerning the type of delivery); and 3) The characteristics of the products being transacted (see Annex 4 with the detailed Logistics Profile properties). In our typology the following profiles are used:

Cluster of shops specialised in one specific type of service/product (LPA). Area characterized by a high commercial density and homogeneity with a varying easiness of handling. Medium to high frequency of deliveries.

Hotels, restaurant, small grocery stores, small neighbourhood markets (LPB). Varied commercial density and logistics accessibility. Usually with special transportation conditions, e.g. fragile and perishable. Urgent delivery with high frequency and defined routine.

Business centre (LPC). High commercial density but low homogeneity with limited access. Easy handling without special needs and a high frequency of deliveries.

Large commercial stores (LPD). High commercial density, low homogeneity with good access. Varied handling, plus possible special requirements on transport. Medium to high frequency of deliveries with defined routine

Residential areas with local trade (LPE). Low/medium commercial density and homogeneity with limited access. Varied handling, plus possible special requirements. Low/medium frequency of deliveries.

2.1.4 LEAD City Typology

In the table below, the construct of the different typologies discussed above is presented: with basically two dimensions: 1) the size of the urban area and 2) the logistics profile. Note that there are a few logistics profiles absent in the heritage and smaller urban areas.

Urban Area Type		Logistics Profile				
		LPA	LPB	LPC	LPD	LPE
		Shop Clusters	Food Service	Business Centre	Commercial zones	Residential
Metropolitan Area	MA	■	■	■	■	■
Large Urban Area	LUA	■	■	■	■	■
Heritage Urban Area	HUA		■			■
Smaller Urban Areas	SUA		■		■	■

Table 2: LEAD City Typology

2.2 Stakeholders analysis & role of the public sector

The fact that there are many different stakeholders involved in UFT is commonly mentioned in papers and research project reports on UFT. Ogden (1992) who was one of the first to write a comprehensive analysis of UFT identified three main stakeholders with an active role in UFT: receivers, carriers and forwarders.

Most of the authors addressing the topic of urban freight stakeholders also distinguish among these three, although some of them do not consider forwarders (also called senders) and receivers to be separate stakeholders [Taylor, (2005); Witlox, (2006); Quak, (2008); Behrends; (2011)] or do not include receivers [Taniguchi & Tamagawa, (2005)]. The importance of policy-makers, decision-makers and local authorities as urban freight transport stakeholders is also commonly recognised [Munuzuri *et al.*, 2005; Taniguchi&Tamagawa, (2005); Taylor, (2005); Witlox, (2006); Quak, (2008); Behrends, (2011); Russo & Comi, (2011); Stathopoulos *et al.,* (2011); Lindholm, (2012); MDS Transmodal Limited, (2012)].

Policymakers take the role of defending the stakes of all urban stakeholders that are affected by urban freight transport. Some authors suggest considering society or citizens as an additional stakeholder [Taniguchi & Tamagawa, (2005); Taylor, (2005); Quak, (2008)]. Ballantyne *et al.* (2013) argue that citizens and visitors have an interest in the system of urban freight transport but do not have a direct influence on the system. An extensive overview of the different stakeholders and their main interests in the context of urban freight transport can be found in MDS Transmodal Limited (2012).

The relevant stakeholders are[3]:

Shippers – manufacturers, wholesalers, retailers, etc. Shippers send goods to other companies or persons and are often not located in the city; as a result, they usually do not feel responsible for urban freight transport issues. They tend to maximise their levels of service in terms of costs and reliability of transport. In many cases, the shipper is the stakeholder responsible for hiring a carrier.

Transport operators – freight carriers, couriers, etc. They usually aim at minimising their costs by maximising the efficiency of their pick-up and delivery tours, and they are expected to provide a high level of service at a low cost. There is a trade-off between a high level of service and the efficiency of freight vehicles loads. Transport operators are the stakeholders carrying out urban freight transport, but in many cases they are restricted by boundaries set by others; for example, opening hours of stores or designated time windows to make the deliveries. Transport operators are often active in a geographically larger area than the city.

Receivers – shopkeepers, offices, construction sites, residents, etc. Receivers are located in the urban areas and are mostly the endpoint of the logistics chain. Receivers are often not responsible for urban freight transport since shipments are organised and paid for by the shipper (so for the receiver the transport price is included within the price of the ordered goods).

Residents and city users – the people who live, work, and shop in the city. Residents can experience nuisance by urban freight transport (e.g. smell, noise nuisance, or vibration).

Resource supply stakeholders – Infrastructure providers, Infrastructure operators and landowners.

Public authorities – Local government and National government.

Visitors, Shoppers and Tourists – who are affected by urban freight transport only to a minor degree, although one could argue that (too many large) trucks in a city centre cause intrusion or decrease the perception of the spatial quality of the city.

2.3 The urban freight transport market

The freight transport industry, particularly the road freight transport sector which is most relevant for UFT, is highly competitive. This means that freight transport operators are highly cost-conscious and respond to market signals. It also means that any additional costs that are imposed by the public sector through increased regulation or other measures will, at least in the medium to long term, be passed onto customers and, ultimately, consumers as they cannot be absorbed by the operators.

[3] *Ogden, K. W., 1992, Urban Goods Movement: A Guide to Policy and Planning, Ashgate, Aldershot*

The structure of, and future trends in each of the following sectors will largely determine the nature of the challenges posed by UFT in the future: Retail; E-commerce; Express, courier and post; Hotel, restaurant and catering (HoReCa); Construction; and Waste.

This categorisation provides a reasonable basis for further analysis, although the distinction between different market sectors is becoming blurred. In particular, the courier and postal operators play a key role in delivering goods purchased on the Internet, which is an increasingly important part of the retail industry and E-commerce.

Figure 4: Sectors/Industries in the Urban Area

The **retail** sector demonstrates how the fragmentation of demand for UFT combined with the fragmentation of supply of UFT results in a greater number of UFT movements with only part-loads than would be possible if both demand and supply were more concentrated. The larger retail chains have greater volumes of traffic and are more likely, by working with their logistics providers, to be able to optimise their deliveries in terms of overall efficiency. The impact of the retail sector on UFT efficiency depends therefore on the structure and dynamics of the retail market. If left to market forces, efficiency may actually decline in the future, with a larger number of deliveries at lower load factors, given the expected trends for city-centre redevelopment and the renewed interest in smaller store formats.

Parcel, courier and express transport services are one of the fastest growing transport businesses in cities. This sector uses large vans or small to medium sized trucks and is based on consolidated delivery and collection tours departing from cross-dock terminals located in close proximity to suburban areas. An express courier delivery tour can involve 70-90 deliveries, while a traditional parcel delivery tour serves about twenty receivers. This is because the express couriers' network and planning processes enable them to increase the efficiency of their delivery tours.

From the express couriers' viewpoint, their efficiency is threatened by the ever-increasing tendency to regulate access to city centres. In particular, each municipality tends to set access restrictions based on its own needs, so that express couriers have to operate in a fragmented regulatory context.

The **HoReCa** sector is generally described as a homogenous market sector, but its commercial activities present very different logistics and organisational constraints according to the specific service offered to the final consumers. In general terms, HoReCa distribution channels are characterised by unpredictability, which can mean that businesses maintain significant stocks but also means that just-in-time (JIT) supplies are often required in small quantities, leading to frequent (and inefficient) deliveries. Nevertheless, the larger, more organized businesses, such as the large hotel and restaurant chains, are more likely to achieve economies of scale through centralised procurement and more consolidated and less frequent deliveries.

Construction activity involves the delivery of a wide range of materials to construction sites, which can be located in already congested areas and sensitive locations such as heritage city centres with pedestrianised zones; it also involves the removal of waste materials for disposal. Industry organisations have accepted that historically construction logistics, including the transport of materials to and from the site, are not always optimised, mainly due to the fragmented nature of the industry and the project-based nature of construction activity. This can lead to a relatively high proportion of lorries running either empty or with only part-loads, lorries having to wait to gain access to construction sites in urban areas or to be unloaded and significant amounts of waste material that has to be removed by lorries from construction sites. Some observers have suggested that improved construction logistics could save between 10 and 30% of project costs.

Adding **Offices** and **Service-related** trips to these sectors gives a fair picture of the main freight transport activities taking place in cities. The organisation of logistics, and as a result of urban freight transport, differs between (and within) these sectors.

In conclusion, the freight industry is generally most efficient in terms of load factors, routing and number of deliveries to individual locations when economies of scale are available to larger operators. For this reason, as a general rule, large-scale retail distribution and express/courier services tend to be more efficient than very fragmented distribution services to small retailers and in the HoReCa sector, where JIT deliveries are more prevalent. Measures that contribute to the consolidation of freight transport activity (requiring co-operation between UFT operators) and collaboration between shippers/receivers in procuring UFT services (while respecting competition rules) should lead therefore to more sustainable UFT.

A special note on E-commerce in UFT (see Figure 3). The growth of e-commerce has led to rapid growth in different kinds of products and services. Although B2C e-commerce still accounts for a smaller market share compared to conventional retail activity, it is growing very fast. In this high-value potential market, efficient and reliable logistics is a key factor of success, even more than with a traditional retail business. In B2C e-commerce two physical distribution models are observed. In the first model, the products flow along existing physical distribution channels. For example, books purchased over the internet are handled by existing

physical distribution channels of express companies and postal networks; 'white goods' such as refrigerators are usually delivered to consumers' homes even if they are purchased conventionally in a store. In the second model, new distribution channels are deployed to supply goods to consumers by retailers. In this case, logistics operations can be located at existing facilities/stores or in order fulfilment centres, which are specially dedicated to e-commerce orders.

Using storage boxes or some kind of collection point allows e-retailers to optimise transport routes and schedules and thereby achieve better vehicle and driver productivity as well as reducing the total transport requirement for each unit delivered. On the other hand, these solutions require special infrastructures for storing goods, especially in the case of e-grocery business.

In addition, local collection points would potentially generate significant numbers of vehicle trips both by companies delivering to the collection point and by consumers collecting from them. Trends seem to indicate that B2C e-commerce increases the total number of UFT movements and leads to greater fragmentation of consignments at the city logistics level. It tends to increase the amount and the frequency of deliveries and decreases the size of a single delivery.

2.4 Review of existing measures & practices

Various academic studies and reports have summarized city logistics measures already (e.g. Wittlöv, (2012); Zhangyuan & Haasis, (2020); Cui, *et al.*, (2015); Browne, *et al.*, (2019); Russo & Comi (2010), *Bozzo et al.* (2014). These studies were reviewed and used to described the proposed measures as part of this deliverable to construct a longlist.

Relevant results from Novelog, (2016); CIVITAS, (2016); Verlinde, (2015); Alice, (2014); MDS Transmodal, (2012); COST 321, (1998); Aifandopoulou & Xenou, (2019): Reasch *et al.*, (2012) were used for the longlist. These measures were filtered and assessed to be suitable to be integrated in a DT, and replicated in other European cities, of which the six LL cities provide a good sample.

The majority of the strategies were listed in Deliverable 1.1 [LEAD, (2021a)] and in this document complemented them with additional measures to come up with the complete list of LEAD strategies. In this deliverable a review of measures and practices is provided that are employed, mainly at a local level, to redress the balance between social cost and social benefit from UFT.

An initial list of measures related to urban freight transport was given by COST 321 (1998). About 60 measures were identified and classified into eight different classes. COST 321 provided quantitative results on the impacts of measures and estimated effects in projects and case studies. Following the COST 321 results, in 2000, the EC established a thematic network called Best Urban Freight Solutions (BESTUFS) with a four-year duration. Interest in

this project led to the follow-up initiative, BESTUFS II. The two projects sponsored by the EC —BESTUFS I and BESTUFS II— provided handbooks and a best practice guide (BESTUFS, 2007) where regulation measures are addressed. These documents include case studies from European cities which provide details of measures implemented and their effects. BESTUFS (2007) proposes guidance to actors involved in the movement of freight in urban areas, when they are considering measures that may be implemented to improve the flows of products in urban areas and reduce the environmental impact of the operation. Three main classes of measures have been identified: (1) goods vehicle access and loading approaches in urban areas (e.g. efficient usage of infrastructure; guidance on measures for goods vehicle access and loading in urban areas, technology in urban freight); (2) principal issues involved in last-mile solutions (e.g. home shopping via e-commerce); and (3) principal issues associated with UCCs. Investigation of tools and policies for urban goods distribution in some European cities was also conducted under another European project called City Ports that was concluded in 2005. This project produced a general method to address city logistics within a comprehensive framework where policies are defined after local analysis, ranking of critical issues, design and evaluation of specific solutions, and through the involvement of the various stakeholders.

The proposed classification is based on the combination of two criteria: what is regulated (e.g. infrastructure, logistics platforms, operative times, vehicles and transport efficiency); how to regulate, by ordering the measures according to a more or less “interventionist” style (e.g. by restrictive measures, by pricing measures; by permissive measures; by an exchange of information between Public Administrations and those who actually are providing the transport services and by the setting up or management of certain services/infrastructures; by incentive measures). Some examples of their application in the cities are also reported (City Ports, 2005). Starting from these proposals and in order to identify homogeneous characteristics that allow us to identify who must make decisions (public authorities, private companies or public-private partnerships) or who has to abide by them (end-consumers, receivers or shippers), the following classification[4] is proposed that also considers the focus in the LEAD project and List of measures presented in Deliverable 1.1.

[4] *Russo, F., A.Comi, (2010), A classification of city logistics measures and connected impacts, Procedia Social and Behavioral Sciences 2 (2010) 6355–6365, The Sixth International Conference on City Logistics.*
COST 321 (1998). Urban goods transport, Final report of the action. Transport Research, European Commission Directorate General Transport, Belgium.
City Ports (2005). City Ports – project interim report. Emilia-Romagna, Bologna, Italy.
BESTUFS (2007). BESTUFS - Good practice guide on urban freight. BESTUFS Consortium, www.bestufs.net.

LEAD Strategies

In the figure below we present a combination of the six categories that consists of measures that we focus on in the LEAD project: Agile storage & last-mile distribution schemes, Smart logistics solutions, EDVs, Avs, Droids, and Innovative Business Models. Complemented with UFT best practices found in the NOVELOG, CIVITAS typology and additional UFT sources.

Consolidation
Agile storage & last-mile distribution schemes
UCC
Micro Hubs
Mobile Hubs
Logistics hotels
Central Innovation District
PI Hub (UCC)
Deliverable 1.1

Delivery
Smart logistics solutions
Off-hour delivery
Nano-store delivery
Parcel Lockers
Door-to-Car
C2C Parcel Lockers
B2B Retailer
B2C Home Deliveries
Deliverable 1.1

Vehicle Technology
EDVs, Avs, Droids
Delivery Robots
Autonomous vehicles
E-Vehicles
Modular E-vehicles
Cargo Bikes
Delivery drones
EV charging sites
CNG / LNG filling stations
(..)
Deliverable 1.1

Governance
Innovative Business Models
Try & Buy
Click&Collect
Dynamic Pricing application
Crowd sourcing
PP partnership
Load Pooling
Deliverable 1.3

New technologies
Digital Twin
Cloud Logistics / computing
AI & IoT data collection
Block Chain
Predictive & Prescriptives
Sensor technology
3D-printing
Logistics market places
Super-Grid logistics
Deliverable 1.1 / 1.3

Supporting measures
Eco-driving
Anti-Idling
Consumer incentive program
Vehicle maintenance program
Route optimization
Promotion best practices

LEAD Supporting Strategies

Generic UFT best practices to support the LEAD strategies and innovation presented in the categories above. Primarerly to enable, restrict or support the LEAD strategies presented.

Regulatory measures
Time windows
Parking regulation
Size / weight restriction
Freight traffic management
Emission restriction (LEZ)
Harmonisation

Land-use planning & Infrastructure
Adopting on-street ULA
Nearby delivery areas
Upgrading central ULA
Collection points
Traffic control
Rail & inland connectivity
HGV signage

Market-based Measures
Road Pricing
Taxation & tax allowance
Permits & mobility credits
Incentives & subsidies
Congestion charging
Parking pricing

Figure 5: Overview of the LEAD measures categories

In Figure 5 the strategy categories are presented. In total there are 9 categories identified. The first six categories are referred to as the LEAD Strategies: (1) *Consolidation* (consisting of Agile storage and Last-mile distribution schemes); (2) *Delivery* (Smart Logistics solutions); (3) *Vehicle Technology* (EDVs, AVs, Droids); (4) *Governance* (Innovative Business models); (5) *New Technologies*; and (6) *Supporting Measures*.

There are three additional categories, referred to as *LEAD Supporting Strategies*: (7) *Regulatory Measures*; (8) *Land-use Planning and Infrastructure Measures*; and (9) *Market-based Measures*.

The list of individual measures that have been considered is not comprehensive, but the aim has been to provide a review of the most significant measures that impact UFT and that can be deployed by the relevant stakeholders discussed earlier.

However, despite this categorisation, which is a useful aid to further analysis, many practices and measures fall into one or more of the above categories and, where necessary, we have included them in the category which we believe is most appropriate because of its inherent characteristics and LEAD objectives. For example, the development of an UCC could be considered to be an infrastructure measure where it involves the development of a new distribution centre and it could also be seen as a land use planning measure if land required for a UCC is safeguarded from other uses; it could also be characterised as a technology measure where low or zero emission vehicles are operated from the UCC. Fiscal and regulatory measures can stimulate the use of UCCs, where, for example, a congestion charge increases the cost for each delivery in an urban area or only zero/low emission vehicles operating from a UCC are allowed to access a city centre at certain times of the day. However, we have chosen to include UCCs in the category Consolidation that consists of concepts focusing on Agile storage and last-mile distribution schemes.

2.5 From Measures to Value case scenarios and policies

In Chapter 5 the individual LEAD Strategies and Value case scenarios that were developed in the LLs (see Deliverable 1.4 [LEAD, 2021d)]) are discussed. A final step is provided in Chapter 6 the use of the LEAD Strategy Longlist to tackle some of the typical policies issues that arise from conflicts between the stakeholders in the city, is illustrated. Conflicts between the different interests of stakeholders inevitably arise, particularly between residents and transport operators in urban areas, and public authorities frequently intervene to try to balance the interests of both sets of stakeholders. For example, measures to restrict access to city centres for HGVs that do not meet particular emissions standards in order to improve air quality and protect the health of residents. Another example is a ban on night-time deliveries by transport operators in city centres because of the noise that can be generated, which can disturb residents' sleep.

There is also an inherent conflict between residents and tourists/visitors as consumers, which want goods to be available in shops, and the same stakeholders who regard road freight movements in urban areas as a nuisance because they create traffic congestion, noise and environmental pollution and are also regarded as intimidating.

The fact that users of personal passenger transport are also residents with a vote in local elections, while freight transport operators do not usually have such direct political influence, means that freight traffic is more likely to be regulated by city authorities than passenger traffic; an example is provided by a Low Emission Zone, which is often applied to HGVs, LGVs and buses but not (yet) to private cars. However, city authorities also increasingly recognise that efficient UFT is important to a city's economy. Given the potential conflict between stakeholder groups in relation to UFT, the public sector's role can be considered to be one of promoting sustainable urban distribution, which seeks to find a balance between minimising both the economic costs and the impacts of UFT on behalf of all stakeholder groups.

In conclusion; it is important to find the combination of measures and strategies to face the challenges in the urban environment.

2.5.1 Public policy issues generated by UFT

This section considers the issues relating to UFT from the point of view of both policy-makers, particularly at a local level, and the perspective of the other stakeholders. UFT is essential to the functioning of the urban economy as it is required to replenish stocks of food and other retail goods in shops, deliver documents, parcels and other supplies to offices and remove waste from urban areas. Although UFT has these important positive effects on the economic welfare of a city and supports the urban economy, it has a number of negative effects, which are considered below.

Road congestion. This key issue is that freight vehicles contribute to congestion, which is caused by the volume of traffic (passenger and freight) being greater than the capacity of the road network. Space being taken on the public highway network by freight vehicles waiting to make deliveries or loading and unloading. When considering the volume of traffic that causes congestion, peaks of freight traffic often coincide with those of passenger traffic.

The conflict between freight and other vehicles is more acute when transport operators do not load/unload the cargo in private off-street loading/unloading bays and any designated on-street bays, but park vehicles on the street in illegal locations.

Environmental pollution: particulate matter (PM) and greenhouse gases (GHG). The circulation of freight vehicles in urban areas can produce significant air pollution. Although their share in the total traffic flows is not usually very high, as they are mostly diesel-powered the more significant impact is due to the release of particulate matter (PM), which is a source of health problems for residents. PM10 is linked with the worsening of conditions such as asthma, heart disease and respiratory diseases.

Air quality is likely to be a greater concern to city authorities than GHG emissions because it is localised and has direct impacts on the health of residents. In addition, there can be significant financial consequences for cities that fail to meet the air quality standards set out in EU Directives.

UFT is also a significant generator of GHG emissions. As explained above, while city authorities are taking measures to reduce GHG emissions from UFT, they may be less of a direct concern than pollutants such as PM10 because global warming is an issue that has to be addressed worldwide and its effects are perceived to be long term.

Noise pollution. Noise pollution generated by freight vehicles while they make deliveries in urban areas during the night is regarded as a nuisance by residents because it disturbs their sleep. For this reason, many city authorities ban night-time deliveries.

Intimidation and safety. City authorities sometimes regard road freight vehicles, particularly HGVs when operating in an urban environment, as being intimidating for pedestrians and cyclists due to their sheer size. There is also concern about the number of serious accidents involving freight vehicles and cyclists; according to Transport for London, the city's mobility agency, half of all cyclist fatalities in London are due to accidents involving freight vehicles.

Economic efficiency in urban distribution. Inefficient distribution in urban areas can be exhibited in low load factors and empty running; a high number of deliveries made to individual premises within a specific period of time; and long dwell times at individual loading and unloading points.

In conclusion, although UFT has important positive effects on the economic welfare of a city and supports the urban economy, it also has negative externalities as described above. These negative effects are due to the lack of internalisation by the users of UFT services of the total costs (congestion, environmental pollution and noise disturbance) associated with it. Therefore, despite the economic benefits generated by UFT, there is a justification for intervention by the public sector in the market to redress the balance between social cost and social benefit derived from UFT.

While intervention by the public sector is justified to reduce the negative impacts of UFT, the most effective measures at all levels of policy-making are most likely to be those that also incentivise UFT operators (supply-side) and/or their customers (demand-side) to increase distribution efficiency which will both reduce costs and/or add value for the private sector while also reducing externalities.

2.5.2 Impacts and challenges

In Deliverable 1.4 [LEAD, (2021d)] the sustainability impact analysis was conducted and specific LLs scenarios were defined and evaluated using a consequence framework (See Figure 6). This approach, followed by the identification of the sustainability impact of each LEAD LLs future scenarios in the time horizon 2030, consisted of different steps. The first step consisted of the development of the consequence analysis framework. The second step was collecting data from the LEAD LLs CoP through the distribution of LL specific surveys. The third and final step analyses the data collected and identifies the impacts of each scenario on the three sustainability dimensions: Economy, Environment and Society.

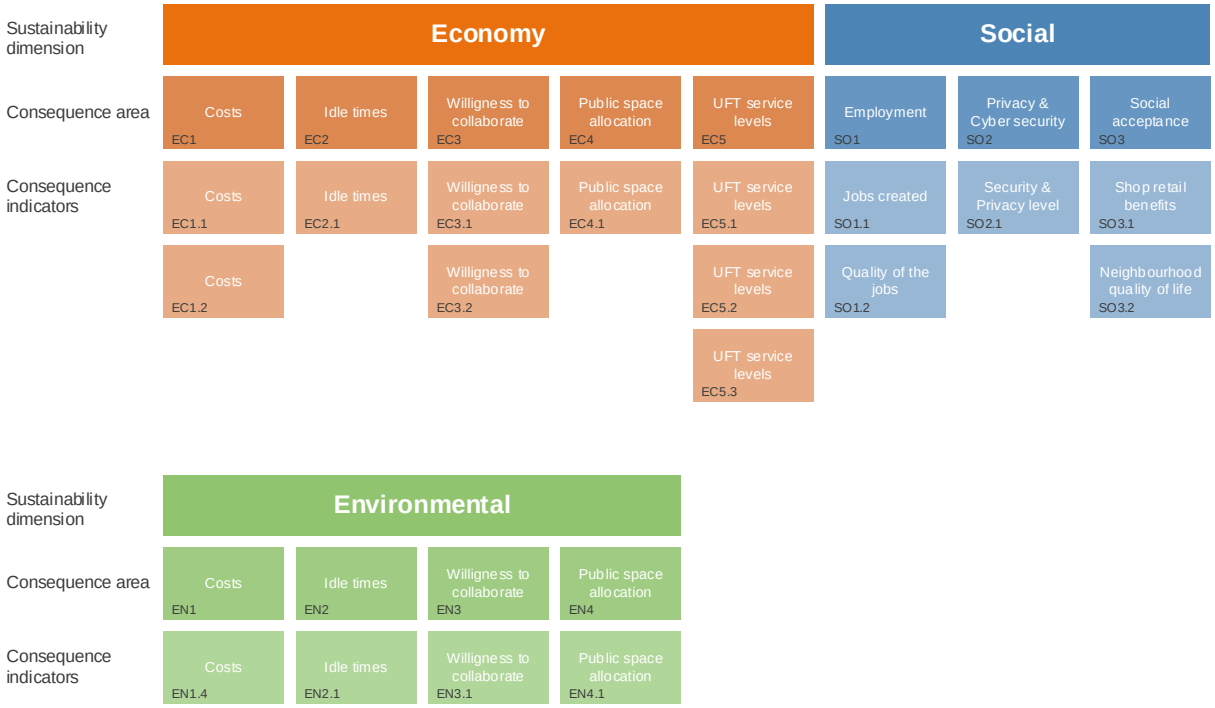

Figure 6: Main components of the consequence analysis.

Source: LEAD (2021d); adapted from (SPROUT, 2020a)

The identification of these areas together with all the potential Consequence Indicators (Cis) assigned to each area, was a result of thorough desktop research and close cooperation with the technical partners involved in WP1 (ZLC, UPM, ARGUSI, MOLDE, TU-DELFT). The consequence areas and the correspondent list of CIs per area are detailed in Annex 4 (description, units of measurement). In Chapter 5 the individual measures are discussed and their link with the consequence areas presented in the figure above.

3 City logistics in the era of on-demand economy

Witnessed by the large body of research, the city and all its aspects provide a highly dynamic environment and present all stakeholders with prominent challenges of sustainable city logistics. For example, urban population growth has motivated logistics providers to increase their delivery frequency within urban areas, which has caused traffic congestion and exacerbated land-use conflicts. To this end, urban logistics providers have employed or launched emerging transport modes to decrease environmental externalities to promote the sustainability of urban logistics; such modes include EVs, delivery drones, and parcel lockers. This observation highlights that conventional urban freight transport is increasingly transforming into a new system of urban freight transport based on urban distribution innovations.

3.1 Some dominant trends

Urban population growth is a critical element in the generation of urban issues. By 2030, the world's urban population will reach more than 5 billion, and 68% of the world's population is projected to be living in the city by 2050 [United Nations, (2018)]. This growth implies that cities need to construct lots of new residential areas and commercial areas. Housing accounts for more than 70% of land use in most cities and determines urban forms and densities, and one billion new homes are needed worldwide by 2025 [UN-Habitat, (2016)]. The urban sprawl leads to increases in the numbers of large and megacities around the world. By 2015, there were 44 large cities and 29 megacities [UN-Habitat, (2016)]. By 2030, the world is projected to have 43 megacities with more than 10 million inhabitants [United Nations, (2018)] and approximately 67 large cities.

In cities, the locations of new buildings create a traffic demand in the existing network structure [UN-Habitat, (2016)]. This causes external traffic loadings on the existing network, and it leads to major transportation delays for network users if planning is not optimal [Hammad *et al*., (2019)]. In consequence, this solution restricts the sustainability of urban freight transport in the aspects of economic and social dimensions. As another response solution, although increasing freight fleets can enhance the efficiency of urban logistics, the degree of the increase exacerbates congestion and parking land conflicts within urban areas. Although logistics providers can employ clean-energy mobility approaches (e.g., cargo-bikes and EVs) to reduce emissions, this solution is a barrier to sustainability in the social and environmental dimensions.

The increase in total external costs in the urban area is largely due to the continuous increase in light commercial vehicles used for last-mile deliveries. The latter, although representing a minor proportion of the total number of vehicles circulating within the city, plays a fundamental role in explaining urban road space occupation and externalities. Today, freight commercial vehicles, with respect to the overall situation, travel 15-25% of the kilometres in the city,

occupy 20% to 40% of the urban road space, cause between 20% and 40% of CO2 emissions related to urban transport and are responsible for 30% to 50% of the main air pollutants (PM and NOx) [Smart Freight Centre, (2017)].

The increase in commercial vehicles used for freight transport not only depends on the rise in demand for goods and services, due to the growth of city dwellers and to the additional spreading of logistic sprawl, but also on e-commerce and on-demand economy.

In sum, exogenous trends have radically influenced the conventional urban freight system. Although the usage of clean-energy mobility contributes to a decrease in emissions and thereby promotes the sustainability of urban freight transport, both urban development trends and urban population growth can restrict the other components of sustainability dimensions (i.e., Social and Economic).

3.1.1 E-commerce

E-commerce is experiencing growth of more than 10% per year worldwide and regionally. This is remarkable considering that, over five years, e-commerce sales ratios nearly tripled globally [World Economic Forum, (2020)]. The first factor that explains this explosion is primarily the increase in people using the internet. In 2018, 4 billion people had access to the internet, an increase of 10% compared to 2016 [Casaleggio Associati, (2018)]. Today, the widespread use of the Internet is undergoing further acceleration due to the epidemic crisis caused by COVID-19. In addition to this factor, online sellers are having a huge success because of the price and perceived convenience of the service.

Given this context, both delivery logistics and service quality acquire a strategic value in determining retail competitiveness. Retailers competing online need to develop on-demand logistic capabilities to keep up with customer expectations which incorporate both high logistics service quality and low costs. Most of the customers' requirements with respect to logistics service quality are focused on short delivery times which often constitutes the main driver for the overall delivery experience.

The increase in the number of e-commerce consumers translates into an increase in freight transport and an increase in light commercial vehicles. Although, in theory, online shopping can make people shop less in physical stores and therefore move less by reducing the kilometres travelled overall, this is not often the case because omnichannel activities[5] imply more kilometres travelled.

[5] *The "omnichannel environment" is a new retail paradigm enabling consumers shopping seamlessly and flexibly through a range of online and offline channels and touchpoints, using advanced technologies on smartphones and other devices.* (Buldeo Rai et al., 2019).

3.1.2 On-demand economy

The *on-demand economy* refers to a new economic model that is based on the use of online platforms that allow immediate *matching* between a user who requires a good or a service and another who is able to provide it *sharing* the assets of goods, skills, time of which it is in possession [Dagnino, (2015)]. The term on-demand refers to the almost immediate use of a service. The consequence of this new paradigm is, among others the increase in traffic, due to the excessive presence of light commercial vehicles and the increased emission of CO2 and polluting materials in the air.

3.1.3 Urban Distribution Innovations

Urban distribution innovations as mentioned previously has motivated the application of innovative transport mobility in the urban transport system. The use of urban distribution innovations could prove to be an efficient solution for promoting sustainable urban freight transport. The definition of urban distribution innovations is the application of emerging transport modes to reduce the negative impacts of urban freight movements, thereby promoting the sustainability of city logistics [He&Haasis, (2019)].

Distribution innovations	
Name	**Description**
Electric vehicles	Applied E-vehicles to transport goods in urban areas.
Modular E-vehicles	A special type of vehicle is used to deliver the goods to consumers by carrying one or multiple cabin modules.
Public transit logistics	Integrated passenger and freight activities (i.e., tram, subway, bus).
Urban freight ships	Utilise ships to transfer goods by inland waterway of the city.
Taxi logistics	Applied taxis to transport goods; the purpose is to reduce traffic congestion.
Cargo-bike	Use of a cargo-bike for freight distribution in city centres.
Robotic vehicles	Use of autonomous (robotic) vehicles for freight distribution in city areas.
Delivery drones	Use of drones for freight delivery in city areas.
Delivery robots	Use of small robots to deliver goods to the destination.
Parcel lockers	The implementation of parcel lockers aims to reduce traffic congestion in residential areas and enhance the efficiency of delivery.
Mobile depot	A mobile depot is a trailer fitted with a loading dock, warehousing facilities, and an office.

Table 3: Distribution innovations. Adapted from He&Haasis, (2019)

According to the literature review, there several urban distribution innovations: EVs, public transit logistics, taxi logistics, cargo-bikes, parcel lockers, delivery drones, robotic vehicles, delivery robots, modular vehicles, mobile depots, and urban freight ships. Table 4 defines these eleven distribution innovations and the applicative implementation process in urban freight transport.

The integration of urban distribution innovations is an efficient solution for further promoting sustainable urban freight transport [He & Haasis, (2019)]. Lots of logistics providers and technology companies have indeed launched similar concepts for the future. For example, DHL Express (2017) piloted the City Hub concept in Frankfurt, Germany, and Utrecht, Netherlands; the vehicles are combined with a customised trailer carrying up to four small containers, and they then use DHL Cubicycles (a cargo-bike that is able to carry a container) to complete last-mile delivery [Deutsche Post DHL Group, (2019)]; Workhorse Group developed the HorseFly UAV Delivery system, which is fully integrated with electric/hybrid delivery trucks, while UPS has tested residential delivery with drones launched from atop a package car [Workhorse Group, (2019)]. Additionally, some research has examined operational integration based on partial distribution innovations. For example, Kikuta *et al.* (2012) mentioned that Yamato Transport Co. (Tokyo, Japan) has been adopting a tram system for transshipping goods to Arashiyama in Kyoto and then using cargo-bikes to conduct last-mile delivery within urban areas. Also see LEAD (2021a) for an extensive review of these innovations.

3.1.4 On-demand logistics and DTs

On-demand delivery conceptually includes a service that, taking advantage of professional crowdsourced delivery capabilities, aims at providing a tailored, yet low-cost, delivery service capable of satisfying customers' desired time/place on very short notice. Recently, many and relevant changes have taken place in this context that have had a substantial impact on city freight distribution. In fact, both large and small e-commerce platforms are contributing to those social changes that are impacting society due to urbanisation, ageing population, asymmetric income distribution, and last but not least epidemic risks that have strongly stimulated a significant increase in instant deliveries and on-demand logistics. However, one should not underestimate the daunting problems these strong and quick changes are producing with respect to safeguarding environmental sustainability and guaranteeing, at the same time, economic and social goals such as labour and social inclusion, income distribution equality and resilience [LEAD, (2021a)].

DTs can be appropriately developed within a LL approach to policy-making and planning. DTs are useful to achieve jointly *ex-ante* acceptable solutions since they provide easy-to-understand descriptions of future scenarios and illustrate the future implications of current choices in a stakeholder-specific manner. One should recall that planning recursively interlinks with piloting and evaluation, suggesting how a Living Lab approach can be integrated with DT modelling. The integration of these two instruments is very promising for

policy-making and planning. As Marcucci *et al*. (2020) have convincingly argued, one should clearly consider the following three main points: (1) a DT system can hardly represent the full reality of a complex urban freight transport system due to its, often cited and widely recognised, deep complexity of one side and lack of the data needed for continuously feeding the model as well as the structural instability of the relationships describing agents' behaviour; (2) DTs can support experiments and pilots in on-demand urban logistics planning and policy-making, by informing stakeholders about future implications of any given policy thus allowing for a more informed decision-making process; and (3) behavioural and simulation models constitute the common base for characterising urban freight transport, where a sound theory and knowledge with respect to the relationships linking contextual reality and behaviour is fundamental to explain what happens in the real world.

3.2 Factors influencing UFT: a survey

In sum, the trends that were discussed in Deliverable 1.1 [LEAD, (2021a)] and mentioned in Section 3.1 of this document have radically influenced the planning of sustainable urban freight transport. The operational integration of distribution innovations needs to consider the future trends of urban development. Meanwhile, sustainable strategies of urban planning have to integrate urban freight transport into the urban development agenda. The LEAD project launched a survey to gather views on the key challenges, trends and influencing factors characterising urban freight transport, involving key experts and practitioners.

Building upon the legacy of the EU-funded NOVELOG project[6], a set of factors influencing the UFT environment has been drawn up. Participants were asked to assess to what extent each factor influences the development of the urban logistics ecosystem and to add any further factors that they consider important that do not appear in the list.

In order to facilitate the largest possible participation, a 2nd stage simplified questionnaire was prepared and translated into six languages[7], so that it could be shared also with local stakeholders.

3.2.1 General Information

125 experts participated in the survey, coming mainly from Spain, Italy, Norway, the Netherlands, and Hungary (59.8%), which not by chance are the countries in which the project takes place. Germany, France and Belgium cover 14.1% of the respondents. It is noticeable to see that 3.9% of respondents come from outside of Europe. The majority of respondents are researchers (46.4%). Public authorities at every level represent 18.8% of the respondents whereas logistics operators correspond to 11%. Other respondents are citizens, members of companies, consultants, or manufacturers/producers.

[6] http://www.novelog.eu/
[7] https://www.leadproject.eu/new-multi-language-survey-to-map-challenges-and-trends-in-urban-freight-transport/

3.2.2 Influencing factors

Influencing factors are elements, e.g. economic, demographic, social, operational, etc. that influence both the current and future state of UFT environments. Building upon the legacy of the EU-funded NOVELOG project, a set of factors influencing the UFT environment has been drawn, including six main categories:

1. Economy & demographics
2. Ecology & social responsibility
3. Consumer requirements
4. New technologies
5. Corridors, nodes and space
6. COVID19.

Compared to NOVELOG, the set has been expanded considering the developments over the past 4 years, the scope of LEAD ('on-demand economy' — shared, connected and low-emission logistics operations) and the COVID pandemic.

Participants were asked to assess to what extent each factor influences the urban logistics ecosystem, based on a 5-scale (from 'not at all' to 'a very great extent'), and add any further factor they consider important, but which does not appear in the list.

In Figure 7 the results of the survey are presented. The most important economic and demographic factors for the respondents are urban population share (% of regional level) and Gross Domestic Product (GDP) per city inhabitant. A high share of urban population is expected to lead to a regional logistics system that is more focused on its urban distribution part. Moreover, respondents acknowledge a strong relationship between economic development and freight activity. GDP increases are expected to lead to more freight movements. Retail establishment size is also considered a strong influential factor: evidence shows that small (e.g. independent) retail establishments are more likely to generate more freight activity, generating movements with smaller vehicles than larger establishments.

Asked about new technologies, the participants ranked the most important technology-driven factors for the respondents in order of importance: (1) ITS, (2) Big Data and (3) IoT+AI.

Demand for environmental-friendly products and demand for reduced waste are considered overall the crucial influence factors for ecology and social responsibility. Consumers increasingly require that both the products and the way these reach them, are environmentally friendly, and they require products that are reusable and recyclable. This puts pressure on urban freight transport at the informational and at the physical delivery level, especially in terms of reverse logistics and circular economy. Conversely, demand for ethical sourcing is not considered particularly significant, or perhaps is that there is not enough awareness about the issue of ethical treatment of employees and subcontractors involved in the procurement, production, and delivery of the products.

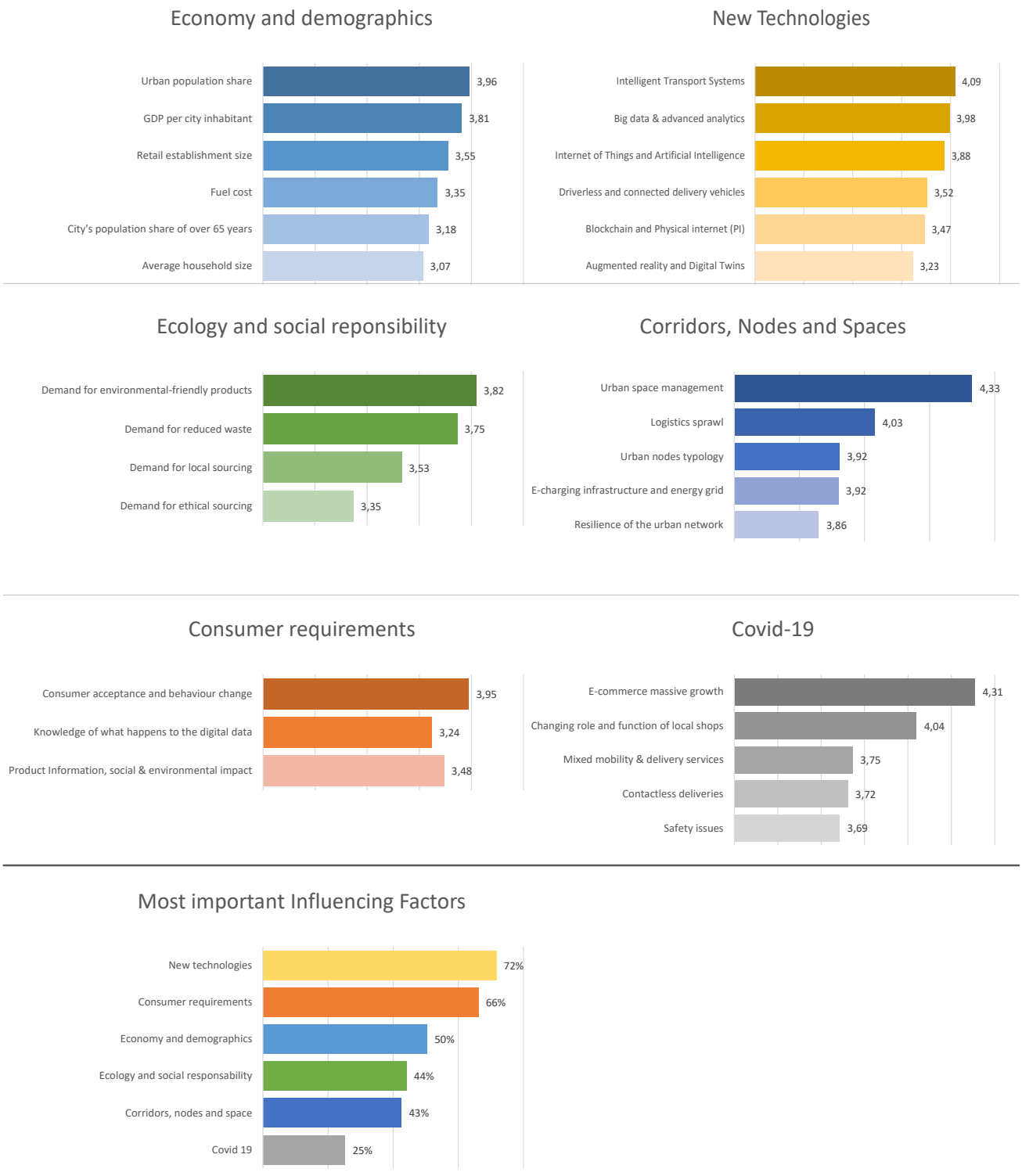

Figure 7: Results survey Deliverable 1.1 [LEAD, (2021a)].

According to the respondents, urban space management and logistic sprawl are the most important actors influencing the development of the urban logistics ecosystem. The way urban space is distributed and designed has a major impact on the way people and goods move in

the city. The rise of on-demand freight and mobility require to manage curb-side space more efficiently, in a shared and dynamic way. Logistics sprawl is the relocation of parcel transport's hubs from the urban cores to the outer suburban areas, which causes a trend towards spatial de-concentration of logistics terminals.

Overall, respondents consider consumer acceptance and behaviour change the most important factor by far, in particular for the academic sector. Willingness to pay or sacrifice service quality (e.g., speed) for more sustainable delivery options, perceived usefulness, security and privacy are key drivers influencing the impacts of on-demand logistics on the urban system. The other two factors are considered more important from the private sector in comparison to the public and academic sectors. Consumers are increasingly concerned about the social and environmental impact of the products they purchase and receive. They more and more require that this information is easily accessible and covers the complete life-cycle of a product, and this is particularly perceived by the private sector. According to the industry, consumers also increasingly want to be reassured that privacy issues are respected.

Overall, the most important influencing factors related to Covid-19 are the massive growth of e-commerce and the changing role and function of local shops. Due to the COVID pandemic, home delivery and instant delivery are growing with an excess of demand that the current offer is struggling to manage due to the lack of workforce in the specific segment. This also implies new spaces for more frequent stops of logistics operators and increasing digitalization. At the same time, the lockdown and movement restrictions are causing a reduction in the demand for traditional purchases in nearby stores. As a consequence, the numbers of retailers offering omnichannel shopping (e-commerce platforms; phone) and new payment forms have increased. Many retailers are also refocusing more on local customers because there are fewer tourists.

There are huge differences among the sectors: the public sector considers the impact of all the factors in a quite similar way and considers the impact of Covid-19 overall less essential in comparison to the others; the academic sector shows more interest in mixed mobility, delivery services and safety issues and contactless deliveries than private; when it comes to private sectors instead, is noteworthy to mention the pivotal importance that is given to changing role and functioning of shops.

3.2.3 The most influencing factors

Overall, in order of importance, new technologies, consumer requirements and economy and demographics are the most important influencing factor. By contrast, Covid-19 is the least considered by respondents, followed by corridors and ecology.

A breakdown by sector shows that the public sector deems corridors and nodes more important than others, whereas it considers economic and demographic factors less

important; the academic sector gives more value to ecology and Covid-19 than others; the private sector stresses the role of consumer requirements.

Overall, urban freight transport has to deal with challenges and needs linked to two types of issues: the first one is related to external costs of logistics (GHG emissions, polluting emissions, congestion); the second one to economic efficiency (reduction of cost, high returns, high-quality services).

Challenges and needs, however, are different in relation to the background of the respondents (public, private, academics). Based on their opinions and perspectives, respondents were asked to briefly describe the main UFT-related current needs and challenges faced by both the public and private sector.

The main difference between the public and private sector is the larger importance given to the reduction of external costs of logistics in the public sector in comparison to the private. On the contrary, private stakeholders consider economic efficiency the most relevant aspect. A remarkable fact is the different vision that public and private have concerning external costs of logistics: while for the public sectors reduction of costs is a target, for the private is usually a challenge to overcome to remain competitive.

Measures to be implemented to fulfil the needs of the public sector vary according to the different perspectives: public sector's and academics respondents stress the importance of green solutions, whereas private sectors consider often more crucial to implement clear and harmonised regulation across cities.

The same consideration is valid for the needs and challenges of the private sector. In this case, respondents from the public sector and academics give more value to public incentives and zero-emissions solutions than the private sector, which considers it challenging to comply with regulations and to deal with reduced profit margin under a highly competitive and demanding market that implies to face increasing operational issues (same-day delivery, load factor, low emission zones, time windows, a critical mass of clients to reach).

Despite the differences, every stakeholder group empathizes the need for good management of the street (efficient use of the street, land for logistics, loading/unloading bays, parking) and the need for enhanced coordination and integration between stakeholders in the creation of solutions. This last point seems to reinforce the idea that the Living Labs implemented in LEAD, but also in other cities, can foster, through experimentation, a growing knowledge of mutual challenges and needs. This allows to co-create new solutions and regulation, to anticipate any undesirable effects on one or another category of stakeholders of the on-demand urban logistics system.

4 Innovations agile storage & last-mile distribution

In Deliverable 1.1 [LEAD, (2021a)] the innovations in UFT were reviewed and discussed at length. In this document, the findings of Deliverable 1.1 are summarised and the LEAD Strategy Longlist will be presented that was built upon this review presented in Deliverable 1.1 (see Annex 2).

In urban distribution, the notion of smart cities has motivated the application of innovative transport mobility systems. An example is the use of autonomous vehicles [Freudendal-Pedersen, et al., (2019)]. The use of urban distribution innovations is an efficient solution for promoting sustainable urban freight transport. The definition of urban distribution innovations is the application of emerging transport modes to reduce the negative impacts of urban freight movements, thereby promoting the sustainability of city logistics [He & Haasis, (2019)].

The last-mile is not only the most expensive and inefficient sector of logistics [SOTI, (2020)], but also a source of negative externalities that affect the future of cities. In the light of an increasingly focused global orientation on a sustainable economy, a reflection on the entire transport sector has developed in the EU, leading to the development of guidelines (e.g. The White Paper on Transport), governance projects (e.g. ALICE) and the destination of research funds (e.g. Horizon 2020). The last-mile is considered one of the central elements of the green revolution in transport and there have been many projects whose core was and is precisely the improvement of the last-mile distribution schemes.

Last-mile logistics solutions range from improving and upgrading infrastructure to introducing new technologies, from replacing vehicles to changing the supply chain through economically, environmentally and socially sustainable logistics schemes. These changes require the coordination of many actors. The movement of goods and services is inextricably linked to the movement of individuals, so a new logistical model shall be integrated into the overall urban transport system.

The actions to be taken also require active intervention by the administrations in harmonising the different interests of stakeholders, creating easy regulatory frameworks, reserving space for logistics, providing incentives, subsidies and sometimes directly financing logistics projects. In addition, new technologies and models require extensive research, the creation of dedicated infrastructures and complex regulatory frameworks. For example, consider the introduction of electric cars/vans, the use of drones or unmanned vehicles. The innovations are clustered into three separate categories: 1) loading and unloading area management, 2) delivery time, locations and modes management, and 3) goods consolidation.

4.1 Delivery locations

4.1.1 Parcel Lockers

The Parcel Locker is one of the most successful tested schemes so far as it is an easily applicable solution in the short term and effective in addressing the problems that last-mile transport poses [Cagliano *et al*., (2020)]. These are automatic lockers located near different public places (posts, supermarkets, petrol stations, commercial roads, metro stations, railways, parking lots, etc.). it is becoming very popular in neighbourhoods as it promotes contactless deliveries, suitable practice in time of COVID-19. The examples in public spaces as metro stations are less common as the deployment of these services may require some authorization to use public land.

The typical operation of a Parcel Locker is very simple as described by [Iwan *et al*., (2016)]. The online buyer selects the Parcel Locker, as the delivery point, then the buyer receives a confirmation email and a text message with the corresponding number of the locker to be opened which s/he will use in the place where the Parcel Locker is located.

The terminology used to describe the Parcel Locker is rather ambiguous. For Parcel Locker, in this case, an automatic locker attended or not attended is meant. The automation feature differentiates Parcel Lockers from other delivery modes such as attended collection delivery points, which were manually operated by operators.

There are many reasons why Parcel Lockers are one of the most viable solutions. First of all, it is a fairly simple technology that is in a mature phase and already widely used in some countries (Poland, Germany) [Parcel and Postal technology international, (2017)]. They are not a scheme that requires huge regulatory interventions compared to other schemes (UCC) or the coordination of many actors.

The economic and environmental benefits of the parcel lockers lie mainly in the elimination of courier-consumer contact, which is further relevant considering the COVID-19 pandemic. The lack of physical presence of the consumer when the package arrives virtually cancels the missed deliveries, which in general range from 2% to 35% of deliveries [Maere, (2018)]. Similarly, parcel locker facilitate the reverse logistics process by avoiding expensive trips for the return of goods [Parcel and Postal technology international, (2017)]. Finally, delivering to a few predefined places rather than to single homes allows to consolidate freight deliveries and prevent freight vans from operating frequent stops.

The use of parcel lockers is rapidly rising, as shows the creation of their own Parcel Locker by Amazon and Google. Even more striking examples of the spread of Parcel Lockers are the 340,000 DHL parcel lockers in Germany, which reach about 90% of the population [Parcel and Postal technology international, (2017)] and the strong growth in China, where the mode of delivery of the Parcel Locker corresponds to 6% of deliveries [Bouton *et al.*, (2017)].

The market push towards the Parcel Lockers is supported by solid scientific literature on economic and environmental benefits. There are several theoretical and empirical studies that highlight these advantages over the traditional home-delivery mode.

Bouton *et al.,* (2017) produced research on Parcel Lockers where it is estimated that emissions could be reduced by 70% due to lower overall mileage and cost reductions of 35% in more densely populated cities than in a home delivery scenario. Research by [Iwan *et al*., (2016)], conducted in Poland, shows that the parcel locker delivery mode of the company InPost pollutes one third less of home delivery on equal terms, with a reduced total mileage of half and ten times more deliveries. The literature on Parcel Locker, in addition to showing its environmental and economic benefits, highlights the characteristics that favour its use by the consumer.

Availability throughout the day, low delivery cost and speed of delivery seem to be the three deciding factors for choosing the Parcel Locker [Moroz&Polkowski, (2016); Lagorio&Pinto, (2020)]. However, other research also highlights other attributes such as the safety and the convenience of the place where the Parcel Locker is located and other general safety issues [Kelli *et al*., (2017)]. Variables such as the certificate of environmental sustainability and assisted delivery seem to have been overlooked by the literature. However, the study of consumer preferences towards Parcel Lockers is likely to be of relative relevance as consumer preferences can vary from country to country as from city to rural areas. The influence of several social factors therefore prevents its generalisation.

As for the supply side of the Parcel Locker, although the initial investment is not low, it does not seem to be a particular issue [Iwan *et al.*, (2016)] unless the market share of the operator is very low [Zurel *et al*., (2018)]. The regulatory aspect, on the other hand, may present some problems.

As regards the lockers on public land, the authorities must share or rent out public space for the Parcel Lockers and provide planning and construction permits [Iwan *et al*.,(2016)]. This may not always be easy as publishing a tender to build Parcel Locker in a meter or along the road involves different levels of difficulty. Some areas that are particularly suitable for Parcel Lockers, such as metros and stations, may also present a safety issue. In Italy, for example, due to terrorism, it is illegal to leave packages unattended. In particular, in the collection or return of packages, a bomb or any dangerous object could be placed inside the Parcel Locker. Another issue is the ownership of the Parcel Locker. The best way to maximize efficiency would be to have public Parcel Lockers that can be used by all operators [Baksa *et al*.,(2017)]. However, several logistics operators have expressed their opposition to the use of public Parcel Lockers. The risk would be the loss of customer confidence, as they would be unable to guarantee the availability of the Parcel Locker itself. The presence of public Parcel Lockers could generate a saturation problem, as all operators would guarantee the packages on the same day, making many Parcel Lockers unavailable indeed. An agreement to secure a certain number of lockers for each individual logistics operators is difficult to reach.

Nevertheless, the Parcel Locker also offers different types of opportunities: rental income from companies that manage Parcel Lockers, sale of previously unused spaces, using the Parcel Locker as an advertising opportunity, and increased shopping flow in stores or facilities that house the Parcel Lockers.

4.1.2 Pick-up points

Pickup Points for online purchases are stores authorized to receive packages from e-retailers and deliver them to the customer. Similarly, to Parcel Lockers, they are inspired by the principle of the consolidation of goods and the goal of minimising missed deliveries. Unlike Parcel Lockers, they are not a new concept: in France, they have been present for several decades [Morganti *et al*.,(2014)]. In general, pickup points are widespread in the UK, Germany and France, with as many as 20% of parcel deliveries in France and 91% of the population having access to a pickup point with less than 10 minutes driving or walking distance [Morganti *et al*.,(2014)].

Pickup Points networks are composed of tobacconists, bookshops, gas stations, clothing stores, and other types of shops that lend their stock space to logistics companies in exchange for a cash payment. According to Morganti *et al*. (2014), the growth of these networks, from the perspective of the logistics operator, depends on external and internal factors (population density and proximity to transport nodes), socio-economic centres, which provide parameters of mobility and accessibility, and finally by the distribution of flows through the network.

While Pickup Points can be economically and environmentally beneficial, they are bound by a number of factors: retailers' willingness to become pickup points, and transport system such as traffic, public transport and roads are important limitations.

The key aspect of the networks is the stability of parcel flows and the ability to adapt to changes in flow, which requires control of retailers acting as pickup points. Retailers are first convinced to be part of the network, and it is not always easy, since for reasons of space, time lost for deliveries or simple disinterest they may not consent to be part of a pickup point network, and then it is necessary to have a quick turnover in case of defection (store sale or simple exit from the network).

There are several researches that have investigated the possible economic and environmental benefits of Pickup Points networks as different factors vary [McLeod & Cherrett, (2009)] consider a single pickup point (a station) and compare it to a basic home delivery option, as the proportion of people using pickup point changes. Assuming a rate of missed deliveries of 12%, an average distance from the pickup point of the consumer of 2.1km and a distance from the depot of 12.1 km, a reduction in CO2 emissions of 33% is estimated in the case of using pickup point as the only method of delivery. Environmental estimates predict a CO2 reduction of around 30% [Song *et al.*, (2013)]. Data shows that there is no

environmental advantage if missed deliveries are less than or equal to 20%. The main limitations to the benefits of pickup points are the means of moving to reach pickup points by the consumer and the increase in costs for the courier. However, most of the studies examined see pickup points as a supplementary solution to home delivery, while today they have increasingly established themselves as an independent delivery mode and not a post-home delivery. Therefore, the supposed non-convenience for the courier is no longer an issue.

A further issue that also emerges considering the system of pickup point networks independent of home delivery is the different preferences of public authorities, consumers and logistics operators. As the number of pickup points increases, consumer satisfaction increases, but at the same time the benefits for 3PLs (Third Party Logistics provider) are reduced and externalities increase, since this forces operators to make more delivery routes and stops. [Cárdenas, (2019)] estimates the optimal number of Pickup Points to achieve efficiency and shows how more environmentally friendly solutions are difficult to achieve.

In conclusion, compared to Parcel Lockers, pickup points have the advantage of having lower costs and being easier to implement, but they can present the problem of network instability, are not usually accessible 24h/7 and have a more limited range of products. Parcel Lockers can also potentially handle larger packages and could theoretically also be refrigerated to contain the grocery purchased online. Pickup points management in general may be more complex as it requires the involvement of more actors (all pickup point store owners), sometimes with conflicting preferences.

In any case, Parcel Lockers and pickup points could represent two complementary solutions, especially if they are part of integrated planning.

4.1.3 Door to Car

Pickup Points and Parcel Lockers contribute solving the missed deliveries issue and can, but not necessarily do, reduce pollution and traffic problems. Another innovative solution is to deliver the products directly to the consumer's car. The mechanism is simple: through a smartphone app the courier receives the location of the car, the license plate and a code with which it can access the boot once, all through blockchain technology. Pilot projects were conducted by Volvo, Skoda, Volkswagen in collaboration with DHL [DHL, (2018)] and by Smart which also created a prototype machine designed specifically for door-to-car deliveries. The system would also allow the possibility of the return of the product. The advent of IoT, which already allows integrated management of private cars via an app, could lead to the sharing of a security system with couriers and postmen in the future.

4.2 Delivery mode

4.2.1 Click & Collect and Try & Buy

The models seen so far, although based on a participatory approach, see logistics operators as key players. However, there are several last-mile logistics schemes where these actors do not often have a central role, which is played by the retailer or e-retailer. The two schemes in question are click & collect and try & buy. In the first case, it is a purchase of a product online and consequent pick up in the e-retailer store. On the contrary, the second case involves ordering one or more online products, testing the product in a physical store, and purchasing it. The two models have a very different level of diffusion: the first one is already very practised, in Europe it is chosen by 36% of online consumers, with peaks of 42% [Casaleggio Associati, (2018)], while the second is present sporadically in a few countries. Another significant difference between the two models is the only applicability of try & buy to the clothing branch.

Both models were born with the idea of cutting the costs of the last-mile. Click & collect aims to limit home delivery by bringing customers to special stores, and secondly aims to encourage online buyers to make new purchases once they arrive in store. According to [Verdict, (2016)], 11% of individuals always make an additional purchase at the store and 60% do it sometimes.

On the contrary, try & buy was born with the idea of avoiding the return of products and subsequent reverse logistics. This model is based on the online purchase of products that are then shipped to special stores where you can only try the products already purchased. The Czech company Zoot is a forerunner [Allen *et al.*, (2018)], having noticed that try and buy encouraged higher value-added purchases.

Again, there are important limitations, particularly regarding click & collect. The functionality of this option from a logistical point of view is linked to the choices of mobility of the consumer: the choice of the car reduces or cancels the benefits of renounce to Home Delivery. It should also be noted that many companies combine different purchasing schemes (Home Delivery, click and collect) and also encourage the shift from one to another, offering free delivery to those who use the click & collect service, reducing the environmental effects.

Try & buy and click & collect fit into a reality of e-commerce that increasingly aims at omnichannelity, that is, the presence of companies on a physical and virtual level integrating the different methods of shopping available to consumers [Casaleggio Associati,(2018)]. An example is offered by Boggi which offers the Boggi Omnichannel experience that allows the customer the click and collect, but also to book, try, buy at the store and receive the product at home. Zara has instead opened pop up stores, where you can try products in-store, buy them online from the store and receive them at home. These new multi-channel experiences are not necessarily more sustainable.

However, a combination of click & collect and try & buy can be more sustainable than all the modes seen here. In this regard, the parcel delivery company DPD (2021) has opened in Amsterdam, next to its urban depot, a shop where you can pick up your parcel (click & collect), but also try in a dressing room your purchases (try & buy) and finally receive the product at home through a more traditional Home Delivery made with EVs.[8]

4.2.2 Crowdshipping

Crowdshipping, unlike the previous two delivery modes, is not about the retailer or the e-retailer but about the actor who delivers the package. Crowdshipping is a concept that indicates, at the most essential level, a freight transport system that operates by outsourcing deliveries to a fleet of non-professionals [Simoni *et al.*, (2020)]. A restrictive interpretation of this concept focuses on the delivery of the goods as an event within the predefined route and a recurrent action of an individual.

Simoni *et al*., (2020) show how crowdshipping carried out through a public means (in the example the metro in Rome) can have positive effects on the reduction of negative externalities (traffic, pollution, accidents), while crowdshipping carried out through a private means can result in negative externalities that can only be partially compensated according to the deviation from the original route, the time at which the delivery is made, and the availability of parking spaces.

A key element in crowdshipping is the induced supply: the market possibility of earning from the transport of goods would inevitably lead a number of individuals to the offer of the delivery service by private means, distorting the original idea of crowdshipping. There would be an "uberisation" of the service, with minimal or no effects on sustainability [Mckinnon, (2016)]. Other critical issues of crowdshipping are the absence of a regular contract for crowdshippers [Marcucci *et al*., (2017)], the potential demand for dangerous or illegal goods [Goetting&Handover, (2016)], an insurance system in case of damage or loss of the package and the lack of trust in a similar system especially if it is sensitive goods (e.g. medicines).

To date, there is no successful model developed for crowdshipping, rather several startups with a very short life. An example is NIMBER which is a successful and growing crowdshipping start-up . The current business model targets peer senders (end-users) and uses peer bringers (everyday commuters) to deliver. The platform matches the two and charges a matching fee. With the participation in LEAD, NIMBER envisions the development of new ‘offerings’ and business models (P2P, B2P, P2B and B2B delivery) and growing the bringer community by promoting the company as a sustainable alternative delivery channel.

Crowdshipping could potentially be an interesting and complementary solution to Parcel Locker. Individuals who make the commute to work via the metro, for example, could pick up

[8] https://www.dpd.com/nl/nl/city-store-rotterdam/

parcels in the Parcel Lockers within the metro and deliver them to the recipient or to another Parcel Locker or pickup point at the exit of the metro station.

4.2.3 Instant delivery

The employment of self-employed couriers or improvised delivery drivers is becoming common practice. They actively engage in ultrafast (instant) deliveries, in a delivery window that goes up to 2 hours, via digital platforms that connect shippers, couriers and consumers [Dablanc *et al*., (2017)]. Examples are Amazon Prime Now, Mercadona, Dia, FNAC. Amazon Flex enables anyone through an app and a means of transportation to make deliveries, although the system requires a self-employment status and it has generated several labour law-related issues in different countries.

Instant delivery applies not only to the delivery of small packages, but especially to the instant delivery of food. Foodora, Deliveroo, Glovo, UberEats are some of the many companies that deliver ready meals through bellboys (now called 'riders') in major European cities, connecting restaurants, bars, ice cream shops with consumers. There is also a similar business model such as JustEat where the platform connects consumer and shipper, without offering the delivery service that is offered by the restaurant/pub.

To date, instant food delivery is widely used, just think of how in Manhattan 31.8% of the population declares to use a food app at least once a week, while in China you get to almost 10% of people who claim to take advantage of such an app almost every day [Dablanc *et al*., (2018)]. The benefits of instant delivery are obvious from the point of view of some of the actors involved. Firstly, there is the satisfaction of the consumer who through instant delivery sees the possibility of a smart and 'on the move' lifestyle. The delivery platform manages to make big profits from the low cost of labour. For retailers, there is the possibility of outsourcing delivery costs, gaining in speed and traceability, and there would be the possibility of becoming distribution centres for online products, thus offering different channels to consumers. There are also cases where restaurants have turned into real kitchens solely for the service of online sellers. Finally, on the environmental level, there can be an advantage: for example 65% of riders in Paris use the bike to deliver [Dablanc *et al*., (2018)].

However, there seem to be many disadvantages.

The mode of delivery provides for an increase in urban transport flows.

Riders have very tight timelines, very often do not comply with the rules of the road and it seems that this is leading to an increase in accidents, even if there are few and inaccurate road accident data [Dablanc *et al*., (2018)]. The same environmental benefits, rest on an absolute increase in the kilometres travelled and emissions that are only compensated by the use of the bike by riders. However, the issue that raises the most concerns about the sustainability of instant food delivery is social sustainability. Riders are for the majority (50% in Paris) [Dablanc *et al*., (2018)] people who do the job as their first job, often from ethnic

minorities and/or from more deprived neighbourhoods, or students who seek to supplement their income. Their uncertain working status, lack of clear rules on riders' contracts and the absence of trade unions often subject them to poor working conditions. There have been several disputes over their work status and protests of the riders themselves. The issue of low wages is mixed with the low willingness to pay of consumers for instant deliveries, which also threatens to undermine the economic sustainability of the business, as revenues tend to remain constant while costs could rise and with these the subsequent risk of withdrawal of investment by partners. New collective and cooperative organisations such as CoopCycle[9] aim to tackle this issue, by socializing bicycle delivery. Finally, one of the biggest limitations of instant delivery (both the food and other sectors) is the difficulty in consolidating deliveries. There are some alternatives: on the one hand, Amazon, which, given the number of deliveries, is able to partially consolidate Amazon Prime deliveries; on the other hand, pure crowdshipping, for example that carried out by the *DHL My ways* pilot project in Stockholm, where deliveries were made by people who did not deviate from their usual route and were not workers.

4.3 Delivery times

4.3.1 Night deliveries

Night deliveries are not so much a new last-mile logistics scheme, rather a way of applying logistics to different last-mile schemes. For many logistic players, such as Citylogin - FM Logistic, the night delivery is only viable for B2B distribution.

Off-hours deliveries could be combined, for example, with the use of Parcel Lockers and the use of EVs or UCCs [Gatta *et al.*, (2019)]. Bouton *et al*. (2017) foresee a 70% reduction in the number of kilometres covered in densely populated cities, a halving of delivery times and a 40% reduction in logistics costs, whereas [World Economic Forum, (2020)] estimates a reduction of delivery costs of 28% and a decrease of congestion of 15%.

At night, heavier vehicles with no daytime access could circulate, at higher speeds, with a lower risk of accidents and with ease of access to loading and unloading areas.

There are many disadvantages that can limit the application. While it is true that the noise problem can be solved by EVs or noise-blocking devices, it is also true that such devices are expensive and employing workers at night has a higher cost, without considering the problem of encouraging businesses to get work or hire staff to work at night.

Oliveira *et al*., (2010) and Holguín-Veras *et al*., (2014) show that it is first essential to evaluate what makes normal daily deliveries sub-optimal. Then, it is necessary to involve all stakeholders and in particular businesses, understand their interests and carry out pilot tests. The role of the administration is crucial since stakeholders may not see the long-term benefits,

[9] https://coopcycle.org/en/

but focus only on short-term losses. The public regulator's commitment is needed to create public and private partnerships, to support the initiative with subsidies and incentives, in particular to convince retailers to accept the choice of off-peak delivery, and to convince hauliers to equip themselves with noise-reducing equipment.

An example of success is in Barcelona, from which the project has expanded throughout Spain. In the Catalan city two large trucks, equipped with devices to reduce sound, are able to replace 7 day trucks going at three times the speed of a standard time [Bouton *et al*., (2017)]. Other examples of night delivery schemes have been successfully applied in New York, London and Stockholm [Holguín-Veras *et al.,* (2014); Sánchez-Díaz *et al*.,(2017)].

4.4 Management of loading and unloading areas

Improving delivery times, locations and modes cannot neglect considerations of loading-unloading areas. To date, the competition for curb side space is extremely intense, emblematic of the fact that traffic depends between 13% and 18% from the search for parking in the main cities [Hampshire & Shoup, (2018)]. In London 62% of the time of a typical daily delivery and 40% of the distance travelled depend on the courier's walking shift [Allen *et al.*,(2018)], prompts the transporter to look for a do-it-yourself solution that consists of putting the van or truck in double row, generating traffic and leading to increased accident risk. The solution to this issue is not so simple since it is necessary to balance the demand of the loading and unloading areas of logistics with the needs of the other actors who use the road. Active mobility, geared towards cycling and walking, despite the proven improved safety and urban liveability, with positive effects on employment, has often created concerns on part of businesses and citizens about accessibility for those who have to use the car, and the availability of loading and unloading areas and traffic [Lee, (2020)]. All-encompassing plans are therefore needed, with the participation of the different stakeholders who directly concerned by the curbside management (e.g. in Toronto [Lee, (2020)]. Solutions are manifold and relate to both the generic parking of cars and the management of the loading-unloading areas.

A first step was taken in Seattle [Goodchild, (2018)], where public and private loading-unloading areas have been georeferenced.

As for parking, local authorities are increasingly trying to move the choice of parking from on-street to off-street locations (e.g. commercial garages, private spaces). One of the most innovative approaches is to predict the demand for parking on the road and, on the basis of this, defining the price (Institute of Transportation Engineers). The initiative has been tried in the United States, in San Francisco, where its application in congested areas of the city has led to increased availability of parking on the street and reduced the time lost in seeking parking, therefore reducing urban congestion [Lee, (2020)].

In the same way, it may be useful to set limits on the duration of parking and to guarantee or prohibit parking for certain types of vehicles at different times of the day, giving advantages to green vehicles, for example by preventing on-street parking at times when you have the peak of daily traffic. Fundamental to this purpose is the design or prediction of the city authorities of the ways in which the curb-side space in the main urban streets (e.g. commercial streets) will be used [Lee, (2020)].

As for freight, some initiatives aim to apply a fee on loading-unloading areas. In Washington, this initially saw a hostility of hauliers, but once it led to a 50% decrease in double-row parking, the hauliers noticed the time and safety benefits of the unloading area. Such a policy, suggests the report of [Lee, (2020)], could be even more effective if accompanied by an increase in off-the-road parking and a reduction in parking time at the curb-side.

If one looks at the overall issue of parking, it is important to remark that cars are parked 95% of the time during the day. For about half of this time fraction, cars are parked in the work area of their owners, often in parking lots provided by the companies themselves.

Reducing or cancelling this company policy could limit the use of cars as a means of transport for commuting, improving the overall availability of parking. [Evangelinos *et al*., (2018)] show the possibility of an increase in available parking spaces, through the monetization of the company parking space, in particular through the reward equivalent to the monetary value of parking in case of voluntary renunciation of the parking space.

4.5 Consolidation

4.5.1 Urban Consolidation Centres

Urban consolidation centres (UCC) are “logistical facilities located relatively close to the area they supply (city centre, entire city, or specific location) from which consolidated deliveries depart” [Allen *et al.,* (2007)].

These facilities may vary according to participants, activities carried out and funding methods.

A UCC can be managed by a single company or consist of several companies, be financed or co-financed by the public sector or other funds and ultimately only be financed by the logistics operators themselves.

Although often the first purpose of a UCC is the delivery of goods (B2B or B2C), they can perform various functions such as the storage of stocks of products, labelling and pricing, the return of goods and services and waste collection. There are also UCCs that do not include the delivery of goods, for example, they only deal with the transport of building materials. The UCC does not necessarily supply an entire city, rather it is easier to serve a specific site or area, see the case of London Heathrow Airport [Allen *et al.,* (2007)].

The traditional benefits of freight consolidation (reduction in the number of trips and mileage, increased vehicle load capacity and lower environmental pollution) are also complemented by improved planning capabilities and inventory control.

According to Bouton *et al*., (2017), an effective UCC system could reduce delivery costs by 25% or 30% (depending on whether the vehicle is electric or not), CO2 emissions by 45% and mileage by 45%. There are also other studies confirming some of these effects and in particular a reduction in the kilometres travelled from 30% to 80% [Allen *et al*., (2007)]. However, there are some studies, such as (World Economic Forum, 2020), that highlight only a possible slight improvement, namely a reduction of emissions, delivery costs and congestion, respectively of 2%, 3%, 5%.

In general, the UCC, by making the supply chain more visible, could encourage its improvement, not to mention that the possibility of concerted action for the creation of a UCC lays the groundwork for broader policies in the logistics sector. A very interesting aspect is the possibility of using green vehicles from the UCCs to further improve environmental sustainability.

The UCC has also significant disadvantages. The main problem is the high investment and operational costs that often require subsidies to be covered. Such a logistics system requires considerable organizational efforts, since different goods require different methods of storage and handling. UCCs also require very large spaces and tend to create traffic near the location [Stefanelli *et al*., (2015)]. The complexity is also linked to very frequent contractual issues. Finally, a further risk is the possibility of a monopoly.

These issues have often been accompanied by unexpectedly low demand, excessive distance from the city and the lack of participation of logistics operators, doubtful of the profit opportunities of the initiative, institutional commitment and partners or simply not interested in the scheme given their already consolidated distribution system [Rooijen & Quak, (2010)].

Although most of UCC's projects have ended due to failure [Allen *et al*., (2007)], there are several examples of successful plans that have been completed or are still in progress.

One example is the London Borough Consolidation Centre, where 224 suppliers supply 300 local shops, generating a 69% reduction in kilometres travelled, 67% reduction in CO2 emissions and a 7.5% cost reduction (European Commission, 2016). The success of this UCC is primarily linked to the focus on a geographical area that is not overly extensive, the requirement of a certain number of goods to be unloaded per delivery, the obligation to use the UCC in public tenders concerning the delivery of goods and the separation of public tenders concerning the supply of an asset and its delivery.

Another example is Broadmead in the United Kingdom, where a consolidation system supplies Bristol's commercial district with medium-sized and non-perishable goods, in particular by supplying 51 shops in the city's central areas [Allen *et al.,* (2007)].

A new model of UCC is the so-called logistic hotels in Paris [Dablanc, (2019)]. These are based on a standard business model, where an owner of an area within the city offers the space for rent to different logistics operators and other stakeholders for other uses, in order to compensate for the possible exit from the hotel by some logistics stakeholders. This avoids the logistic sprawl and both the companies that carry the goods (renters) and the owner can make profits. However, this model also presents significant organizational challenges, the overcoming of which will be assessed in the coming years.

Ultimately, UCCs need different geographical, infrastructural, spatial and player conditions to function. Geographically, it is an advantage to be located in areas with significant transport problems (traffic, difficulty in access), with inadequate and unsuitable infrastructure to deal with the growth of freight traffic, with historic centres and neighbourhoods suffering from commercial vehicle traffic and where there is a common interest in improving the urban environment. A location at the edge of an urban access zone could also be convenient, such as in the case of the low emission zone for the Logistic Hotel developed in Lyon and expected to open in 2023. At the actor level, the presence of many independent businesses and retailers with a dedicated and complex supply chain can favour a UCC.

The interests of different actors (retailers, couriers, public sector, citizens) should be aligned. Public and private support is needed, as well as institutions able to put together the various preferences of stakeholders. Public support is particularly necessary both to support UCC projects economically, at least at the beginning, and in the proactive phase to reverse harmful trends for entire cities, for example the logistic sprawl, offering long-term solutions, like in London and Gothenburg [Orving *et al*., (2019)]. In order to have a project that is self-sufficient from an economic point of view, an approach that is not top-down is extremely important [Allen *et al.*, (2007)].

Finally, another aspect to consider is the integration of logistics into urban plans, ensuring that a sufficient amount of logistics areas in the city are reserved before they are occupied for other purposes. This issue is particularly important given the normal scarcity of available and low-cost urban spaces. [Ørving & Eidhammer, (2019)].

4.5.2 Micro-hubs

Following several failures of the large UCCs of the 1990s, the idea of UCC has in some cases evolved: the new UCCs have become smaller, with a more limited range of delivery [Janjevic & Ballé, (2014)], more like places of trans-shipment than UCCs and with limited functions than UCCs [Verlinde *et al*., (2012)]. These new logistics facilities have been called micro-hubs or micro-consolidation centres. Micro-hubs are characterized by the use of light vehicles (small vans, walking or cargo-bike) and with low environmental impact.

Their advantages, beyond the reduction in emissions, can be manifold.

The apparent time lost by new low-emission vehicles is more than offset by less loading and unloading time, making logistics costs lower [Lee *et al.*, (2019)]. The combination of micro-hubs and sustainable vehicles also fits very well with other logistical combinations such as off-hours delivery, which requires non-noisy vehicles. New city policies that create access windows for freight delivery, restricted traffic areas and areas accessible only to sustainable vehicles, offer an ever-increasing incentive for this new type of logistics scheme. In addition, new EVs are perceived as suitable for the central tourist areas. These facilities are usually cross-dock centres with not or limited space for storage and handling operations. Therefore, synchronization between inbound and outbound flows needs to be well planned.

As with other types of models, the operation of the hubs is linked to intense collaboration between the various actors whose possibilities must be evaluated at a preliminary stage also through field research. Public authorities must then provide an appropriate environment for the hub and EVs. This means restricting access to heavy vehicles, parking space on the road mainly for small vehicles and with preferential access to green vehicles, widespread electric grids, incentives to switch to green vehicles, and economic support where necessary. In general, a policy more favourable to pedestrians and cyclists is better associated with freight transport based on light and zero-emission vehicles. Another very important and often overestimated aspect is the willingness of couriers to join a similar scheme [Quak, (2014)]. Finally, the delivery area must be profitable in itself, i.e. there must be a high demand for freight transport because the long-term profitability of the project depends on that [Verlinde *et al*., (2012)].

The study of Urban Freight Lab (2020) observes different types of micro-hubs, considering whether the consolidation mechanism is through one or more operators.

The simplest model consists of a transport company that consolidates deliveries to urban stores, such as the case of the Brussels mobile depot. Another mechanism, based on only one company, is that of UPS with its Pickup Points.

Models where micro-hubs consolidate deliveries of multiple carriers are more complex because they require more cooperation. One of the most recent, but most successful cases, is that of the logistics company Binnenstadservice (BSS) in the Netherlands. BSS provides a service reserved for small retailers. At the request of the latter, the goods are transported by external couriers, rather than directly to the store, to the BSS hub, from where they will then be delivered with EVs to the retailer [Rooijen & Quak, (2010)]. In this way the retailer, rather than receiving many separate deliveries from different suppliers, receives a consolidated one at the time requested, saving time and money. Similarly, couriers avoid frequent and near-empty deliveries in the city and share (on a voluntary basis) some of the costs saved with BSS. The Dutch company also offers additional services such as reverse logistics and storing products in stores in exchange for extra costs, the only source of BSS revenue along with shared courier savings. Nowadays, the strategy upscaled: in fact, the focus is on the larger

retailers and logistic services providers as BSS now organises also (city) logistics operation more at a national scale [Quak *et al*., (2020)].

Another interesting and in some ways alternative example is the case of Yokohama [Browne *et al*., (2012)], where an association of sellers of a commercial street runs, with the partial help of the local government, a micro-hub. The case is interesting because it is the first case of management entrusted directly to a retailers' association in Japan. The creation of the hub was accompanied by the use of low emission vehicles, ensuring space for parking freight vehicles, eliminating illegal vehicle parking and improving urban road signs.

Finally, there are also hybrid cases where companies have their own micro-hubs, but they share others with other companies: it is the case in London, where Gnewt Cargo, a logistics company based on a 100% electric fleet, also consolidates part of the deliveries of Hermes and TNT [London City Hall, (2018)]. The success of the initiative was helped by the creation of a low-emission zone in London and the improvement of the electricity grid.

A similar example is the KoMoDo Project in Berlin, where five logistics companies shared an urban micro-hub, delivered 160,000 parcels in an area of 2-3 kilometres reducing emissions and noise levels and double parking. Following the success of the pilot project, 3-5 new city hubs are planned to open in Berlin in 2020[10].

4.5.3 Mobile Depot and small EVs

Mobile depots are one of the most innovative initiatives in the field of urban logistics. The basic idea is a mobile means of transport (a bus, a caravan, a container), present within the city from which goods are loaded on light vehicles, which can be cargo-bikes, van-electric or electric tricycles.

The trial of mobile depots is generally associated to the testing of small and electric vehicles. Cargo bikes and electric tricycles have been tried in several cities, including London, Paris, Stuttgart, Utrecht, Yokohama and have become quite popular. Only later, in 2013 in Brussels, the use of cargo bikes with a caravan as a mobile depot was trailed for the first time.

The benefits associated with mobile depots and EVs are numerous and go beyond reducing environmental pollution and traffic. The vehicles mentioned provide flexibility and accessibility to different infrastructures such as pedestrian areas, bus lanes (when allowed), a faster flow through traffic and better parking possibilities. Small EVs are less expensive in terms of purchase price, tax, insurance, storage, depreciation, running costs, and there are no parking and traffic charges, they are faster in the event of traffic and drivers do not need specific training of license to drive the vehicle. Light vehicles are also a much lesser threat to the safety of pedestrians and passengers [Arvidsson & Pazirandeh, (2017)].

[10]https://www.velove.se/news/komodo-city-hub-project-in-berlin-it-works-its-fun

Despite these advantages, mobile depots also have issues that mainly affect their economic viability.

As several cases in Europe show, these logistics schemes have relied on very expensive distribution centres. In the case of Brussels and Berlin, an additional loading and unloading phase was required with expensive intermediate storage [Arvidsson & Pazirandeh, (2017)].

All this makes the subsidies necessary to make these projects feasible.

In the case of Brussels, for example, costs for TNT (the logistics company operating in Brussels) have doubled: costs for bikes, for transhipment on bikes, maintenance of the depot, the management of additional warehouses and packages beyond the maximum weight that can be managed by bikes. All these elements represent barriers to the competitiveness of the service in terms of costs, not to mention the initial investment to create a mobile depot [Verlinde *et al*., (2014)].

However, ad hoc scenarios for the Brussels case showed that a substantial improvement in the depot's capacity (from 40% to 90% of use) and an improvement in the delivery density of goods can make the model more competitive [Verlinde *et al*., (2014)].

There are other examples of a theoretical production application of the mobile depot that are pushing for further experimentation. One example is a mobile depot that moves around the city following the city's transport networks, directly connected to electric carriers and with standardised loading units, in order to reduce intermediate storage costs and facilitate transhipment [Verlinde *et al*., (2014)]. In a similar scenario, assuming a sufficient level of capacity to use the depot, competitive advantages can also be obtained by the investment company. Another important aspect to consider is again the need for coordination between different stakeholders, in particular a fair sharing of risk and benefits that can overcome resistance.

4.6 New technologies

4.6.1 Automated and Autonomous delivery systems

An entire logistics industry is emerging or in the process of doing so and is based on ongoing technological advances in automation. In the field of logistics, automation means the ability to use for deliveries drones, droids, automatic vehicles and automatic vehicles with built-in Parcel Locker.

One of the first examples of using automated delivery systems was in 2011, when Amazon completed the delivery of a package through the use of a drone.

Drones would cut labour costs and package arrival times, allowing a cost delivery reduction of six times compared to traditional van [D'Andrea, (2014)] and enabling the most urgent deliveries.

According to [Goodchild&Toy, (2018)], drones would reduce CO2 emissions, even though the best-case scenario would be a mixed delivery system based on integration with vans, so that drones would be used only for the very last-mile.

The main problem of drones that makes them unattractive between the various automated solutions is the extremely small load they can carry (15-16 drones needed to replace one van) [Paddeu *et al*., (2019)], the need for a minimum space of two square meters for landing, (not available in most of city apartments), lack of security (theft, in particular the possibility to be hacked for malicious uses, accidents, privacy), acoustic pollution (a negative ecological impact on birdlife), the need for good weather conditions, lack of energy efficiency and existence of regulations preventing them from circulating freely in the air [Bouton *et al*., (2017); Paddeu & Parkhurst, (2020)]. Furthermore, stakeholders declared their negative perception of drone utilization in urban areas [Paddeu & Parkhurst, (2020)].

Despite these hardships, the idea of adopting drones to deliver goods has generated significant interest among logistic players, as several pilot tests have been conducted by DHL, Amazon, UPS, Google).

One system that is considered to have the greatest potential is the one based on automated vehicles (AVs). AVs can be road-based (driverless car or trucks) or ground-based (droids).

While a few studies have been conducted on the impact of road-based AVs in urban last-mile delivery [Paddeu&Parkhurst, (2020)], there are several pilot projects on-going: Robomart, an American start-up, claimed to be the first self-driving store, Ford is testing autonomous pizza delivery in partnership with Domino's, Nuro, an American start-up, is testing grocery delivery and medical supply delivery.

Bouton *et al*., (2017) consider this scheme able to reduce delivery costs by 50% and reduce congestion due to automatic navigation systems and better driving habits, while (World Economic Forum, 2020) deems this solution able to reduce costs by 4% and congestion by 4%. The possible electrification of the vehicle would be an additional plus to the use of such a system. However, improvement depends on the level of automation (CoExist, 2020) and nowadays, enterprises have not reached yet a complete level of automation [Paddeu&Parkhurst, (2020)].

When it comes to speaking about ground-based, the situation is similar: there are several pilots delivery solutions such as Eliport, a new start up, based in Barcelona, Jingdong, China's second-biggest e-commerce company after Alibaba and Starship, a start-up that deployed its robots in 8 cities around the world.

Starship, in particular, offers a service where the autonomous robot drives itself from the origin to the destination, using a path algorithm to find the quickest and safest path, travelling at an average of 6.5km/h speed (up to a maximum of 16km/h) and guaranteeing security with micro cameras and alarms [Paddeu & Parkhurst, (2020)].

On-demand solutions similar to the one developed by Starship, could reduce drastically failed deliveries and indirectly congestion, polluting emissions and operational costs for logistic operators[Paddeu&Parkhurst, (2020)], in this regard [World Economic Forum, (2020)] quantifies a reduction of emission, delivery costs and congestion respectively of 6%, 20% and 25% while [Toy, (2020)] states that a few cents paid by the customer as a delivery surcharge can make the last-mile delivery of e-commerce items and groceries nearly free.

However, other studies, shows that commercial viability is not demonstrated: low compatibility of tools/ equipment at the destination points, safety and security issues due to human backup being remote than proximate, could increase delivery costs [Kunze, (2016)].

Furthermore, the implementation of droids is limited by regulations that not allow circulating on roadway or footway and by a resistance among professionals to the sharing of public space with droids, especially during the day [Paddeu & Parkhurst, (2020)].

Finally, there is also the possibility of autonomous vehicles with built-in Parcel Locker. The idea, although not yet deployed, has attracted considerable interest, so much so that Google acquired the patent for this technology in 2016. In theoretical hypotheses, these vehicles would be stationary in certain areas communicated to consumers or on the go, by making home deliveries. Similar to the traditional Parcel Locker, the recipient would be notified of the arrival date, location, how to open the Parcel Locker and the opening code. Lower labour costs would also lead to a halving of costs [Bouton *et al*., (2017)], but there would be an increase in the number of kilometres travelled, bringing about an increase of delivery costs and congestion of 8% and 25% [World Economic Forum, (2020)]: as these vehicles/Parcel Lockers are smaller than normal vans, with the same amount of goods transported, more deliveries would be needed. This makes electrification an essential element for the sustainability of this means of delivery.

Technology still needs to reach complete automation in order to ensure safety and reliability. Moreover, public institutions have to support trials, as the profitability of these solutions has not proved and help to remove barriers to the use of automation (e.g. procurement of equipped-roadway infrastructures, funding of ICTs technologies, specific regulatory framework to ensure safety, security, and address responsibility in case of accidents, fostering collaboration between stakeholders). In third place, lack of economies of scale and stakeholders opposition (e.g drivers) has to be managed [Paddeu & Parkhurst, (2020)].

4.6.2 Cloud Computing, AI and Data Collection through the Internet of Things

In addition to the aforementioned futuristic autonomous vehicles, still far from being realised, automation is already largely spreading in the world of logistics. Cloud Computing, Artificial Intelligence and data collection through the IoT are now the basis of the supply chain and central tool to face new challenges, such as selling more, delivering faster and predicting the ever-increasing demand for goods. These new technologies enable real-time data analysis that is then used in machine learning for robotic warehouse management, demand planning, peak management, and finally for inventory management [DHL, (2018)].

An example of the logistical application of the practices described is the use of augmented reality (AR) technology. This offers several uses that directly and indirectly affect the last-mile: on the one hand, it allows to increase the productivity of the warehouses, allowing operators a visual representation of the information present within the hubs. On the retail side, on the other hand, it would offer the consumer the opportunity to improve the ability to display a product within a given environment or directly on his own body, thus allowing to limit the return of products deemed unsuitable.

A first movement in this direction is given by the Ikea app, Ikea Place, which allows you to select a piece of furniture and see how it fits the customer's environment before making the purchase, and by the fashion company Gap which offers an app that allows you to simulate the dressing fit at home or at the store. In the future, the use of augmented reality seems to be able to extend to other logistics subjects including couriers with the use of 3D glasses for a better view of the routes [DHL, (2018)].

The most classic and most effective examples of artificial intelligence, cloud computing and real-time data are all those technologies that can plan real-time routes and improve driving sustainability based on traffic, weather, road closure and opening (e.g. GPS, GALILEO) [Mckinnon, (2018)]. It incorporates the efficiency of courier routes and the modernisation of vehicles through these technologies.

Among these technologies, load pooling is the application in the field of logistics of Uber. Load pooling consists of matching, through an online platform, the commercial vehicles of couriers with available space for goods with the needs of shops or logistics companies to ship a package. The algorithm receives information from the couriers about the available space, the route, the limitations to the receivable goods and the route of the courier, and from the customer the characteristics of the asset to be shipped, the delivery windows, the destination and the place of arrival of the package to be shipped. After receiving the information, it provides both with an optimised route and dynamic pricing based on the alternatives chosen. The benefit of this practice for the couriers is to operate at full load and to maximise the density of delivery of goods (drop densities). Bouton *et al.*, (2017) evaluate the benefits of this practice in reducing the number of kilometres travelled by 30%, reducing emissions by 30% and reducing delivery costs by 25% while the World Economic Forum, (2020) estimates a

reduction of emissions of 5% and a reduction of delivery costs of 8%. The great advantages of *load pooling* are the absence of technological barriers and the limited cost of infrastructure. This mode is now spreading: Uber, for example, is moving from people to goods, DHL has its own digital platform, UPS has bought companies that ran these algorithms and finally the outsourcing of Amazon services also moves in this direction.

The use of these technologies serves not only to directly improve the supply chain but also to monitor everything that happens on the road and indirectly influences logistics. Through geofencing, namely the creation of a virtual perimeter ('fence') associated to a real geographic area, it is possible to collect data on moving vehicles and use them to control access to certain areas, for commercial purposes, to control and book unloading areas, to assess traffic and finally to control the operation of freight delivery mechanisms.

This huge stream of data is then used for scientific research and to produce evidence, to strengthen enforcement mechanisms and to control and also to directly improve the productivity of deliveries, regardless of the mode.

The biggest limitation of geofencing is privacy: data transfer in fact requires a consensus of the parties and complex legal mechanisms. However, the effects of these technologies are potentially enormous, as they may be able to share information in real time among all stakeholders in logistics. These new technologies merged together will do even more: they will allow creating dynamic simulations of reality (DTs), or even real digital copies of real objects that are able to update in real time according to the changes of the objects from which they derive, thus offering not only the opportunity to know and predict any logistical process, but the possibility of completely revolutionised logistics.

5 Towards a LEAD Strategy Longlist

The majority of the strategies listed in Deliverable 1.1 [LEAD, (2021a)] and complemented in this work package was used to come up with the complete list of LEAD strategies. In this deliverable a review of measures and practices that are employed was is provided, mainly at a local level, to redress the balance between social cost and social benefit from UFT.

A classification[11] is presented that also considers the focus in the LEAD project and produced a classification of measures and practices in order to provide some clarity and aid the further analysis in the project, while recognising that individual measures are not implemented at a local level in isolation but as part of a mix of measures.

However, despite this categorisation, which is a useful aid to further analysis, many practices and measures fall into one or more of the above categories and, where necessary, we have included them in the category which we believe is most appropriate because of its inherent characteristics and LEAD objectives.

For example, the development of an UCC could be considered to be an infrastructure measure where it involves the development of a new distribution centre and it could also be seen as a land use planning measure if land required for a UCC is safeguarded from other uses; it could also be characterised as a technology measure where low or zero emission vehicles are operated from the UCC. Fiscal and regulatory measures can stimulate the use of UCCs, where, for example, a congestion charge increases the cost for each delivery in an urban area or only zero/low emission vehicles operating from a UCC are allowed to access a city centre at certain times of the day.

5.1 LEAD Strategy Longlist

In total 68 LEAD Strategies were clustered in the 9 categories that cover the important sustainability dimensions (Economy, Social, Environment). In the tables below the individual strategies are presented.

[11] Russo, F., A.Comi, (2010), A classification of city logistics measures and connected impacts, Procedia Social and Behavioral Sciences 2 (2010) 6355–6365, The Sixth International Conference on City Logistics
COST 321 (1998). Urban goods transport, Final report of the action. Transport Research, European Commission Directorate General Transport, Belgium.
City Ports (2005). City Ports – project interim report. Emilia-Romagna, Bologna, Italy.
BESTUFS (2007). BESTUFS - Good practice guide on urban freight. BESTUFS Consortium, www.bestufs.net.

LEAD Strategy Longlist (1)

Agile storage & last-mile distribution schemes

Consolidation		Description	Remark
Urban Consolidation Centres[1)]	C1	Warehouse (permanent facilities) with inventory and handling/ packaging operations.	
Micro Hubs	C2	Cross-dock permanent facilities with no inventory and minimal handling operations.	
Mobile depots	C3	Cross-dock trailers/ vans (no inventory) minimal handling operation - last leg vehicles on board	
Central Innovation District	C4	Hub to connect consumers, operators (lockers), carriers, crowd-shipping services	
Logistics hotels	C5	Multi use, multi-storey urban warehouses (parcel operation; multimodal; parking).	
Physical Internet Hub (UCC)	C6	UCC with Physical Internet technology	

Smart Logistics Solutions

Delivery			
Off-hour delivery[2)]	D7	Shifting deliveries from peak period to off hours (7pm to 6am)	
Nano-store B2C	D8	Deliveries to consumers at commercial locations (Pickup points)	
Parcel lockers B2C	D9	Deliveries from business to consumers at parcel lockers	
Door-to-car B2C	D10	Deliver the products directly to the consumer's car (based on blockchain technology)	
C2C parcel lockers	D11	Deliveries from consumers to consumers at parcel lockers	
B2B Retailer	D12	Deliveries to commercial locations (local shops, restaurants, etc.)	
B2C Home delivery	D13	Deliveries to consumers at home	

EDVs, Avs, Driods

Vehicle Technology			
Delivery Robots	V14	Autonomous vehicles used for delivering goods.	
Autonomous vehicles	V15	Vehicle using various in-vehicle techniques and sensors (autopilot, steer by wire, radar, etc.)	
E-Vehicles	V16	Applied E-vehicles to transport goods in urban areas	
Modular E-vehicles	V17	A special vehicle used to deliver goods by carrying one or multiple modules.	
Cargo bikes	V18	Use of a cargo-bike for freight distribution in city centers	
Taxi Logistics	V19	Applied taxis to transport goods; the purpose is to reduce traffic congestion	
Delivery drones	V20	Use of drones for freight delivery in Urban areas	
Light electric vehicles	V21	Vehicles with limited payloads ($0.5m^3$-$3m^3$), speed (<25km/h) and electrical motor assistance.	
LNG / CNG Truck	V22	Light vehicle truck propelled with LNG or CNG	
EFFV Inland transport[4)]	V23	Environmentally Friendly Freight Vehicle in Inland shipping. Urban freight ships	
EFFV Rail transport[4)]	V24	Environmentally Friendly Freight Vehicle in Rail or Tram transport.	
Retail Stores with EV charging	V25	Conventional retail stores with parking services with electric charging stations.	
EV fast charging	V26	Logistic facilities with EV charging points for electric delivery vehicles.	
CNG / LNG filling stations	V27	Infrastructure designed for filling a vehicle with LNG/ CNG fuel.	
Hydrogen filling station	V28	Infrastructure designed for filling a vehicle with hydrogen fuel.	

1) If indicated otherwise source is LEAD Deliverable 1.1 City Logistics landscape in the era of on-demand economy.
2) Holguín-Veras et al., (2018), Direct impacts of off-hour deliveries on urban freight emissions, Transportation Research Part D: Transport and Environment Volume 61, Part A, June 2018, Pages 84-103.
3) Zhangyuan&Haasis, (2019), Integration of Urban Freight Innovations: Sustainable Inner-Urban Intermodal Transportation in the Retail/Postal Industry, Sustainability, Vol.11, 1749-March.
4) Ecorys, Tecnico, TPR, (2017), The Use of Environmental Friendly Freight Vehicles. Non-binding guidance documents on urban logistics, European Commission.B-1049 Brussels.

Table 4: LEAD Strategy Longlist (1)

LEAD Strategy Longlist (2)

Innovative Business Models

Governance		Description	Remark
Try & Buy	G30	Delivery mode with ordering products online, testing and buying the product in a physical store.	
Click & Collect	G31	Model that consists of a online purchase and consequent pick up in the e-retailer store.	
Dynamic Pricing application	G32	Cost setting product or services that is highly flexible.	
Crowd-sourcing / distribution	G33	Delivery mode that leverages networks of local, non-professional couriers.	
PP Partnership	G34	Cooperative arrangement between two or more public and private partners.	
Load Pooling	G35	Matching, using an online platform, a pool commercial vehicles of couriers with available space.	
New technologies			
Cloud Computing / Logistics	T36	Technologies enabling real-time data analysis for robotics, demand planning, peak management.	
AI & IoT data collection	T37	Artificial intelligence simulation and Internet of Things application in logistics	
Block Chain[2)]	T38	Decentralized technology linking records (blocks) of information and data using cryptography.	
Predictive & Prescriptive analytics	T39	Application of Predictive & Prescriptive analytics to support and aid decision-making.	
Sensor technology[3)]	T40	Application of sensors in the supply chain (originally developed in consumer applications)	
Digital Twin	T41	Virtual replicas uses to run simulations before actual interventions are made.	
Logistics Marketplaces	T42	Digital brokerage services with a centralized marketplace / platform	
Supergrid Logistics	T43	Highly integrated logistics marketplaces as platforms of consolidation supply chain networks.	
Supporting measures			
Eco-driving	S44	The practice of driving in such a way as to minimize fuel consumption and the emissions.	
Anti-Idling[4)]	S45	Technologies fuel-operated coolant heaters, auxiliary power units, and truck stop electrification	
Consumer-incentive programs	S46	Consumer-incentive programs	
Vehicle maintenance	S47	Promote vehicle maintenance to reduce emissions	
Route optimization	S48	Route optimization is the process of finding the most cost-effective route for a set of stops.	D1-13
Promotion Best practices	S49	Promotion Best practices to educate and disseminate research and experience	

1) Euromonitor consulting, (2018), Euromonitor. (2018). SHORTENING THE LAST MILE: WINNING LOGISTICS STRATEGIES IN THE RACE TO THE URBAN CONSUMER, DHL custom report .
2) DHL Customer Solutions & Innovation, (2020), LOGISTICS TREND RADAR, 5th Edition, Delivering Insights Today, Creating Value Tomorrow.
3) Richter, K., O. Poenicke, (2013), LOW-COST SENSOR TECHNOLOGY, A DHL perspective on implications and use cases for the logistics industry December 2013, Frauenhofer, DHL.
4) Civitas, (2016), Smart choices for cities, Making urban freight logistics more sustainable, CIVITAS WIKI consortium.

Table 5: LEAD Strategy Longlist (2)

LEAD Strategy Longlist (3)

Regulatory measures		Description	Remark
Time windows[1]	R50	Regulated access to urban area's in time	
Parking regulations	R51	Regulations on parking (time, location, fee, reservation systems, timesharing).	M68
Size / weight access restrictions	R52	Vehicle weight and size restrictions (dimensions, axles, weight)	
Freight traffic flow management	R53	Freight-traffic flow management measures, truck routes, restricted multi-use lanes.	
Emission zone restrictions (LEZ)[2]	R54	Access to urban areas limited to freight vehicles that meet certain emission standards.	
Harmonisation legislation	R55	Harmonisation of legislation related to time windows size/weight and emissions on country level.	
Land-use planning & Infrastructure			
Adopting on-street ULA[2]	L56	Adapting existing street designs and loading areas to accommodate vehicles	
Nearby delivery areas[2]	L57	develop off-street areas at businesses or facilities that regularly receive freight	
Upgrading cental ULA	L58	redesigning docks to accommodate the geometric needs of current and future trucks	
Collection points	L59	Use of specific locations for pick-up and deliveries (see Parcel lockers)	D9-D11
Traffic control	L60	Monitor and control traffic with the aid of signs, equipment, and devices.	
Rail & waterway connectivity	L61	aim of modal shift programme is to encourage the use of alternative modes.	
HGV signage	L62	Clear and efficient routing and signage for HGV	
Market-based Measures			
Road pricing[2]	M63	Motorists pay directly for driving on a particular roadway or in a particular area (fixed or variable)	
Taxation and tax allowance[2]	M64	Taxation can be imposed on vehicle emissions, fuel, vehicle ownership or use.	
Permits & Mobility credits[2]	M65	Tradable permits / mobility credits model to reduce high levels of congestion and pollution.	
Incentives & Subsidies	M66	Incentives or subsidies to encourage the development of sustainable urban distribution.	
Congestion charging[3]	M67	Refers to variable road tolls (higher prices under congested conditions).	M63
Parking pricing	M68	Parking charging schemes, where motorists pay directly for using facilities.	R51

1) MDS Transmodal Limited, (2012), DG MOVE European Commission: Study on Urban Freight Transport FINAL REPORT
2) Civitas, (2016), Smart choices for cities, Making urban freight logistics more sustainable, CIVITAS WIKI consortium.
3) Aifandopoulou, G., E. Xenou, (2019), Topic Guide, Sustainable Urban Logistics Planning, framework of the NOVELOG project.

Table 6: LEAD Strategy Longlist (3)

5.2 The link between Sustainability and the LEAD Strategy Longlist

With the longlist of LEAD strategies available, the next step is to link the individual measures to the Sustainability Dimensions and Consequence Areas (discussed in 2.5.2). This helps to find the specific LEAD Strategies to formulate and support specific policy goals.

In Table 8 to Table 10 the individual LEAD Strategies are again presented with the link with the Sustainability Dimensions and underlying Consequences areas.[12] The combination between the LEAD strategy and the Sustainability consequence was based on the survey that was conducted (Task 1.4) in which the different scenarios were evaluated (including a lot of the strategies included in the longlist).

In the tables below, a link between the LEAD Strategies and Sustainability Consequence Area was made, without ranking the impact high or low. The purpose of these tables is just to identify those strategies that fit a specific policy goal.

In addition, the city typology discussed in 2.1.1 is included in the figures below (Z1 to Z4). A final column was added referring to the Logistics Profile (A to E) as presented in Section 2.1.3.

By linking the individual LEAD Strategies to the Sustainability Dimensions and Consequences, and the City Typology we hope to help the LLs and relevant stakeholders to formulate specific policies and strategies to tackle their specific challenges.

[12] See Deliverable 1.4 Innovation Agenda - Value case scenarios and validation KPIs. Chapter 2.3 for more information on the sustainability impact analysis and methodology that was used.

LEAD Strategy & Sustainability dimensions overview (1)

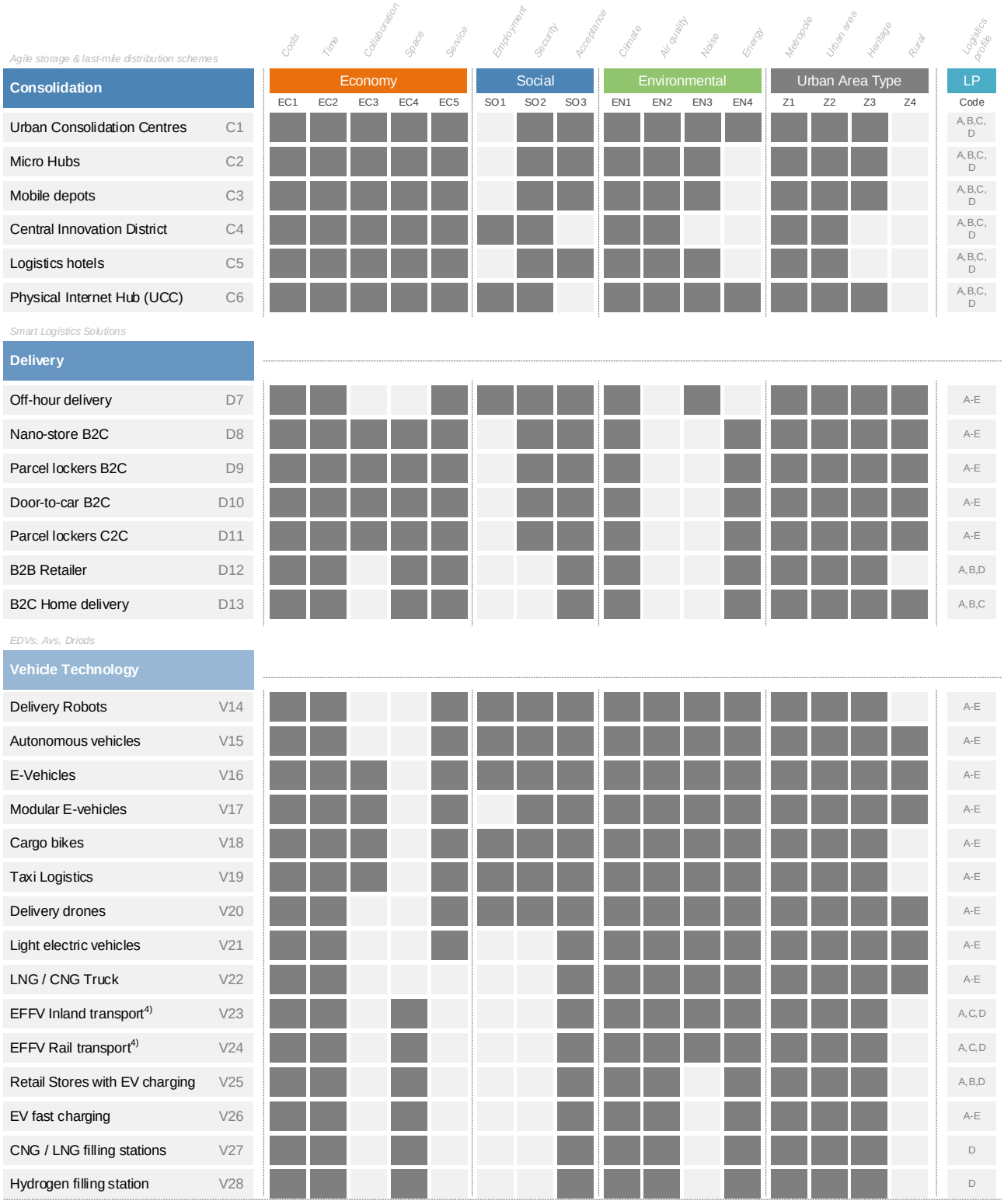

Table 7: LEAD Strategy & Sustainability dimensions overview (1)

LEAD Strategy & Sustainability dimensions overview (2)

Table 8: LEAD Strategy & Sustainability dimensions overview (2)

LEAD Strategy & Sustainability dimensions overview (3)

Table 9: LEAD Strategy & Sustainability dimensions overview (3)

5.3 Value case scenarios

A value case is defined as a combination of different measures to achieve a certain objective. In Deliverable 1.4 [LEAD, (2021d)] several value case scenarios per LLs were presented (Madrid, Porto, Oslo, the Hague, Budapest, and Lyon). Based on additional research a longlist of other value cases in which specific combinations of UFT measures were included was also evaluated. In the map below these different value cases are presented. In Annex 2 the longlist and references are provided.

Figure 8: Overview of UFT value case scenarios[13]

The value cases were setup by the LEAD CoPs that started with a prospection of the ongoing initiatives and previous projects that allowed the identification of the interested parties to involve [ZLC has built upon the experience developed in previous projects such as Mobility4EU, SPROUT and INDIMO[14]]. Finally, the template included in [SPROUT, (2020b)] and the stakeholder engagement strategies described in (INDIMO, 2020) were the basis for supporting the LEAD Living Labs in mapping the suitable stakeholders and defining engagement strategy.

The LLs value case scenarios comprise the baseline scenario and four future scenarios. The former is used as the baseline scenario to compare the impacts on the externalities of

[13] *Ruescha, et al., (2012), The Seventh International Conference on City Logistics Sustainable goods supply and transport in conurbations: Freight strategies and guidelines Procedia - Social and Behavioral Sciences 39 (2012). Novelog, (2016), Civitas, (2016).*
[14] *See for additional information on these projects: https://cordis.europa.eu/projects/en*

implementing some actions. The latter refers to the actions that will be implemented which are the result of combining a set of logistics measures defined from the strategies and trends identified by WP1. LLs defined the value case scenarios in a three-step process.

Firstly, this activity started mapping the last-mile city logistics measures (see Annex 3). The list of logistic measures was generated through a process of analysing the strategies in outstanding scientific reports ((Verlinde et al., 2014), (Gatta et al, 2019), (Parcel and Postal technology international, 2017)) and projects (STRAIGHTSOL[15], BESTUFS[16], C-LIEGE[17], CITYLOG[18], NOVELOG[19]). More detailed information about some of the logistics measures can be found in (LEAD, 2020b).

Secondly, this information was presented to LLs using a template along with further details about how fulfilling it to describe the future scenarios. The LLs used this template as a reference to iteratively build their scenarios. During T1.4, the LLs partners met several times for agreeing with the preliminary set of scenarios they wanted to present before starting with the consequence analysis and the validation workshops.

Finally, once the Living Labs agreed with the preliminary set of scenarios, the future scenarios were described with narrative text and used to assess the sustainability impacts and identify the opportunities and threats. The outcomes of these two activities help to validate the scenarios.

To illustrate how the longlist of measures can be used in a real-life environment we will briefly describe the value case scenarios that were formulated and evaluated in the different Living Labs. See for further information deliverable 1.4.

5.3.1 LL1 Madrid value case

The first illustration is taken from the LL1 Madrid. Madrid is the biggest and most populated city in Spain with 3.3 million inhabitants, and together with its metropolitan area is the third biggest Functional Urban Area (FUA) in Europe, with 6,779,888 inhabitants. Located in the centre of the country between the Atlantic and the Mediterranean TEN-T[20] corridors, is one of the main crossroads and it functions as an important logistic and commercial hub –being the first Spanish metropolitan area in economic activity —, and the tenth of Europe.

The target location for the Madrid LL activities is within the central district of the municipality. It is the most touristic area of the city and accounts for 141,527 registered inhabitants.

[15] http://www.straightsol.eu/
[16] http://www.bestufs.net/
[17] http://www.c-liege.eu/home/
[18] https://cordis.europa.eu/project/id/233756
[19] http://novelog.eu/
[20] https://ec.europa.eu/transport/themes/infrastructure/ten-t_en

The LL will consist of an UCC placed at the Plaza Mayor parking facility, strategically located in the old centre of the city and the Low Emission Zone/UVAR of “Madrid Central”. In the figure below the set of LEAD Strategies that is included in this scenario are depicted.

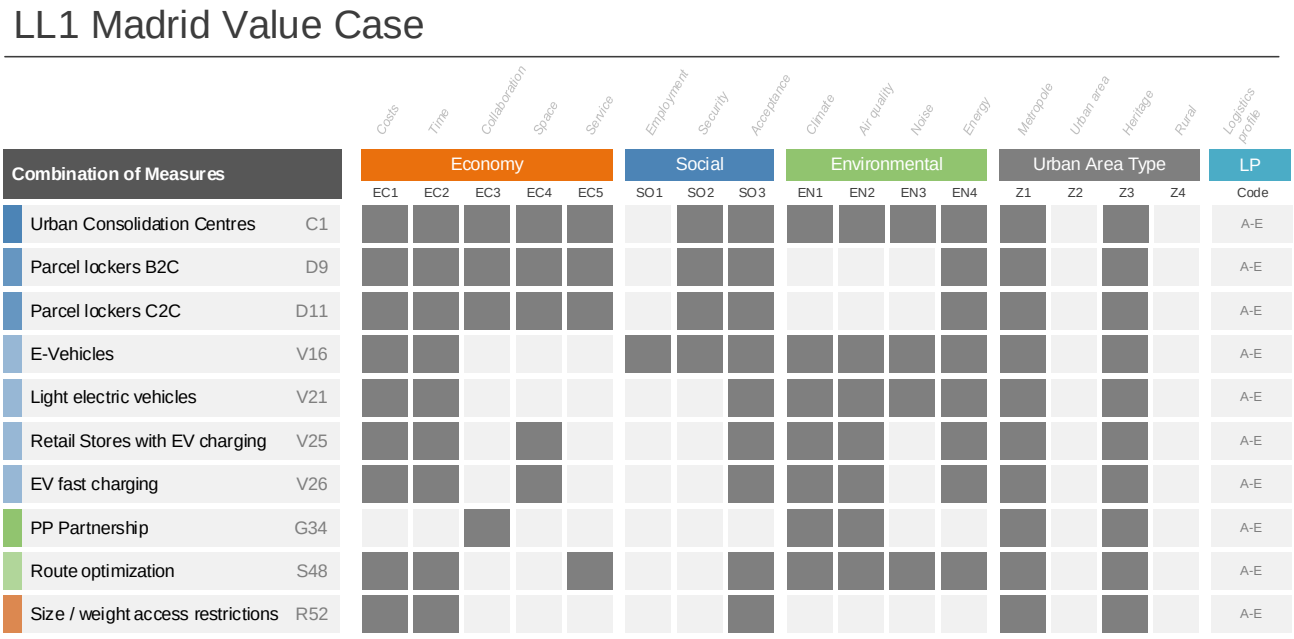

Table 10: LL1 Madrid Value case overview of measures for scenario 4.

5.3.2 LL2 Hague value case

The second illustration is taken from the LL in The Hague. The population of The Hague is currently around 0.5 M and expected to grow by 20% until 2040. The Hague is a hot spot for international institutions (193 organizations currently, with an expat community of over 60,000 people). The city is undergoing a densification process in already dense areas. The main areas undergoing redevelopment and growth are the Central Innovation District (CID) and Binckhorst area. The CID is the mixed CBD and residential area between the three main railway stations: Centraal, Holland Spoor and Laan van NOI. The CID currently is the home of 80,000 inhabitants with 23,000 housing units, offers 63,000 jobs and attracts 200,000 commuters and 30 M visitors per year. Attached to the CID is the Binckhorst area, a former industrial district of The Hague that is being revitalized in order to accommodate new housing and commercial areas, with easy underground access to the motorway network.

Important approaches for sustainable parcel logistics include crowd shipping solutions, platform-based approaches and public consolidation places like mobility hubs. The mission of the LL in The Hague is to connect different stakeholders involved in the urban freight system in the CID to provide a more efficient parcel service with less environmental impact that improves the liveability of the CID area.

It will do this by creating platform linkages, using a smart connector that can act between platforms, allowing the exchange of data to make door-to-door chains from different services.

LL2 The Hague Value Case

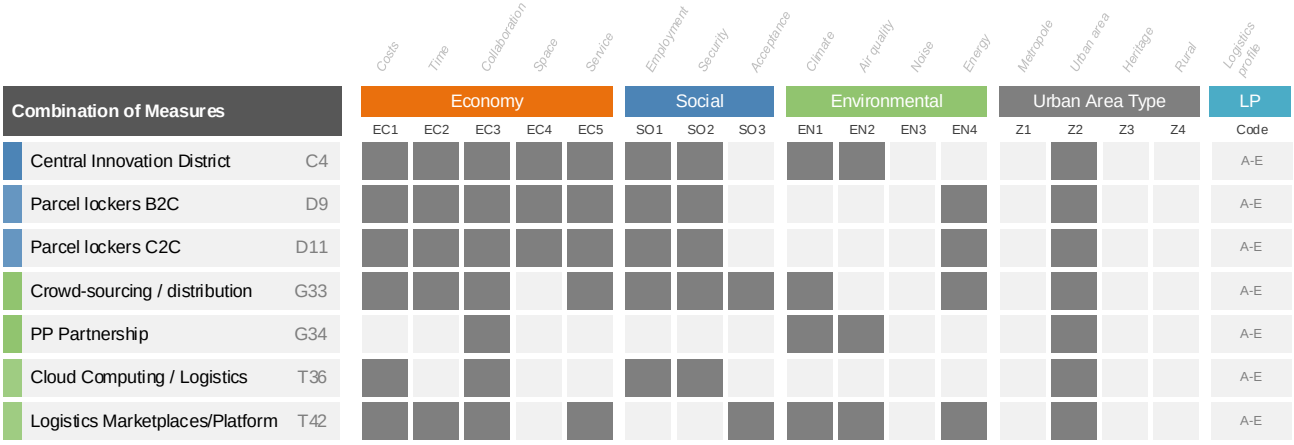

Table 11: LL2 The Hague Value case overview of measures for scenario 4.

Scenario 4 is the most complex one. It includes an open integration platform to connect the many different urban freight organization. This additional measure may further reduce the operational and total costs and support the use of parcel lockers included in S2. The creation of an open logistics connection facility may increase the number of cooperative solutions and users' sustainable behaviour. It may impact positively on the price and reliability.

5.3.3 LL3 Lyon Value case

The third scenario is taken from LL Lyon. Stretching over 1,5 km², Confluence is a distinctive district as it naturally encompasses the peninsula tip of Lyon's historical centre, while fostering massive urban construction with over a million m² built in between year 2000 and 2030. Urban policies are looking forward to settling a peaceful and low-motorized environment, hence confronting the still-roaring automotive mobility. Another goal is also to ensure a better share of public spaces. Hosting and being surrounded by some iconic landmarks of the city Lyon Confluence combines commercial, economic and cultural activities with housing.

Existing sites include: (1) Unibail Shopping Centre (70.000 m²), (2) Parking operated by LPA, (3) Logistics centre operated by La Poste. Potential development sites are logistics hotel operated by LPA a multimodal hub dedicated to freight operations (road, train and river). This is a candidate to support local experimentations and an area that can include some small logistics installations. Another potential site is Perrache, multimodal hub connected to the major TEN-T transport networks that can house a logistics space, and a limited number of physical gates (entries and exits).

LL3 Lyon Value Case

Combination of Measures		Economy					Social			Environmental				Urban Area Type				LP
		Costs	Time	Collaboration	Space	Service	Employment	Security	Acceptance	Climate	Air quality	Noise	Energy	Metropole	Urban area	Heritage	Rural	Logistics profile
		EC1	EC2	EC3	EC4	EC5	SO1	SO2	SO3	EN1	EN2	EN3	EN4	Z1	Z2	Z3	Z4	Code
Urban Consolidation Centres	C1	■	■	■	■	■		■	■	■	■	■	■		■	■		A, B, D, E
E-Vehicles	V16	■	■			■	■	■	■	■	■	■	■		■	■		A, B, D, E
Cargo bikes	V18	■	■			■	■	■	■	■	■	■	■		■	■		A, B, D, E
Light electric vehicles	V21	■	■			■			■	■	■	■	■		■	■		A, B, D, E
PP Partnership	G34			■						■	■				■	■		A, B, D, E
Parking regulations	R51	■	■						■	■	■	■	■		■	■		A, B, D, E
Size / weight access restrictions	R52	■	■						■	■	■	■	■		■	■		A, B, D, E
Parking pricing	M68	■	■		■	■			■	■	■				■	■		A, B, D, E

Table 12: LL3 Lyon Value case overview of measures for scenario 4

Future scenarios are based on a sequential 4 steps process. A new Urban Consolidation Centre (UCC) to be based in an existing underground parking represents the pivot infrastructure. On this basis, four delivery scenarios will combine low emission distribution means (cargo bikes, light EVs, light autonomous vehicles) and the extension of the catchment area towards northern urban districts.

5.3.4 LL4 Budapest Value case

A fourth scenario is taken from the LL Budapest and takes place in the city of Budapest, as an urban node, affected by the Orient East Med and Mediterranean TEN-T corridors[21], is an important logistics area with 20% of the country's population. The target location for the pilot activities for Budapest LL will be defined within the inner-city area, enclosed by the Grand Boulevard where the density of retailers/ shops and loading areas are the highest.

Budapest LL (with the coordination of the participating partners: BKK, Waberer's-Szemerey Logisztika, Széchenyi István University and Panasonic) will explore in the LEAD framework: Advantages of using UCCs for serving a certain area. Different locations for centres (along TEN-T corridor, suburbs, city centre), also to explore the optimal distance of UCCs from the endpoint of delivery,

[21] *https://ec.europa.eu/transport/themes/infrastructure/mediterranean_en*

LL4 Budapest Value Case

Combination of Measures		Economy					Social			Environmental				Urban Area Type				LP
		Costs	Time	Collaboration	Space	Service	Employment	Security	Acceptance	Climate	Air quality	Noise	Energy	Metropole	Urban area	Heritage	Rural	Logistics profile
		EC1	EC2	EC3	EC4	EC5	SO1	SO2	SO3	EN1	EN2	EN3	EN4	Z1	Z2	Z3	Z4	Code
Urban Consolidation Centres	C1	■	■	■	■	■		■	■	■	■	■	■	■		■		A,B,C
Micro Hubs	C2	■	■	■	■	■		■	■	■	■	■		■		■		A,B,C
Nano-store B2C	D8	■	■	■	■	■		■	■	■			■	■		■		A,B,C
B2B Retailer	D12	■	■		■	■			■				■	■		■		A,B,C
E-Vehicles	V16	■	■			■	■	■	■	■	■	■	■	■		■		A,B,C
Light electric vehicles	V21	■	■			■			■	■	■	■	■	■		■		A,B,C
LNG / CNG Truck	V22	■	■						■	■	■	■	■	■		■		A,B,C
PP Partnership	G34			■						■	■			■		■		A,B,C
Time windows	R50	■	■			■			■			■	■	■		■		A,B,C

Table 13: LL4 Budapest Value case overview of measures for scenario 4

For the environmental dimension, the time the micro platform is available will impact on the GHG emissions and air quality. The longer it is available the greater the positive impact. About considering a mobile or permanent facility may impact negatively energy needs. The use of a mobile depot 24 hours will slightly increase consumption.

For the social dimension, regardless of the combination of measures, all the scenarios will slightly improve the number and quality of jobs, the neighbourhoods' life and local stores benefits, however, they may increase the cybersecurity and data privacy concerns.

For the economic dimension, the four scenarios will positively impact on users' sustainable behaviour, delivery time and reliability and logistics' space. However, on the one hand, the use of a mobile depot will negatively impact the operator's costs, especially on the operational costs while a permanent facility will have a positive effect. On the other hand, the mobile depot will impact positively on traffic congestion while the permanent micro hub will have a negative effect. Finally, the price may get better only when the scenario presents a mobile depot 7/12h.

5.3.5 LL5 Oslo Value case

The fifth illustration is the Oslo value case. This living lab is located in Oslo, the capital of Norway with a total surface area of 454 km2. Two-thirds of the area consist of protected forest. Oslo has around 690.000 inhabitants whereas around 1.5 million people reside in the Greater Oslo area. Oslo has traditionally been an industrial town with mills, mechanical industries and shipyards. During the last 40 years, the traditional industries have been widely replaced by the knowledge-intensive business services sector. As the population of Oslo increases rapidly, the former industrial plants are redeveloped for housing and commercial activities.

The former city planning was zone-based, depending on mass-transportation between zones for housing and zones for industry and commercial activities. Present city planning creates a more mixed urban structure that allows for new thinking of transportation with more attention towards softer modes and micro-mobility.

As mentioned above, Oslo City has goals and ambitions to reduce GHG emissions and reduce the use of cars through better conditions for the softer modes, public transport and shared mobility. Oslo is affected by many underlying trends, like increases in urbanization, digitalization, environmental consciousness among the population and use of shared services. In addition, the need for flexibility and led use of private cars creates markets for innovating home deliveries.

LL5 Oslo Value Case

Combination of Measures		Costs	Time	Collaboration	Space	Service	Employment	Security	Acceptance	Climate	Air quality	Noise	Energy	Metropole	Urban area	Heritage	Rural	Logistics profile
		Economy					Social			Environmental				Urban Area Type				LP
		EC1	EC2	EC3	EC4	EC5	SO1	SO2	SO3	EN1	EN2	EN3	EN4	Z1	Z2	Z3	Z4	Code
Urban Consolidation Centres	C1	■	■	■	■	■		■	■	■	■	■	■		■	■		A-E
Micro Hubs	C2	■	■	■	■	■		■	■	■	■	■			■	■		A-E
Nano-store B2C	D13	■	■	■	■	■		■	■	■	■		■		■	■		A-E
E-Vehicles	V16	■	■			■	■	■	■	■	■	■	■		■	■		A-E
Light electric vehicles	V22	■	■			■			■	■	■	■	■		■	■		A-E
Retail Stores with EV charging	V24	■	■		■				■	■	■		■		■	■		A-E
EV fast charging	V25	■	■		■				■	■	■		■		■	■		A-E
Crowd-sourcing / distribution	G33	■	■	■		■	■	■	■	■	■		■		■	■		A-E

Table 14: LL5 Oslo Value case overview of measures for scenario 4

This means that there is a need for more efficient urban freight logistics and hence new and innovative urban freight logistics concepts. Smart city logistics in general are expected to provide more efficient transport and logistics solutions and make urban freight logistics more sustainable. One example that will be addressed in the Oslo LL is to used spare transport capacity for urban freight through shared mobility by means of e.g. crowdshipping. Even though the market for home deliveries and urban freight is increasing, one could then achieve a reduced need for freight transport kilometres.

5.3.6 LL6 Porto Value case

The LL6 is located in the Porto metropolitan area in the North of Portugal. Porto is the second-largest city in Portugal and one of the Iberian Peninsula's major urban areas. Porto city is small compared to its metropolitan area, with a population of 237,559 people. Porto's metropolitan area has an estimated 1.7 million people (2019) in an area of 2,395 km2 making

it the second-largest urban area in Portugal[22]. This LL is led by Sonae Modelo Continente (MC)[23], the leading multi-format omnichannel Food Retailer in Portugal.

During the first lockdown in Portugal, the e-commerce through its own app and digital platform www.continente.pt had grown more than six times and stabilized more than twice when compared to 2019. So, it is an important moment to introduce new mindsets, new business models and new strategies regarding the home deliveries service to our customers. The vision for Porto Living Lab is clear: turn the Sonae MC home deliveries based on electric mobility through turning retail stores into electric mobility nodes and test some new business models based on this important transition on its last-mile home deliveries.

LL6 Porto Value Case

Agile storage & last-mile distribution schemes		Costs	Time	Collaboration	Space	Service	Employment	Security	Acceptance	Climate	Air quality	Noise	Energy	Metropole	Urban area	Heritage	Rural	Logistics profile
Combination of Measures		Economy					Social			Environmental				Urban Area Type				LP
		EC1	EC2	EC3	EC4	EC5	SO1	SO2	SO3	EN1	EN2	EN3	EN4	Z1	Z2	Z3	Z4	Code
B2C Home delivery	D13	■	■		■	■			■				■	■			■	E
E-Vehicles	V16	■	■			■	■	■	■	■	■	■	■	■			■	E
Modular E-vehicles	V17	■	■	■		■	■	■	■	■	■	■	■	■			■	E
Light electric vehicles	V22	■	■			■			■	■	■	■	■	■			■	E
Retail Stores with EV charging	V24	■	■		■				■	■	■		■	■			■	E
Route optimization	S48	■	■			■			■	■	■	■	■	■			■	E

Table 15: LL6 Porto Value case overview of measures for scenario 4

The main challenges to be tackled will be the positioning of the EDV charging stations, routing optimization and the cost factor. To study, test and prepare the TO BE scenarios some important factors will be considered (grid connection costs, renewable energy sources, etc.) as well as some parameters (Lead time, distance travelled, CO2 emissions, traffic, stops frequency, stops duration, types of batteries and its strategy, vans and motorbikes models, charging types, etc.).

[22] *https://en.wikipedia.org/wiki/Porto*
[23] *https://sonaemc.com/en/*

6 Feasible combinations: LEAD Policies

This chapter focuses on the impact of the policy measures and how the LEAD Strategies can be used in the generation of UFT policies and evaluation. While intervention by the public sector is justified in order to reduce the negative impacts of UFT, the most effective measures at all levels of policy-making are most likely to be those that also incentivise UFT operators and/or their customers to increase distribution efficiency. Such measures will have the effect of both reducing costs and/or adding value for the private sector while also reducing negative externalities.

6.1 Policy impact modelling and evaluation

Before presenting a specific policy example (a combination of LEAD Strategies) the work done in Deliverable 1.2 is briefly summarised. The aim of this deliverable was to consolidate best practices and develop a knowledge base and library of reference models for urban logistics and describe the models that are to be included in the LEAD model knowledge base. The objective of this Knowledge Base is to assist the LLs in identifying the models necessary to develop the DT and to serve as a reference for stakeholders when developing their modelling strategy. For detailed information on the Knowledge base see LEAD deliverable 1.2 [LEAD, (2021b)].

6.1.1 Outputs

The output of the set of models included in the Knowledge Base (KB) are categorised into 7 groups: policy analysis, cost, demand, externality, network, logistic service data and logistical infrastructure:[24]

1) Policy analysis, corresponds to the measurements of effectiveness, impacts and acceptance of policies and actions, such as risk valuations and Social Cost Benefit Analysis (SCBA). In the model library this has been accomplished by Stakeholder Acceptability model (MOLDE1) and an impact assessment one (Polis1).

2) Cost related outputs are important aids in the decision making of both private stakeholders and public authorities. The most important KPI is the total logistic costs incurred, either by individual firms or by the urban logistic system. Additional partial costs can also be considered, such as transport, investment, storage and operating costs.

3) Demand outputs measure the flow of goods within the city. They can be expresses as OD matrices of commodities, both for parcels and regular shipments, or as a receivers'

[24] *For the individual models we refer to Deliverable 1.2.*

preferences and transport modes market shares. Agent Based Model (ABMs) are models that allow evaluating all of these metrics by simulating the behaviour of the agents involved.

The **Externality (4)** category refers to the measurement of externalities of UFT. The main KPI here is the volume of emissions usually by Impact Assessment Models. For additional background on the included externalities see LEAD (2021b).

5) Network outputs are measurements of the state and use of the road network. These measures can be KPIs of different partners, such as travel distance (total or per vehicle type), travelled times, vehicle kilometres and transported tonnes, all of them being outputs of descriptive nature. Additionally, descriptive measurements of network usage, travel times, travel distances, traffic flows and network loads also belong to this category.

The **Logistic service outputs (6)** include measurement of the Level of Service (LoS) and service attributes of different alternatives. In this category, optimization models and the optimisation subcomponents provide LoS measures, like the percentage of attended clients or unattended orders.

Finally, **Logistical infrastructure metrics (7)** refers to the location of UCC and warehouses.

6.1.2 Measures

The main actions analysed in the Knowledge Base are either active measures taken by the stakeholders or passive by the overall economy or societal trends that models can potentially address. The 7 measures that have been defined are shorted from the ones that have the longest/term effect to ones with the shorter term. These are: consumer habits changes, land use shifts, road infrastructure development, logistic infrastructure, logistic management, transport market and infrastructure use. The categories were adapted from Tavasszy & de Jong (2014) to include different measures and temporal application scopes.

Consumer preferences refer to changes in consumers preferences over time. The increase in e-commerce, or increasing consumer demand for services with a lower environmental impact are included in this category. Although some models can include trends as input, there was no model that could solely calculate consumer preference changes.

Land use englobes the measures that change the land uses patterns. These measures create new commercial production and residential areas and they modify the production and attraction of products.

Construction of new transport network infrastructure, an important measure that public authority can introduce and have important effects. The new infrastructure refers to new roads, development of bike lanes or new electric charging infrastructure or expanding the capacity of existing ones.

Logistics infrastructure-related decisions are medium term and affects the location and distribution of inventory, affect transport costs and influence the LoS. Other infrastructure dedicated to logistics such as warehouses, UCCs, terminals and transhipment facilities can also be developed. These decisions are related to the infrastructure location and capacity of the inventories.

Logistic management covers the different management strategies that can affect the supply side of the supply chain. Inventory policies, including shipment size and replenishment frequency fall in this category as well as vehicle load factors.

Transport market-related measures affect the choice of transport service providers. It covers both the supply and demand side of the transport services. A new alternative, such as crowdshipping, price strategies or the client's response to changes in LoS are examples of these actions and that models covering this category might be able to address. It contrasts with logistic management by focusing on the demand side.

Network infrastructure utilisation refers to the short-term operational decisions of deliveries. From the supply side, they correspond to scheduling, network allocation and routing deliveries. For the demand side, they could relate to receiving windows for shops. Public authorities can set restrictions on certain roads, such as weight restriction, emission restrictions and time restrictions that would fall in this category.

The two additional categories correspond to **externalities** for models that focus only on the evaluation of externalities and **complementary models** that provide data collection or broader impact assessment tools that do not fit in other categories.

The relationship between the type of questions or measure and type of model is summarised in the table below, where the models that can potentially address a particular combination of outputs and measures can be obtained. The number denotes the number of models in the KB.

Type of question / measure		Descriptive models					Design		
		DM1 Policy analysis	DM2 Cost	DM3 Demand	DM4 Externality	DM5 Network	DM6 Logistics service	DM7 Logistics infrastructure	DM8 External to freight
Consumer preferences	M1			1					
Land-Use	M2	2	1	4	4	2	1		
Network Infrastructure construction	M3	2	1	5	5	4	1		
Logistics infrastructure	M4	2	1	3	4	1	3		
Logistics management	M5	1	4	1	1	4	4		
Transport market	M6			4	2	2	2		
Infrastructure use	M7	1	4	4	4	6	4	1	
Externality analysis	M8				3				
Complementary models	M9	1	2	4	4		2		2

Table 16: Relationship between measure and Output-category

6.2 Synthesis of the results: Example policies.

The value cases will involve different stakeholders across the supply chain —including last-mile delivery carriers and policy makers— in a co-creation process aligning different priorities, perceived values and competing interests, accounting for consumers' preferences and, thus, their most likely behaviours. Cost, environmental and operational efficiencies will be achieved through a combination of measures, referred to as LEAD Strategies (see Figure 1). In this chapter some examples of logical combinations of LEAD strategies with the aim to support the overall objective to implement specific strategies in the LLs will be presented:

Focus on regulation. This example focuses on the delivery in historic centres where the main economic activities are shops, restaurants and cafés.

Efficient deliveries: Encouraging the procurement and provision of efficient deliveries and collections in urban areas in terms of both internal and external costs.

Low emission vehicles: Encouraging the development and take-up of low emission vehicles for "last-mile" deliveries.

6.2.1 Focus on regulation

This is a combination of individual measures to deal with challenges with deliveries in the historic centre where the main economic activities are shops, restaurants and cafés. The main cargo commodities delivered into the centre are likely to be ambient retail goods to the shops and food and beverage supplies to the cafés and restaurants (ambient, chilled and frozen). Most deliveries into the historic centre are likely to be carried out using vehicles operated directly by wholesalers and suppliers to catering/retail outlets (i.e. in-house operation) or by their contracted haulage carriers.

The main issues relating to UFT in this example are the need to ensure that deliveries are carried out at times that do not conflict with movements of tourists and shoppers within the pedestrian zone and air quality, with the city exceeding legal.

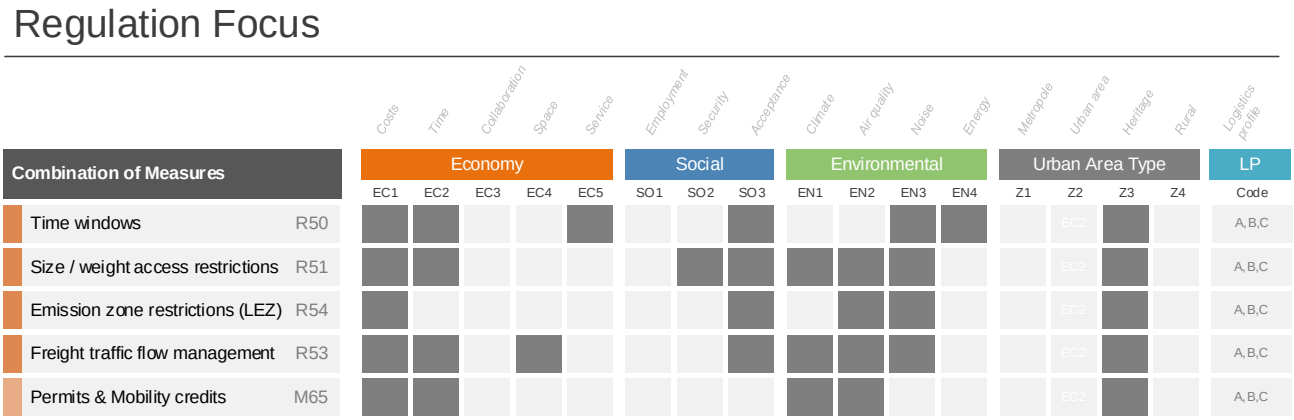

Table 17: Regulation Policy Focus

The policy presented as an example here has the objective to regulate the flow of incoming traffic to protect its historic city centre and to provide an attractive environment for tourists, visitors and residents through the implementation of time windows and weight restrictions.

Measures that have been included in relation to UFT in this example city are as follows:

Time window (R50): Access for deliveries into the pedestrianised zones of the city is only between 06.00 and 09.30 to avoid conflicts with tourists, shoppers and residents.

Size/weight access restriction (R51): Vehicles exceeding 7.5 tonnes are not allowed within the inner ring road at peak times (06.30 to 09.00 and 14.00 to 17.00) and vehicles exceeding 3.5 tonnes cannot access the pedestrian zone in the centre of the city at any time.

Emission zone restriction (R54), All HGVs (over 3.5 tonnes gross laden weight) are required to meet Euro 4 emissions standards.

Loading and unloading bays: bays are available for freight vehicles in the city centre outside the pedestrian zone. Within the pedestrianised areas vehicles are able to park close to the

receiving locations outside the time window because there is little or no conflict with other vehicles or pedestrians at that time of the day.

Access charging: Each LGV that wishes to access the pedestrian zone has to purchase an annual permit.

Mobility credits: concept that establishes the total amount of “acceptable” emissions within a specified zone of a city and then allocates them to economic operators such as retailers and occupiers of offices to “purchase” freight transport services that are not subject to additional access charges or restrictions.

This is how a typical strategy can be formulated and constructed. First to be tested in the LL and resulting in implementation. It is the LEAD Strategy Longlist that provides the building blocks for the policy

6.2.2 Efficient deliveries

Another example is presented in the figure below. Closer to the LEAD value cases discussed in the LLs. Encouraging the procurement and provision of efficient deliveries and collections in urban areas in terms of both internal and external costs.

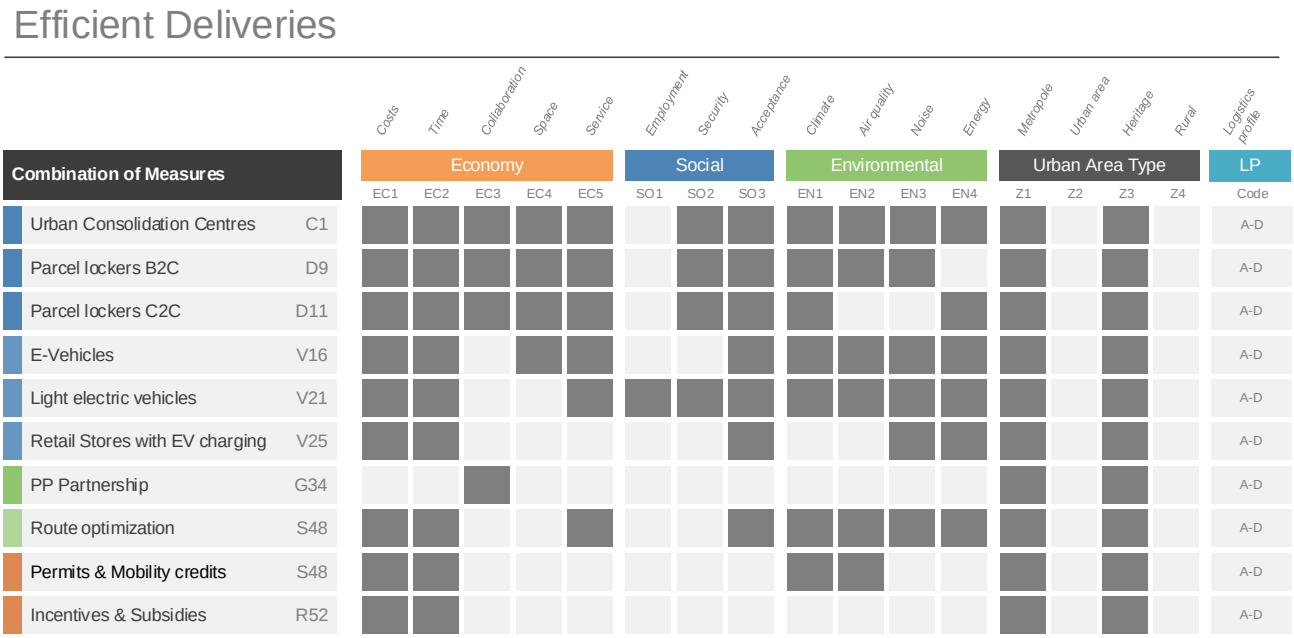

Table 18: Efficient Deliveries Policy

In the table above a comprehensive set of LEAD Strategies is presented to facilitate efficient deliveries and use of e-vehicles, using a UCC and stimulating through Permits, Credits and Incentives.

6.2.3 Low emission vehicles

A final policy example focuses on the development and take-up of low emission vehicles for last-mile deliveries. LEZs are where access to urban areas is limited to freight vehicles that meet certain emissions standards and are usually introduced in Metropolitan areas or Larger Urban Areas (Z1 and Z2) where air quality is a particular concern. Access may be allowed for more polluting vehicles if the owner is prepared to pay a punitively high daily charge. LEZs are becoming increasingly common in major European cities as a practical means for city authorities to meet European air quality standards. Below is a comprehensive combination of LEAD Strategies.

Low Emission Vehicle Focus

Combination of Measures		Costs	Time	Collaboration	Space	Service	Employment	Security	Acceptance	Climate	Air quality	Noise	Energy	Metropole	Urban area	Heritage	Rural	Logistics profile
		Economy					Social			Environmental				Urban Area Type				LP
		EC1	EC2	EC3	EC4	EC5	SO1	SO2	SO3	EN1	EN2	EN3	EN4	Z1	Z2	Z3	Z4	Code
Urban Consolidation Centres	C1	■	■	■	■	■		■	■	■	■	■	■		■	■		A,B,C
Micro Hubs	C2	■	■	■	■	■		■	■	■	■	■			■	■		A,B,C
Nano-store B2C	D8	■	■	■	■	■		■	■	■			■		■	■		A,B,C
E-Vehicles	D12	■	■		■	■			■				■		■	■		A,B,C
Light electric vehicles	V16	■	■			■	■	■	■	■	■	■	■		■	■		A,B,C
EV fast charging	V21	■	■			■			■	■	■	■	■		■	■		A,B,C
PP Partnership	G34	■	■						■	■	■	■	■		■	■		A,B,C
Emission zone restrictions (LEZ)	R54			■						■	■				■	■		A,B,C
Taxation and tax allowance	M64	■	■			■			■			■	■		■	■		A,B,C

Table 19: Low Emission Policy

In this example, a combination is sought between a UCC, Micro Hubs and a range of E-vehicles embedded in Emission zone restrictions and Taxation and Allowance measures. Again a mere example of a possible combination in which the LEAD Strategy Longlist provided the building blocks.

7 Conclusions and next steps

In this report, the results of WP1 of the LEAD project were presented with the aim to develop a range of logistics solutions for shared, connected and low-emission logistics operations, empowered by an adaptive modelling approach and DT (DT) models.

The results that were presented and discussed at length in the separate Deliverables 1.1 to 1.4 were briefly summarised in this deliverable and used to derive the overall objective of WP1.

The majority of the strategies were listed in Deliverable 1.1 and were complemented in this deliverable with additional measures, based on extensive literature review, to come up withthe complete list of LEAD strategies.

These strategies, technologies and logistics concepts were organized and structured into a LEAD typology (captured and clustered in the LEAD Strategy Longlist) for urban distribution settings that can be tested in the LLs. The strategies were clustered into nine separate categories.

In the LLs in 6 cities stakeholders were engaged across the supply chain for local last-mile solutions co-creation [LEAD, (2021d)] and multi-stakeholder communities of practice were established to contribute to the co-development of sustainable on-demand freight mobility systems and Analysed the factors (strategic, regulatory, business, technology, environmental) influencing complex city logistics systems through a consolidated survey of the current needs, trends and challenges of last-mile logistics.

Next to the LLs a library of reference models was created, to be used as the baseline for the development of DTs found in Deliverable 1.2 [LEAD, (2021b)] that will provide the environment to test the LEAD Strategies.

In Deliverable 1.1 the factors influencing complex city logistics systems in the era of the on-demand economy and evaluated innovative delivery vehicles and enablers/barriers for their integration in urban logistics were investigated. This formed the basis for the typologies of agile urban freight storage and distribution schemes, including PI enabled approaches found in Deliverable 1.1 [LEAD, (2021a)]. In this same Deliverable 1.1 the comparative evaluation of emerging Electric Delivery Vehicles (EDVs) is presented. Together forming the building blocks for the LEAD project.

In Deliverable 1.3 [LEAD, 2021c)] a set of innovative business models was discussed and presented. And finally, in this Deliverable 1.5 the results are presented of the final task to synthesize the results of the WP1.

The set of more than 68 so-called LEAD strategies is presented to help the stakeholders formulate appropriate scenarios and policies. Next steps will be to validate, test and apply these strategies and policies in the LLs and DTs. Based on the work in WP1 and strategies presented in this deliverable there is a list of a comprehensive set of strategies, clustered into 9 LEAD Strategy categories that will help to develop feasible and comprehensive scenarios and policies. This set of strategies will support the stakeholders in the LLs and DTs to develop feasible scenarios.

It provides the combination of innovations in logistics (consolidation, delivery, vehicle technology) but also provides stakeholders with strategies that focus on new business models and technology. For example, *Try&Buy*, *Click&Collect* and *Crowd Sourcing*. It also consists of concepts like *Block chain*, *Cloud computing* and *Logistics Market Places*.

Next to these innovations, a range of supporting strategies on Regulation, Land-use, infrastructure and market-based measures is included to support the LEAD Specific strategies with the proper context and supporting measures to fully harvest their potential.

It is the combination of the different LEAD strategies from the nine categories that make up for a successful scenario or policy to tackle a specific challenge in UFT. This was experienced in the LLs through the value case and the additional policy examples in Chapter 6.

In order to help the different stakeholder in the LLs and in a later stage other EU cities the LEAD strategies were linked to specific CIs and city types and logistics profiles.

8 References

List of references

Aditjandra, P.T. (2008), The Relationship Between Urban Form and Travel Behaviour: A Micro-analysis in Tyne and Wear, Newcastle University, available at: http://scholar.google.co.uk/scholar?q=aditjandra&hl=en&as_sdt=1,5&as_sdtp=on#3.

Aditjandra, P.T., Galatioto, F., Bell, M.C. and Zunder, T.H. (2016), “Evaluating the impacts of urban freight traffic: application of micro-simulation at a large establishment”, European Journal of Transport and Infrastructure Research, Vol. 16 No. 1, pp. 4–22.

Aifandopoulou, G., E. Xenou, (2019), Topic Guide, Sustainable Urban Logistics Planning, framework of the NOVELOG project.

Alice, (2014), Alliance for Logistics Innovation through Collaboration in Europe (ALICE) / ERTRAC, 2014, Urban mobility WG - Urban freight research roadmap

Allen, J., Browne, M. and Cherrett, T. (2012), “Investigating relationships between road freight transport, facility location, logistics management and urban form”, Journal of Transport Geography, Elsevier Ltd, Vol. 24 No. September, pp. 45–57.

Allen, J., Piecyk, M., Piotrowska, M., McLeod, F., Cherrett, T., Ghali, K., Nguyen, T., Bektas, T., Bates, O., Friday, A., Wise, S., & Austwick, M. (2018). Understanding the impact of e-commerce on last-mile light goods vehicle activity in urban areas: The case of London. Transportation Research Part D: Transport and Environment, 61(June 2017), 325–338. https://doi.org/10.1016/j.trd.2017.07.020

Allen, J., S. Anderson, M. Browne, and P. Jones, 2000, A framework for considering policies to encourage sustainable urban freight traffic and goods / service flows. Transport Studies Group, University of Westminster, London

Allen, J., Thorne, G. and Browne, M. (2007), BESTUFS Good Practice Guide on Urban Freight Transport, BESTUFS consortium, PTV AG.

Allen, Julian, Thorne, G., & Browne, M. (2007). Good practice guide on urban freight transport. Bestufs Administration Centre, 84. www.bestufs.net

Allen, M., Babiker, M., Chen, Y., Taylor, M., Tschakert Australia, P., Waisman, H., Warren, R., Zhai, P., Zickfeld, K., Zhai, P., Pörtner, H., Roberts, D., Skea, J., Shukla, P., Pirani, A., Moufouma-Okia, W., Péan, C., Pidcock, R., Connors, S., … Waterfield, T. (2018). IPCC, 2018: Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global

greenhouse gas emission pathways, in the context of strengthening the global. In Aromar Revi.

Al-Thani, S.K.; Skelhorn, C.P.; Amato, A.; Koc, M.; Al-Ghamdi, S.G. Smart technology impact on neighborhood form for a sustainable Doha. Sustainability 2018, 10, 4764.

and network congestion. Trans. Res. Part E Logist. Transp. Rev. 2017, 107, 38–59. [CrossRef]

Anderson, S.; Allen, J.; Browne, M. Urban logistics–how can it meet policy makers' sustainability objectives? J. Transp. Geogr. 2005, 13, 71–81. [CrossRef]

Anderson, S.; Allen, J.; Browne, M., (2005) Urban logistics–how can it meet policy makers' sustainability objectives? J. Transp. Geogr., 13, 71–81.

Arvidsson, N., & Pazirandeh, A. (2017). An ex ante evaluation of mobile depots in cities: A sustainability perspective. International Journal of Sustainable Transportation, 11(8), 623–632. https://doi.org/10.1080/15568318.2017.1294717

Baksa, C., Bjurö, O., Eriksson, S., Forslund, L., Hildingsson, A., Levin, J., Lindberg, P., Maraschin, E., & Selander, S. (2017). Svensk postmarknad 2017 Rapportnummer. www.pts.se

Ballot, E., Barbarino, S., Bree, B. Van, Liesa, F., Franklin, J. R., Hooft, D., Paganelli, P., & Tavasszy, L. A. (2020). Roadmap to the Physical Internet. 769967, 1–22.

Balm, S., Amstel, W.P. van, Habers, J., Aditjandra, P. and Zunder, T.H. (2016), "The Purchasing Behavior of Public Organizations and its Impact on City Logistics", Transportation Research Procedia, Elsevier B.V., Vol. 12 No. June 2015, pp. 252–262.

Bamwesigye, D.; Hlavackova, P., (2019), Analysis of Sustainable Transport for Smart Cities. Sustainability 2019, 11, 2140.

Behrendt, F. Cycling the smart and sustainable city: Analyzing EC policy documents on internet of things, mobility and transport, and smart cities. Sustainability 2019, 11, 763. [CrossRef]

Behrendt, F. Cycling the smart and sustainable city: Analyzing EC policy documents on internet of things, mobility and transport, and smart cities. Sustainability 2019, 11, 763.

Belet, P., Menseart, W., Sys, I., & Verstrepen, S. (2009). Carbon Footprint Comparison of Parcel Delivery via Pick-Up Points Versus Home Delivery: Case Kiala Belgium.

BESTFACT. (2013), Best Practice Handbook 1, Deliverable 2.2, available at: http://www.bestfact.net/wp-content/uploads/2014/01/BESTFACT_BPH.pdf.

BESTFACT. (2015a), BESTFAC D2.3 Best Practice Handbook 2, available at: http://www.bestfact.net/wp-content/uploads/2015/09/BESTFACT_D2.3_BP_Handbook_2_v1.0_20150205.pdf.

BESTFACT. (2015b), BESTFACT D2.4 Best Practice Handbook 3, available at: http://www.bestfact.net/wp-content/uploads/2016/01/BESTFACT_D24_BPH_final.pdf.

Bhattarai, A. (2017). Walmart is asking employees to deliver packages on their way home from work. The Washington Post. Washington Post.

Blum, A. and Gruhler, K. (2011), “Typologies of the Built Environment and the Example of Urban Vulnerability Assessment”, in Müller, B. (Ed.),German Annual of Spatial Research and Policy 2010, Springer-Verlag, Berlin Heidelberg, pp. 147–150.

Bouton, S., Hannon, E., Haydamous, L., Heid, B., Knupfer, S., Naucler, T., Neuhaus, F., Nijssen, J. T., & Ramanathan, S. (2017). An integrated perspective on the future of mobility, part 2: Transforming urban delivery. McKinsey & Company, September, 48.

Bozzo, R., Conca,A., Marangon, F., (2014), Decision Support System for City Logistics: Literature Review, and Guidelines for an Ex-ante Model, Transportation Research Procedia Vol.3, pp 518-527.

Browne, M., Allen, J., Nemoto, T., Patier, D., & Visser, J. (2012). Reducing Social and Environmental Impacts of Urban Freight Transport: A Review of Some Major Cities. Procedia - Social and Behavioral Sciences, 39, 19–33. https://doi.org/10.1016/j.sbspro.2012.03.088

Browne, M., S. Behrends, J.Woxenius, G. Giuliano, J. Holguin-Veras, (2019), Urban Logistics, Management, Policy and Innovation in a Rapidly Changing Environment. KoganPage,

Brundtland Commission (1987). Our common future. Oxford University Press.

Cagliano, A. C., Mangano, G., & Zenezini, G. (2020). POLITECNICO DI TORINO Repository ISTITUZIONALE Technological trends in last-mile contexts: A European perspective Technological Trends in Last-mile Contexts: a European Perspective (Vol. 2020).

Campagna, A., Baraglia, F., ERTICO and CERTH. (2015), NOVELOG D2.1: Framework for Data, Information and Knowledge Collection for Urban Freight and Service Demand Understanding, Rome.

Cárdenas, I. (2019). Unlocking the benefits of pick-up points for sustainable E-commerce distribution in urban areas (Issue August).

Casaleggio Associati. (2018). 済無E-Commerce in Italia 2018. 53(9).

Casaleggio Associati. (2018). 済無E-Commerce in Italia 2018. 53(9).

CE Delft. (2019). Handbook on External Costs of Transport. In European Commission. https://www.cedelft.eu/en/publications/2311/handbook-on-the-external-costs-of-transport-version-2019

CIVITAS WIKI consortium. (2015), Making urban freight logistics more sustainable, CIVITAS POLICY NOTE, www.eltis.org, available at: http://www.eltis.org/resources/tools/civitas-policy-note-making-urban-freight-logistics-more-sustainable.

CIVITAS, (2016), Smart choices for cities. Making urban freight logistics more sustainable.

C-LIEGE. (2012), IEE C-LIEGE Deliverable 4.2 C-LIEGE Toolbox for the establishment of the city logistics manager.

CoExist. (2020). Enabling " Automation-Ready " Transport Planning. 723201.

Cui, J., Dodson, J., Hall, P.V., (2015), Planning for urban freight transport: An overview., Transp. Rev. Vol.35, 583–598.

Cui, J.; Dodson, J.; Hall, P.V. Planning for urban freight transport: An overview. Transp. Rev. 2015, 35, 583–598. [CrossRef]

D'Andrea, R. (2014). Guest editorial can drones deliver? In IEEE Transactions on Automation Science and Engineering (Vol. 11, Issue 3, pp. 647–648). Institute of Electrical and Electronics Engineers Inc. https://doi.org/10.1109/TASE.2014.2326952

Dablanc L., Freight transport for development toolkit: Urban Freight - Freight Transport, a Key for the New Urban Economy, World Bank – Department for International Development, 2009

Dablanc, L. (2018). On-demand instant deliveries and impacts on urban planning.

Dablanc, L. (2019). Logistics Hotels and Rail Freight Logistics in French Cities.

Dablanc, L. Goods transport in large European cities: Difficult to organize, difficult to modernize. Transp. Res. Part A Policy Pract. 2007, 41, 280–285. [CrossRef]

Dablanc, L., Morganti, E., Arvidsson, N., Woxenius, J., Browne, M., & Saidi, N. (2017). The rise of on-demand 'Instant Deliveries' in European cities. Supply Chain Forum, 18(4), 203–217. https://doi.org/10.1080/16258312.2017.1375375

Dagnino. (2015). Uber law: prospettive giuslavoristiche sulla sharing/on-demand economy.

Dagnino. (2015). Uber law: prospettive giuslavoristiche sulla sharing/on-demand economy.

Deutsche Post DHL Group, (2019). DHL Cubicycles City Hub Frankfurt 02. Available online: https://www.dpdhl. com/en/media-relations/media-center/tv-footage/dhl-cubicycles-city-hub-frankfurt-02.html (accessed on 11 February 2019).

DPD, (2021), DPD City Store Deal. https://www.dpd.com/nl/nl/city-store-rotterdam/

DHL. (2018). Shortening the Last-mile: Winning Logistics Strategies in the Race To the Urban Consumer. Deutsche Post DHL Group, 1–24. https://www.logistics.dhl/content/dam/dhl/local/global/core/documents/pdf/g0-core-wp-shortening-the-last-mile-en.pdf

Directorate-General for Research and Innovation. (2018). Final Report of the High-Level Panel of the European Decarbonisation Pathways Initiative. https://doi.org/10.2777/636

Ducret, R. (2014), Nouvelles organisations de la distribution urbaine des colis sur le dernier kilomètre: innover par une approche spatiale de marchandises en ville, Ecole Nationale Superieure des Mines de Paris.

Ducret, R. and Gonzalez-Feliu, J. (2015), “Connecting demand estimation and spatial category models for urban freight : First attempt and research implications”, in Taniguchi, E. and Thompson, R.G. (Eds.),The 9th International Conference on City Logistics, Institute for City Logistics, Tenerife, Vol. IX, pp. 154–168.

Ducret, R., Lemarie, B. and Roset, A. (2015), “Cluster Analysis and Spatial Modeling for Urban Freight: Identifying Homogeneous Urban Zones based on Urban Form and Logistics Characteristics”, in Taniguchi, E. and Thompson, R.G. (Eds.),The 9th International Conference on City Logistics, Institute for City Logistics, Tenerife, Vol. IX, pp. 358–373.

Edwards, J., McKinnon, A., Cherrett, T., McLeod, F., & Song, L. (2009). The impact of failed home deliveries on carbon emissions: are collection / delivery points environmentally-friendly alternatives? Green Logistics:, 2(13), 102–108. http://eprints.soton.ac.uk/73809/

Environmental Protection Agency. (2018). https://www.epa.gov/greenvehicles/fast-facts-transportation-greenhouse-gas-emissions

Esper, T. L., Jensen, T. D., Turnipseed, F. L., & Burton, S. (2003). the Last-mile: an Examination of Effects of Online Retail Delivery Strategies on Consumers. Journal of Business Logistics, 24(2), 177–203. https://doi.org/10.1002/j.2158-1592.2003.tb00051.x

EU – European Union, 2014, Eurostat regional yearbook 2014. Luxembourg

European Commission (2007). “Green Paper on Urban Mobility”, Stakeholder Consultation Report, European Commission (DG TREN).

European Commission. (2007), Freight Transport Logistics Action Plan, Brussels.

European Commission. (2011), 2011 WHITE PAPER Roadmap to a Single European Transport Area.

European Commission. (2016). GPP in practise, Issue No 61.

European Environment Agency. (2019). No. https://www.eea.europa.eu/data-and-maps/indicators/transport-emissions-of-greenhouse-gases/transport-emissions-of-greenhouse-gases-12

European Environment Agency. (2020). Transport: increasing oil consumption and greenhouse gas emissions hamper EU progress towards environment and climate objectives — European Environment Agency. https://www.eea.europa.eu/publications/transport-increasing-oil-consumption-and

Eurostat. (2020). Freight transport statistics - modal split.

Eurostat. (2020). Freight transport statistics - modal split.

Evangelinos, C., Tscharaktschiew, S., Marcucci, E., & Gatta, V. (2018). Pricing workplace parking via cash-out: Effects on modal choice and implications for transport policy. Transportation Research Part A: Policy and Practice, 113, 369–380. https://doi.org/10.1016/j.tra.2018.04.025

Facility Location Optimisation in Smart Cities. Energies 2019, 12, 1318. [CrossRef]

Faugère, L., & Montreuil, B. (2017). Hyperconnected Pickup & Delivery Locker Networks. In Proceedings of the 4th International Physical Internet Conference, 6(July), 1–14. https://www.researchgate.net/publication/318260861

Faure, L., Burlat, P. and Marques, G. (2015), “Evaluate the Viability of an Urban Consolidation Centre with regards to Urban Morphology”, in Taniguchi, E. and Thompson, R.G. (Eds.),The 9th International Conference on City Logistics, Institute for City Logistics, Tenerife, pp. 412–421.

Ferraris, A.; Santoro, G.; Papa, A. The cities of the future: Hybrid alliances for open innovation projects. Futures 2018, 103, 51–60.

Freudendal-Pedersen, M.; Kesselring, S.; Servou, E. What is smart for the future city? Mobilities and automation. Sustainability 2019, 11, 221. [CrossRef]

Freudendal-Pedersen, M.; Kesselring, S.; Servou, E., (2019), What is smart for the future city? Mobilities and automation. Sustainability 2019, 11, 221.]

Fruhling, A. L., & Digman, L. A. (2000). The Impact of Electronic Commerce on Business-Level Strategies. Interdisciplinary Informatics Faculty Publications University, 13(3–4), 167–189. https://doi.org/10.1207/s15327744joce133&4_02

Gatta, V., Marcucci, E., Delle Site, P., Le Pira, M., & Carrocci, C. S. (2019). Planning with stakeholders: Analysing alternative off-hour delivery solutions via an interactive multi-criteria approach. Research in Transportation Economics, 73(November 2017), 53–62. https://doi.org/10.1016/j.retrec.2018.12.004

Gevaers, R. (2013). Evaluation of innovations in B2C last-mile, B2C reverse & waste logistics.

Gevaers, R., Voorde, E. Van De, & Vanelslander, T. (2014). Cost Modelling and Simulation of Last-mile Characteristics in an Innovative B2C Supply Chain Environment with Implications on Urban Areas and Cities. 125, 398–411. https://doi.org/10.1016/j.sbspro.2014.01.1483

Giuffrida, M., Mangiaracina, R., Perego, A., & Tumino, A. (2016). Home delivery vs parcel lockers: An economic and environmental assessment. Proceedings of the Summer School Francesco Turco, 13-15-Sept, 225–230.

Goetting, E., & Handover, W. N. (2016). Crowd-shipping: Is crowd-sourced the secret recipe for delivery in the future? Hong Kong.

Goodchild, A. (2018a). ALLEY INFRASTRUCTURE INVENTORY AND OCCUPANCY STUDY 2018.

Goodchild, A. (2018b). THE FINAL 50 FEET OF THE URBAN GOODS DELIVERY SYSTEM.

Goodchild, A., & Toy, J. (2018). Delivery by drone: An evaluation of unmanned aerial vehicle technology in reducing CO2 emissions in the delivery service industry. Transportation Research Part D: Transport and Environment, 61, 58–67. https://doi.org/10.1016/j.trd.2017.02.017

Hammad, A.W.; Akbarnezhad, A.; Haddad, A.; Vazquez, E.G. Sustainable Zoning, Land-Use Allocation and

Hammad, A.W.; Akbarnezhad, A.; Haddad, A.; Vazquez, E.G. Sustainable Zoning, Land-Use Allocation and Facility Location Optimisation in Smart Cities. Energies 2019,

Hammad, A.W.; Akbarnezhad, A.; Rey, D. Sustainable urban facility location: Minimising noise pollution

Hampshire, R., & Shoup, D. (2018). What Share of Traffic is Cruising for Parking? https://www.researchgate.net/publication/325247222_What_Share_of_Traffic_is_Cruising_for_Parking

Handy, S. (2015), “Trip generation : Introduction to the special section”, The Journal of Transport and Land Use, Vol. 8 No. 1, pp. 1–4.

He, Z.; Haasis, H.D. Integration of Urban Freight Innovations: Sustainable Inner-Urban Intermodal Transportation in the Retail/Postal Industry. Sustainability 2019, 11, 1749. [CrossRef]

He, Z.; Haasis, H.D. Integration of Urban Freight Innovations: Sustainable Inner-Urban Intermodal Transportation in the Retail/Postal Industry. Sustainability 2019, 11, 1749.

Hesse, M. (1995), “Urban space and logistics: on the road to sustainability?”, World Transport Policy and Practice, Vol. 1 No. 4, pp. 39–45.

Hesse, M. (2008), The City as a Terminal: The Urban Context of Logistics and Freight Transport, Ashgate Publishing Ltd, Farnham.

Holguín-veras, J. (2016), “Accomodating What Freight?”, TRB 95th Annual Meeting, The National Academy of Sciences, Engineering, and Medicine, Washington D.C., available at: https://vimeo.com/151957163.

Holguín-Veras, J., T. Encarnación, C.A. González-Calderón, J. Winebrake, C.Wang, S. Kyle, N. Herazo-Padilla, L.Kalahasthi, W. Adarme, V. Cantillo, H.Yoshizaki, R.Garrido, (2018), Direct impacts of off-hour deliveries on urban freight emissions, Transportation Research Part D: Transport and Environment Volume 61, Part A, June 2018, Pages 84-103.

Holguín-Veras, J., Wang, C., Browne, M., Hodge, S. D., & Wojtowicz, J. (2014). The New York City Off-hour Delivery Project: Lessons for City Logistics. Procedia - Social and Behavioral Sciences, 125, 36–48. https://doi.org/10.1016/j.sbspro.2014.01.1454

Iconet. (2019). PI-aligned digital and physical interconnectivity models and standards. https://www.iconetproject.eu/ International Transport Forum. (2019). ITF Transport Outlook 2019.

Intuit. (2017). DISPATCHES FROM THE NEW ECONOMY: THE ON-DEMAND ECONOMY WORKER STUDY.

ISPRA (2008). Qualità dell’ambiente urbano – V Rapporto. Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA), Italy, Rome.

Iwan, S., Kijewska, K., & Lemke, J. (2016). Analysis of Parcel Lockers’ Efficiency as the Last-mile Delivery Solution - The Results of the Research in Poland. Transportation Research Procedia, 12(June 2015), 644–655. https://doi.org/10.1016/j.trpro.2016.02.018

Janjevic, M., & Ballé, A. (2014). Development and Application of a Transferability Framework for Micro-consolidation Schemes in Urban Freight Transport. 125(0), 284–296. https://doi.org/10.1016/j.sbspro.2014.01.1474

Kelli, L., Oliveira, D., Morganti, E., Dablanc, L., & Lúcia, R. (2017). Research in Transportation Economics Analysis of the potential demand of automated delivery stations for e-commerce deliveries in Belo Horizonte , Brazil. 65, 34–43. https://doi.org/10.1016/j.retrec.2017.09.003

Kikuta, J.; Ito, T.; Tomiyama, I.; Yamamoto, S.; Yamada, T. New Subway-Integrated City Logistics Szystem. Procedia-Soc. Behav. Sci. 2012, 39, 476–489. [CrossRef]

Kim, J., & Park, J. (2005). A consumer shopping channel extension model: Attitude shift toward the online store. Journal of Fashion Marketing and Management, 9(1), 106–121. https://doi.org/10.1108/13612020510586433

Kubek, D., & Więcek, P. (2019). An integrated multi-layer decision-making framework in the Physical Internet concept for the City Logistics. Transportation Research Procedia, 39, 221–230. https://doi.org/10.1016/j.trpro.2019.06.024

Kunze, O. (2016). Replicators, Ground Drones and Crowd Logistics A Vision of Urban Logistics in the Year 2030. Transportation Research Procedia, 19, 286–299. https://doi.org/10.1016/j.trpro.2016.12.088

Lagorio, A., & Pinto, R. (2020). The parcel locker location issues: An overview of factors affecting their location. Interconnected Supply Chains in an Era of Innovation - Proceedings of the 8th International Conference on Information Systems, Logistics and Supply Chain, ILS 2020, 414–421.

LEAD, (2019). Low-Emission Adaptive last-mile logistics supporting 'on-demand economy' through DTs NUMBER — 861598 — LEAD, Proposal.

LEAD, (2021a). DELIVERABLE 1.1: City Logistics landscape in the era of on-demand economy. Main challenges, trends and factors influencing city logistics. E.Marcucci (MOLDE), V.Gatta (MOLDE), G. Lozzi (POLIS).

LEAD, (2021b). DELIVERABLE 1.2: Knowledge Base – Reference Models. R.Tapia, I. Kourounioti (TUDelft)

LEAD, (2021c). DELIVERABLE 1.3: Innovative Business Models, Governance and Public-Private Partnerships, Knowledge for innovative actions, measures and business models in the LEAD Living Labs. E.Marcucci (MOLDE), V.Gatta (MOLDE), G.Lozzi (POLIS).

LEAD, (2021d). DELIVERABLE 1.4: Innovation Agenda - Value case scenarios and validation KPIs. B. Royo (ZLC), C. (ZLC), S.Lekkakos (ZLC), S. Fernández (EMT), D.Latorre (CITYLOGIN), J.M.Vasallo(UPM), N. Sobrino (UPM), R. Tapia (TUDELF), Y. Brian (IRT SYSTEMS), J. Miczki (BKK), S. Bràthen (MOLDE), N. Goveia (SONAE)

Lee, J. (2020). Sharing the Curbside Advancing curbside management in the City of Toronto Sharing the Curbside Advancing curbside management in the City of. May.

Lee, J., Kim, C., & Wiginton, L. (2019). Delivering Last-Mile Solutions. June, 1–80. https://www.pembina.org/pub/delivering-last-mile-solutions

Leonardi, J., Browne, M., Allen, J., Zunder, T. and Aditjandra, P.T. (2014), “Increase urban freight efficiency with delivery and servicing plan”, Research in Transportation Business & Management, Vol. 12, pp. 73–79.

Lima, F., & Franfo, T. (2019). Porto and Nothern Portugal: A magnet for investment. EY Attractiveness survey 2019. Portuga Regional. Porto.

Lindholm M.E., 2014, Successes and Failings of an Urban Freight Quality Partnership – The Story of the Gothenburg Local Freight Network, 8th International Conference on City Logistics

Lindholm, M.E., 2012, Enabling sustainable development of urban freight from a local authority perspective. PhD. Thesis, Chalmers University of Technology. Goteborg, Sweden.

London City Hall. (2018). The Mayor's Ultra Low Emission Zone for London.

Macário R., (2012), Innovation policy as a driver for the development of urban logistics, International Transport Forum Leipzig.

Macário R., 2012, Innovation policy as a driver for the development of urban logistics, International Transport Forum Leipzig, 2nd May 2012

Maere, B. De. (2018). Is het gebruik van pakjesautomaten ecologisch duurzaam ? October Brussel, Vrije Universiteit.

Marcucci, E, Le Pira, M., Carrocci, C. S., Gatta, V., & Pieralice, E. (2017). Connected shared mobility for passengers and freight: Investigating the potential of crowdshipping in urban areas. 2017 5th IEEE International Conference on Models and Technologies for Intelligent Transportation Systems (MT-ITS), 839–843. https://doi.org/10.1109/MTITS.2017.8005629

Marcucci, Edoardo, Gatta, V., Le Pira, M., Chao, T., & Li, S. (2021a). Bricks or clicks? Consumer channel choice and its transport and environmental implications for the grocery market in Norway. Cities, 110. https://doi.org/10.1016/j.cities.2020.103046

Marcucci, Edoardo, Gatta, V., Le Pira, M., Hansson, L., Bråthen, S. (2020). Digital Twins: A Critical Discussion on Their Potential for Supporting Policy-Making and Planning in Urban Logistics. Sustainability, 12(24), 10623. https://doi.org/10.3390/su122410623.

Marshall, S. (2012), "Science, pseudo-science and urban design", URBAN DESIGN International, Nature Publishing Group, Vol. 17 No. 4, pp. 257–271.

Mckinnon, A. C. (2016). Crowdshipping A communal approach to reducing urban traffic levels ? September.

Mckinnon, A. C. (2018). Decarbonizing Freight Transport : A Review of Technical, Managerial and Operational Options. June.

McLeod, F. N., & Cherrett, T. J. (2009). Quantifying the environmental benefits of collection/delivery points. OR Insight, 22(3), 127–139. https://doi.org/10.1057/ori.2009.2

Mcleod, F., Cherrett, T., Bailey, G., Allen, J., Browne, M., Leonardi, J., Aditjandra, P., et al. (2015), "Sustainable Procurement for Greener Logistics in the Higher Education Sector",

Proceedings of the 20th Annual Logistics Research Network (LRN) Conference, The Chartered Institue of Logistics and Transport (UK), University of Derby, pp. 1–8.

MDS Transmodal and Centro di recerca per il Trasporto e la logistica (CTL). (2012), DG MOVE European Commission : Study on Urban Freight Transport Final Report.

MixMoveMatch. (2017). Making Moves Sustainable.

Morganti, E., Dablanc, L., & Fortin, F. (2014). Final deliveries for online shopping: The deployment of pickup point networks in urban and suburban areas. Research in Transportation Business and Management, 11, 23–31. https://doi.org/10.1016/j.rtbm.2014.03.002

Moroz, M., & Polkowski, Z. (2016). The last-mile issue and urban logistics : choosing parcel machines in the context of the ecological attitudes of the Y generation consumers purchasing online. Transportation Research Procedia, 16(March), 378–393. https://doi.org/10.1016/j.trpro.2016.11.036

Napolitano, M. (2013). Omni-channel distribution: Moving at the speed of “now” - Modern Materials Handling. https://www.mmh.com/article/omni_channel_distribution_moving_at_the_speed_of_now

Novelog, (2016); NOVELOG: Guiding cities towards a sustainable urban freight environment 30 September.

Novelog (2018a), NEW COOPERATIVE BUSINESS MODELS AND GUIDANCE FOR SUSTAINABLE CITY LOGISTICS,

Novelog (2018b), Novelog Project, D4.1, Integrated inventory of urban freight policies and measures, typologies and impacts.

OECD/IA. (2014). No Title. https://data.worldbank.org/indicator/EN.CO2.TRAN.ZS

OECD/ITF. (2015). The Carbon Footprint of Global Trade.

Ogden, K. W., 1992, Urban Goods Movement: A Guide to Policy and Planning, Ashgate, Aldershot

Oliveira, L. K. De, Braga, A. D. S., & Abreu, B. R. A. (2010). Relevant attributes in overnight goods delivery : researchers ’, transporters ’ and retailers ’ preference in urban distribution. 12th WCTR, January, 11–15.

Ørving, T., & Eidhammer, O. (2019). Evaluation of Oslo City Hub.

Österle, I., Aditjandra, P.T., Vaghi, C., Grea, G. and Zunder, T.H. (2015), “The role of a structured stakeholder consultation process within the establishment of a sustainable urban

supply chain", (Gary Graham, D.,Ed.)Supply Chain Management: An International Journal, Emerald Group Publishing Limited, Vol. 20 No. 3, pp. 284–299.

Paddeu, D., & Parkhurst, G. (2020). The potential for automation to transform urban deliveries: Drivers, barriers and policy priorities. In Advances in Transport Policy and Planning (1st ed., Vol. 5). Elsevier Inc. https://doi.org/10.1016/bs.atpp.2020.01.003

Paddeu, D., Calvert, T., Clark, B., & Parkhurst, G. (2019). New Technology and Automation in Freight Transport and Handling Systems.

Parcel and Postal technology international. (2017). DHL expands Parcel Locker network in Germany.

Parcel and Postal technology international. (2017). DHL expands Parcel Locker network in Germany

Parcel and Postal technology international. (2017). DHL expands Parcel Locker network in Germany.

Patella, S.M., Grazieschi, G., Gatta, V., Marcucci, E., Carrese, S. (2021). The Adoption of Green Vehicles in Last-mile Logistics: A Systematic Review. Sustainability, 13(6). https://doi.org/10.3390/su13010006.

Patrick, J. H., Pruchno, R. A., & Rose, and M. S. (1998). Recruiting Research Participants: A Comparison of the Costs and Effectiveness of Five Recruitment Strategies. The Cerontological Society of America, 38(2), 295–302.

Punte, S., Tavasszy, L., Baeyens, A., & Liesa, F. (2019). A framework and process for the development of a ROADMAP TOWARDS ZERO EMISSIONS LOGISTICS 2050; ALICE-ETP. December, 40. http://www.etp-logistics.eu/wp-content/uploads/2019/12/Alice-Zero-Emissions-Logistics-2050-Roadmap-WEB.pdf

Quak, H. (2014). Sustainability of Urban Freight Transport : Retail Distribution and Local Sustainability of Urban Freight Transport (Issue April).

Quak, H., Van Duin, R., & Hendriks, B. (2020). Running an urban consolidation centre: Binnenstadservice 10 years back and forth. Transportation Research Procedia, 46, 45–52. https://doi.org/10.1016/j.trpro.2020.03.162

Quak, H.J., 2014, Access restrictions and local authorities' city logistics regulation in urban areas, in E. Taniguchi and R. G. Thompson (eds.), City logistics: mapping the future, 177 – 199. CRC.

Rai, H. B., Mommens, K., Verlinde, S., & Macharis, C. (2019). How does consumers' omnichannel shopping behaviour translate into travel and transport impacts? Case-study of

a footwear retailer in Belgium. Sustainability (Switzerland), 11(9). https://doi.org/10.3390/su11092534

Rassafi, A., Vaziri, M., (2005), Sustainable transport indicators: Definition and integration. International Journal Environmental Science Technology, Vol.2, 83-96.

Rassafi, A.; Vaziri, M., (2005), Sustainable transport indicators: Definition and integration. Int. J. Environ. Sci. Technol.

Rodrigue, J.P., (2020), New York: Routledge. The Geography of Transport Systems, FIFTH EDITION.

Rotem-Mindali, O., & Weltevreden, J. W. J. (2013). Transport effects of e-commerce: What can be learned after years of research? Transportation, 40(5), 867–885. https://doi.org/10.1007/s11116-013-9457-6

Rougès, J.-F., & Montreuil, B. (2014). Crowdsourcing Delivery : New Interconnected Business Models to Reinvent Delivery. 1st International Physical Internet Conference, 1, 1–19.

Ruesch, M., P. Hegi, U. Haefeli, D. Matti, B. Schultz, P. Rütsche, (2012), Sustainable goods supply and transport in conurbations: Freight strategies and guidelines, The Seventh International Conference on City Logistics, Procedia - Social and Behavioral Sciences Vol.39, 116 – 133.

Russo, F., Comi, A. (2010). A classification of city logistics measures and connected impacts. Procedia - Social and Behavioral Sciences Vol.2(3) pp 6355-6365

Sánchez-Díaz, I., Georén, P., & Brolinson, M. (2017). Shifting urban freight deliveries to the off-peak hours: a review of theory and practice. Transport Reviews, 37(4), 521–543. https://doi.org/10.1080/01441647.2016.1254691

Simoni, M. D., Marcucci, E., Gatta, V., & Claudel, C. G. (2020). Potential last - mile impacts of crowdshipping services : a simulation - based evaluation. 1933–1954.

Smart Freight Centre. (2017). Developing a Sustainable Urban Freight Plan – a review of good practices. 72. https://www.smartfreightcentre.org/pdf/Developing-a-Sustainable-Urban-Freight-Plan-a-review-of-good-practices-SFC-Final-June2017.pdf

Smart Freight Centre. (2017). Developing a Sustainable Urban Freight Plan – a review of good practices. 72. https://www.smartfreightcentre.org/pdf/Developing-a-Sustainable-Urban-Freight-Plan-a-review-of-good-practices-SFC-Final-June2017.pdf

Song, L., Guan, W., Cherrett, T., & Li, B. (2013). Quantifying the greenhouse gas emissions of local collection-and-delivery points for last-mile deliveries. Transportation Research Record, 2340, 66–73. https://doi.org/10.3141/2340-08

SOTI. (2020). The Last-mile Sprint: State of Mobility in Transportation and Logistics report.

SOTI. (2020). The Last-mile Sprint: State of Mobility in Transportation and Logistics report.

SPROUT. (2020a). D3.2: Sustainability impact analysis of city-specific scenarios. https://sprout-civitas.eu/resources/d3-2-sustainability-impact-analysis-of-city-specific-scenarios.

SPROUT. (2020b). D4.1 SPROUT Pilots evaluation framework. https://sprout-civitas.eu/wp-content/uploads/2020/07/SPROUT-D4.1-Pilot-Evaluation-Framework.pd

Stefanelli, T., Di Bartolo, C., Galli, G., Pastori, E., & Quak, H. (2015). Making urban freight logistics more sustainable. Civitas Policy Note, 1–63. http://www.eltis.org/resources/tools/civitas-policy-note-making-urban-freight-logistics-more-sustainable

Sternberg, H., & Norrman, A. (2017). The Physical Internet – review, analysis and future research agenda. International Journal of Physical Distribution and Logistics Management, 47(8), 736–762. https://doi.org/10.1108/IJPDLM-12-2016-0353

SUGAR. (2011), SUGAR Sustainable Urban Goods Logistics Achieved by Regional and Local Policies, (Dablanc, L.,Ed.), European Regional Development Fund, Bologna, available at: https://halshs.archives-ouvertes.fr/halshs-01069813/file/handbook_sugar_1.pdf.

Swilling, M., Robinson, B., Marvin, S., Hodson, M., Allen, A., Herrero, A. C., Landman, A., Ratanawaraha, A., Revi, A., Truffer, B., Binz, C., Janisch, C., Conway, D., Daste, D., Pieterse, E., Morais, G. W. De, Choi, G. W., Adelekan, I., Dávila, J., … Pengue, W. A. (2013). City-Level Decoupling Urban resource flows.

Taniguchi, E., R. G. Thompson, T. Yamada, and R. Van Duin, 2001, City logistics: network modelling and intelligent transport systems. Pergamon, Oxford

Tobey, M.B.; Binder, R.B.; Chang, S.; Yoshida, T.; Yamagata, Y.; Yang, P.P. Urban Systems Design: A Conceptual Framework for Planning Smart Communities. Smart Cities 2019, 2, 522–537. [CrossRef]

Tobey, M.B.; Binder, R.B.; Chang, S.; Yoshida, T.; Yamagata, Y.; Yang, P.P. Urban Systems Design: A Conceptual Framework for Planning Smart Communities. Smart Cities 2019, 2, 522–537. [CrossRef]

Toy, J. (2020). Trend Radar 5th edition. Dhl, 1–84.

Tozzi, M., Corazza, M.V. and Musso, A. (2014), “Urban goods movements in a sensitive context: The case of Parma”, Research in Transportation Business and Management, Elsevier Ltd, Vol. 11, pp. 134–141.

Transport for London. (2007), “Transport for London London Freight Plan sustainable freight distribution : a plan for London Foreword by Mayor”, Transport, London, available at: http://www.tfl.gov.uk/microsites/freight/documents/London-Freight-Plan.pdf.

TURBLOG. (2011a), Handbook on Urban Logistics - TURBLOG_ww, Lisbon.

TURBLOG. (2011b), FP7 TURBLOG Deliverable 2 Business Concepts and Models for urban logistics, Lisbon.

UN. (2015). TRANSFORMING OUR WORLD: THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT.

UNDP. (2018). No Title. https://www.undp.org/content/seoul_policy_center/en/home/sustainable-development-goals/goal-11-sustainable-cities-and-communities.html

UN-Habitat, (2016). World Cities Report 2016. Urbanization and Development-Emerging Futures; Technical Report;

UNHabitat: New York, NY, USA, 2016.

United Nations. 2018 Revision of World Urbanization Prospects; United Nations: New York, NY, USA, 2018.

UN-Report. (2014). World Urbanization Prospects: The 2014 Revision.

Urban Freight Lab. (2020). Common MicroHub Research Project: Research Scan. April, 12. https://depts.washington.edu/sctlctr/sites/default/files/research_pub_files/SCTL-Microhub-Research-Scan.pdf

van Rooijen T., H. Quak, 2014, City Logistics in CIVITAS recommendations for setting up successful city logistics measures, POLIS Conference, 27th - 28th November 2014, Madrid

van Rooijen T., H. Quak, 2014, City Logistics in the European CIVITAS Initiative, 8th International Conference on City Logistics, Procedia - Social and Behavioral Sciences 125 (2014) 312 – 325

Van Rooijen, T., & Quak, H. (2010). Local impacts of a new urban consolidation centre - The case of Binnenstadservice.nl. Procedia - Social and Behavioral Sciences, 2(3), 5967–5979. https://doi.org/10.1016/j.sbspro.2010.04.011

Verdict. (2016). Click & Collect in the UK.

Verhoef, P. C., Kannan, P. K., & Inman, J. J. (2015). From Multi-Channel Retailing to Omni-Channel Retailing. Introduction to the Special Issue on Multi-Channel Retailing. Journal of Retailing, 91(2), 174–181. https://doi.org/10.1016/j.jretai.2015.02.005

Verhoef, P. C., Kannan, P. K., & Inman, J. J. (2015). From Multi-Channel Retailing to Omni-Channel Retailing. Introduction to the Special Issue on Multi-Channel Retailing. Journal of Retailing, 91(2), 174–181. https://doi.org/10.1016/j.jretai.2015.02.005

Verlinde et al. (2014). Does a mobile depot make urban deliveries faster, more sustainable and more economically viable: results of a pilot test in Brussels. Transportation Research Procedia.

Verlinde, S., (2015), Promising but challenging urban freight transport solutions. PhD. Thesis, VUB Brussels, Belgium.

Verlinde, S., 2015, Promising but challenging urban freight transport solutions. PhD. Thesis, VUB Brussels, Belgium

Verlinde, S., Macharis, C., & Witlox, F. (2012). How to consolidate urban flows of goods without setting up an urban consolidation centre ? 39, 687–701. https://doi.org/10.1016/j.sbspro.2012.03.140

Verlinde, S., Macharis, C., Milan, L., & Kin, B. (2014). Does a Mobile Depot Make Urban Deliveries Faster, More Sustainable and More Economically Viable: Results of a Pilot Test in Brussels. Transportation Research Procedia, 4, 361–373. https://doi.org/10.1016/j.trpro.2014.11.027

Wittlöv, A. Urban freight transport: Challenges and opportunities. In Urban Freight for Livable Cities: How to Deal with Collaboration and Trade-Offs; Tryckeri AB Orion: Täby, Sweden, 2012; pp. 12–23.

Wittlöv, A., (2012), Urban freight transport: Challenges and opportunities. In Urban Freight for Livable Cities: How to Deal with Collaboration and Trade-Offs; Tryckeri AB Orion: Täby, Sweden, 2012; pp. 12–23.

Wolfram, M.; Consult, R. Expert Working Group on Sustainable Urban Transport Plans; Rupprecht Consult: Cologne, Germany, 2004.

Workhorse Group. HorseFly UAV Delivery System. Available online: http://workhorse.com/aerospace (accessed on 7 June 2019).

World commission on environment and development. (1987). Brundtland Report.

World Economic Forum. (2020). The Future of the Last-Mile Ecosystem. January.

World Economic Forum. (2020). The Future of the Last-Mile Ecosystem. January.

Zhangyuan H., H. Haasis (2020), A Theoretical Research Framework of Future Sustainable Urban Freight Transport for Smart Cities, Sustainability, Vol.12, 5/3/2020.

Zhangyuan He 1,2,* and Hans-Dietrich Haasis 3, A Theoretical Research Framework of Future Sustainable Urban Freight Transport for Smart Cities, 2020

Zunder, T.H., Aditjandra, P.T. and Carnaby, B. (2014), “Developing a Local Research Strategy for City Logistics on an Academic Campus”, International Journal of Urban Sciences, Vol. 18 No. 2, pp. 262–277.

Zunder, T.H., Aditjandra, P.T., Schoemaker, J.T., Vaghi, C., Laparidou, K. and Oesterle, I. (2016), “Engaging city stakeholders to achieve efficient and environmentally friendly urban freight movements”, in Blanquart, C., Clausen, U. and Jacob, B. (Eds.),Towards Innovative Freight and Logistics Vol. II, John Wiley &Sons, Inc., Paris, pp. 275–287.

Zurel, Ö., Van Hoyweghen, L., Braes, S., & Seghers, A. (2018). Parcel Lockers, an Answer to the Pressure on the Last-mile Delivery? New Business and Regulatory Strategies in the Postal Sector, 299–312. https://doi.org/10.1007/978-3-030-02937-1_22

Annex 1 : Zoning

In urban planning as well as transportation planning, land use is usually the object of zonal characterization. Each land use zone is subject to a series of regulations depicting what can be built in terms of criteria such as nature, function, and density, giving municipal governments tools to influence urban development. Rodrigue (2020) identifies four major types of land use zoning:

1) Functional zoning. The most prevalent form of zoning where land use zones are defined according to their function, such as commercial, residential, or industrial. Each zone type is subject to specific rules and regulations concerning the type of activities built. The assumption is that urban functions should be allocated to specific areas to improve their efficiency and mitigate externalities associated with incompatible land uses.

2) Form-based zoning. Define zones according to their physical characteristics, mostly from an urban identity perspective, such as the downtown area. This form of zoning is usually easier to relate to the general population since it uses zonal definitions that are well known and help create an urban identity by underlining areas with unique characteristics.

3) Intensity zoning. Defines land use zones by the permitted intensity level, such as the number of residential units per unit of surface or allowed commercial surface. Such regulation enables a level of flexibility in urban development since it permits developers to select which development types take place as long as this development abides by density constraints. Density can also be set to minimum criteria to avoid a wasteful usage of real estate.

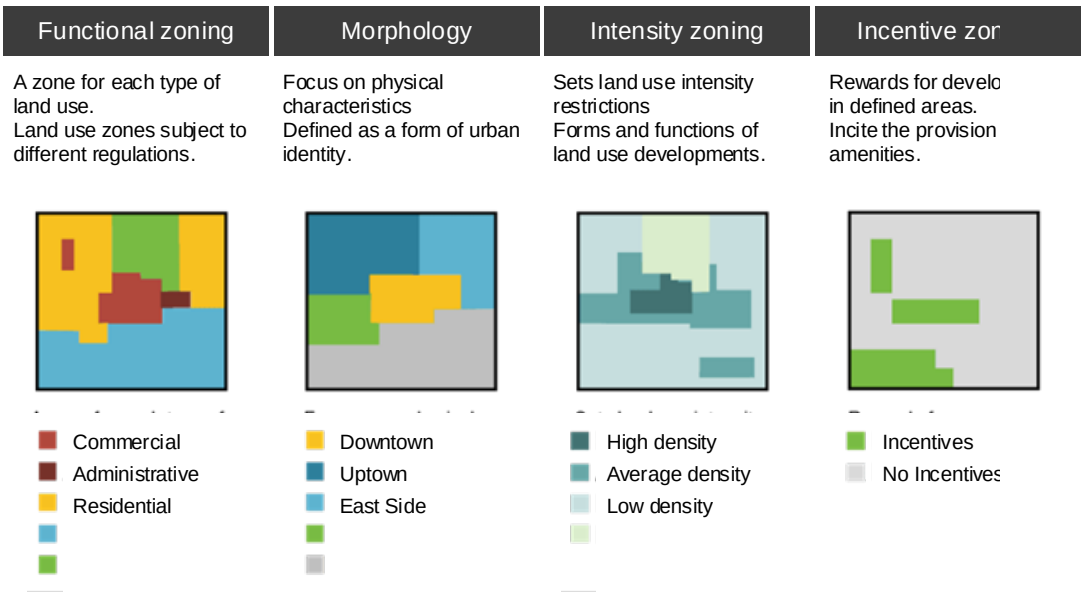

Figure 9: Zoning in Urban Environment. Based on Rodrigue (2020)

4) Incentive zoning. Often part of revitalization or development plans where developers are allowed to build residential, commercial, or industrial (manufacturing, warehousing) projects

in specific areas by providing various incentives such as tax abatement or basic infrastructure (road, utilities, public transport services). Further, developers can be granted lower restrictions, namely density limits, if amenities are such as park areas and infrastructure are developed as well.

In the study DG Move: Study on Urban Freight Transport, MDS Transmodal (2012) came up with 4 zones, based on functions and morphology. First, they defined an urban area based on the definition of the United Nations and used by a number of EU member states: *Areas that have urban (i.e. built-up) land of 20 or more hectares that are less than 200 metres apart and linked to form a continuous built-up area.*

This also provides a reasonable definition for the purposes of the LEAD study, but it still includes a very wide range of towns and cities with different freight transport issues at varying levels of intensity. Based on an analysis of the cities and towns they examined within the DG Move study: Study on Urban Freight Transport, MDS Transmodal developed a categorisation of urban area to facilitate the analysis of UFT issues and measures/practices in Europe:

Metropolises, which are the very largest urban areas in Europe with over 3 million inhabitants[25], with a central core city and a larger area around the core from which residents commute to the centre and therefore tend to have underground, suburban railway and bus networks to facilitate commuting. Metropolises are very large urban areas in terms of geographic extent and population, are often administrative and financial centres for EU Member States and usually suffer from poor air quality and high levels of road traffic congestion.

Other Large Urban Zones, based on the Eurostat definition, urban areas with more than 500,000 inhabitants excluding the metropolises as defined above. These urban areas are likely, due to the concentrations of traffic found there, to suffer from poor air quality and road congestion and are also often major retail and tourism centres.

Smaller Heritage Urban Areas, which experience lower levels of absolute road traffic and are less likely to have significant air quality issues but are “sensitive” environments because of the importance of the town or city in cultural or heritage terms.

Other Smaller Urban Areas, which are smaller in terms of geographic area and population and less likely to have significant air quality problems. They may experience road traffic congestion in peak hours due to local commuting. As these urban areas are less likely to experience significant issues due specifically to UFT, they are less relevant for this study.

[25] *The definition of “metropolis” for the purposes of this study has been based on a judgmental view by the consultancy team that cities with a population of more than 3 million have UFT and mobility issues of a greater intensity than cities with a smaller population.*

Another study in the United Kingdom addressing the ‘Green Logistics’ agenda, used 14 selected urban areas, identified one important additional parameter that influenced freight distribution journeys to be commercial and industrial land use patterns, and thus location [Allen *et al.*, (2012)]. A study in France based on 19 cities demonstrated that the size of the urban area, the settlement density, urban morphology relative to the location of urban consolidation/distribution centres, the development of the city, street design, and the type of housing– were all likely to influence last-mile delivery [Ducret, (2014)]. Research in Italy found that land use characteristics, such as narrow streets, limited on-street parking, and a high number of intersections, are all significantly influencing the performance of freight urban tours, despite the short distance range between an UCC and its delivery stops [Tozzi *et al.*,(2014)].

Another important issue addressed by Ducret and Gonzalez-Feliu, (2015) was the correlation between the spatial typology and the freight trip generation patterns. They found that the above zones typologies have difficulty with freight demand estimation [Holguín-veras, (2016)].

Annex 2 : Value case examples in Europe

In the table below some examples are provided of specific values cases and UFT policies

City	Country	Source
Athens	Greece	Novelog
Barcelona	Spain	Novelog
Bologna	Italy	Novelog
Copenhagen (City Center)	Denmark	Novelog
Gothenburg	Sweden	Novelog
Graz	Austria	Novelog
London	United Kingdom	Novelog
Mechelen	Belgium	Novelog
Pisa	Italy	Novelog
Reggio Emilia	Italy	Novelog
Rome	Italy	Novelog
Turin	Italy	Novelog
Venice	Italy	Novelog
Bremen	Germany	Russo&Comi
Vilnius	Lithuania	Russo&Comi
Bordeaux	France	Russo&Comi
Lisbon	Portugal	Russo&Comi
Paris	France	Russo&Comi
Utrecht	Netherlands	Russo&Comi
Enschede	Netherlands	Russo&Comi
Tilburg	Netherlands	Russo&Comi
Stockholm	Sweden	Russo&Comi
London	United Kingdom	Russo&Comi
Madrid	Spain	LEAD
Budapest	Hungary	LEAD
Lyon	France	LEAD
Porto	Portugal	LEAD
Oslo	Norway	LEAD
The Hague	Netherlands	LEAD
Munich	Germany	Hearsch et al.
Düsseldorf	Germany	Hearsch et al.
Barcelona	Spain	Hearsch et al.
Zurich	Switzerland	Hearsch et al.
St Gallen	Switzerland	Hearsch et al.

Table 20: Overview of Value cases

Annex 3 : List of logistics measures

Source : LEAD (2021a)

Table 21: LEAD Urban freight logistics measures

Typologies of agile storage & last-mile distribution schemes: consolidation	
Name	**Description**
Urban Consolidation Centre	Warehouse (permanent facilities) with inventory and handling/ packaging operations.
Micro-hubs	Cross-dock permanent facilities with no inventory and minimal handling operations (change the type of vehicle/ mode of transport)
Mobile depots	Cross-dock trailers/ vans with not inventory and minimal handling operation (change the type of vehicle/ mode of transport) - last leg vehicles on board
Central Innovation District	Hub to connect consumers, operators (lockers), carriers, crowdshipping services
Logistics hotels	Multiuse, multi-storey urban warehouses (parcel operation; multimodal; parking).
Physical Internet hub	UCC with Physical Internet technology

Table 22: LEAD Urban freight logistics measures: delivery mode

Delivery locations	
Name	**Description**
B2B - Retailer	Deliveries to commercial locations (local shops, restaurants, etc.)
B2C - Home deliveries	Deliveries to consumers at home
B2C -Nano-stores	Deliveries to consumers at commercial locations (Pickup points)
B2C - Parcel locker	Deliveries from business to consumers at parcel lockers
B2C – Door to car	Deliver the products directly to the consumer's car (based on blockchain technology)
C2C - Parcel locker	Deliveries from consumers to consumers at parcel lockers

Table 23: Type of vehicles charging stations

Type of vehicles charging stations	
Name	**Description**

Retail stores with EVs charging stations	Conventional retail stores with parking services that incorporate electric charging stations for their customers.
Electric Vehicle (fast) charging points	Logistic facilities (Source : LEAD (2021a) Table 22) that incorporate EV charging points for electric delivery vehicles.
Liquified/ Compressed Natural Gas (LNG/ CNG) filling stations	Infrastructure designed for filling a vehicle with LNG/ CNG fuel. It can be part of a station for fossil fuel refuelling or an independent infrastructure.
Hydrogen filling stations	Infrastructure designed for filling a vehicle with hydrogen fuel. It can be part of a station for fossil fuel refuelling or an independent infrastructure.

Table 24: Type of vehicle entering in the LEZ

Type of Vehicle (distributing in the LEZ, entering the LEZ)	
Name	**Description**
Delivery robots	Autonomous vehicles used for delivering goods
Autonomous vehicles	An autonomous vehicle is one that can drive itself from a starting point to a predetermined destination in “autopilot” mode using various in-vehicle technologies and sensors, including adaptive cruise control, active steering (steer by wire), anti-lock braking systems (brake by wire), GPS navigation technology, lasers and radar[26].
Light electric freight vehicles (bikes, tricycles, scooters)	Wide variety of types with limited payloads (0.5m^3-3m^3), limited speed (<25km/h) and electrical motor assistance (typically cycling). It offers some benefits to the parcels/ mail (limited size) deliveries in cities as easy to park, manoeuvrable and do not produce emissions. It reduces vans high operating costs for low value mail items[27].
Proper Electric Van (eg. Kangoo ZE)	Electric van with up to 3 passengers and payloads between (3.5m^3 and 4.6m^3)
CNG truck < 3.5 tonnes	Light vehicle truck propelled with CNG.

Table 25: LEAD Urban freight logistics measures: others

Other categories	
Name	Description
Route optimization	Route optimization is the process of finding the most cost-effective route for a set of stops.
Eco-driving	The practice of driving in such a way as to minimize fuel consumption and the emission of carbon dioxide.

[26] *https://www.gartner.com/en/information-technology/glossary/autonomous-vehicles*
[27] *https://ctl.mit.edu/sites/ctl.mit.edu/files/theses/43799155-RVeldman_Research_Fest.pdf*

Other categories	
Name	Description
Vehicles maintenance	It refers to a practice where an automobile is serviced on a regular basis to prevent a major breakdown or the need for major repair.
Consumer incentives programmes	It is an offering for potential new business local exchange customers and to existing business local exchange customers to encourage the retention or continuation of existing services by those existing customers.
Dynamic pricing application[28]	An approach to setting the cost for a product or service that is highly flexible. The goal of dynamic pricing is to allow a company that sells goods or services over the Internet to adjust prices on the fly in response to market demands.
Off-hour deliveries	Allow to delivery freight during the off-peak hours of 7 pm to 6 am in efforts to decrease congestion and truck emission. DELIVERABLE 1.1 refers to this measure as Night deliveries
Crowdshipping	It is a delivery mode. It leverages networks of local, non-professional couriers to deliver packages to customers' doors.
Try & Buy	It is a delivery mode which involves ordering one or more online products, testing the product in a physical store, and purchasing it.
Click & collect	It is a delivery mode. It consists of a purchase of a product online and consequent pick up in the e-retailer store.
Public Private Partnership[29]	Cooperative arrangement between two or more public and private sectors, typically of a long-term nature. It involves government(s) and business(es) that work together to complete a project and/or to provide services to the population. They are an example of multistakeholder governance which is a key target of United Nations Sustainable Development Goal 17. Public–private partnerships have been implemented in multiple countries, are primarily used for infrastructure projects, such as the building and equipping of schools, hospitals, transport systems, and water and sewerage systems.
Cloud Computing, Artificial Intelligence (AI) and Data Collection through the Internet of Things (IoT)	These new technologies enable real-time data analysis that is then used in machine learning for robotic warehouse management, demand planning, peak management, and finally for inventory management (Euromonitor, 2018).

[28] *https://whatis.techtarget.com/definition/dynamic-pricing*
[2929] *https://en.wikipedia.org/wiki/Public%E2%80%93private_partnership*

Annex 4 : Logistics Profile Characteristics

Profile A	
City Area Features	
Commercial density	**High**
Homogeneity	**High**
Logistic acessibility Measures considering logistic needs Level of Congestion	**Reasonable/Bad** Some measures considering logistic needs High/Reasonable
Restriction applied	Yes/no
Product Characteristics	
Easiness of handling	**Easy/Reasonable/Difficult**
Special conditions	**No special needs/special needs**
Agent Profile/Deliveries Profile	
Urgency of deliveries	**Irrelevant/Relevant/Urgent**
Frequency of deliveries	**Medium/High**
Amounts to be delivered	**Many**
Planned deliveries	No defined routine/Defined routine

Table 26: Logistics Profile overview

CITY AREA FEATURES

Features	Classification		
1.1. Commercial density	**Low** <30% Commercial face to residencies/services/industry	**Medium** 30% to 70% Commercial face to residencies/services/industry	**High** >70% Commercial face to residencies/services/industry
1.2. Homogeneity	**Low** Several types of services and products	**Medium** Mix of residential areas with offices and commercial stores	**High** Cluster of one type of service or similar products
1.3. Logistic acessibility	**Bad**	**Reasonable**	**Good**
1.3.1. Measures considering logistic needs	Bad level of access between the shop and the parking (e.g. no loading bays)	Some specific measures considering logistic needs (e.g. loading bays non exclusive)	Transport network suited for the logistic needs (e.g. exclusive loading bays)
1.3.2. Level of Congestion	High level of traffic congestion (Commercial speed < 3km/h)	Reasonable (High on peak hours)	Low (Fluid traffic - commercial speed >12km/h)
1.4. Restriction applied	**Yes** Off-peak hours, week days, ...	**No**	

PRODUCT CHARACTERISTICS

Characteristics	Classification		
2.1. Easiness of handling	**Difficult**	**Reasonable**	**Easy**
2.1.1. Size	Large (wheelbarrow, crane)	Medium (> 1 person to carry one unit)	Small (>1 unit per person to carry)
2.1.2. Weight	Heavy (wheelbarrow, crane)	Medium (> 1 person to carry one unit)	Light (>1 unit per person to carry)
2.1.3. Holding conditions	Difficult	Reasonable	Easy
2.2. Special conditions	**Special needs** e.g. valuable products, frozen products, etc..	**Might have special needs** e.g. open packages, if food handled ambient temperature, chilled, etc...	**No special needs**
2.2.1. Fragility	Fragile	Might have special needs	No special needs
2.2.2. Perishability	Perishable	Not perishable	

AGENTS PROFILE/DELIVERIES PROFILE

Characteristics	Classification		
3.1. Urgency of deliveries	**Irrelevant**	**Relevant**	**Urgent**
3.2. Frequency of deliveries	**Low** < once a week	**Medium** Several days per week	**High** Daily
3.3. Amounts to be delivered	**Few**	**Several**	**Many**
3.3.1. Number of shops	One shop	Several shops	Retail center/big shops
3.3.2. Vehicles weight and size	Light goods vehicle or smaller vehicles	Van /small truck	Heavy goods vehicles
3.4. Planned deliveries	**No defined routine**	**Defined routine** e.g. after hours deliveries, 8-10 a.m., ...	

Annex 5 : Sustainability impact analysis

Source : LEAD (2021d)

This section further details the sustainability consequence areas, the corresponding lists of CIs and the continuum performance of each CI.

Consequence areas and consequence indicators description

1 Sustainability dimension: Economic

1.1 *Consequence area – costs*: This area concerns the potential impacts on the delivery costs required for developing and operating the current/ future last-mile scenarios. Some indicative assessment questions in order to better identify which the related impacts are: *Will this scenario require additional private investments (% of existing daily operational costs) or not?*

Table 27: Economic dimension: Cost consequence indicators description.

Consequence indicator	Description	Unit of measurement
Operational delivery cost	Daily average operational cost for a carrier	Euro (€)
Total delivery costs	Daily Average total cost (operational and non-operational)	Euro (€)

Consequence area – need of space: This area concerns the need of public space required by the last-mile distribution activities. Some indicative assessment questions to better identify which will be the related impacts are : *Will this scenario require additional urban space for handling operations/ parking/ transport?*

Table 28: Economic dimension: urban space needs consequence indicators description.

Consequence indicator	Description	Unit of measurement
Logistics space	Logistical activities of storage, freight transport require substantial amounts of land. Logistics land involves distribution, logistics and warehouse (DLW), mainly includes storage land, land for external traffic and land for public facilities, of which warehousing has the greatest demand for land[30].	Square meters (m2)

1.2 *Consequence area – idle time*: This area refers to the time lost by slower speeds, longer trips or traffic jams. Some indicative assessment questions to better identify which will be the related impacts are : *Will this scenario increase the time lost by traffic congestion? Will this scenario increase the travel times? Will this scenario increase the vehicles' speed?*

[30] Woudsma, C.; Jensen, J.F. Accessibility and Freight: Transportation and Land Use—Exploring Spatial-Temporal Dimensions; Levinson, D.M., Krizek, K.J., Eds.; Emerald Group Publishing Limited: Bingley, UK, 2005;pp. 267–295.

Table 29: Economic dimension: idle time consequence indicators description.

Consequence indicator	Description	Unit of measurement
Traffic congestion	Daily average time lost caused by congestion.	Minutes (min)

1.3 *Consequence area – urban freight transport service level*: This area refers to the service level of the urban freight transport services providers. Some indicative assessment questions to better identify which will be the related impacts are : *Will this scenario increase the time required for delivering goods in the city? Will this scenario increase the number of parcels delivered in time and good conditions?*

Table 30: Economic dimension: urban freight transport service level indicators description.

Consequence indicator	Description	Unit of measurement
Urban delivery price	Average price for last-mile deliveries per parcel.	Euros per parcel (€/ parcel)
Urban delivery time	Average time required for delivering a parcel	Minutes per parcel (€/ parcel)
Urban delivery reliability	Daily average percentage of parcels delivered in time and good conditions	Percentage of packages delivered in time and good conditions compared to the total number of packages (daily)

1.4 *Consequence area – willingness to collaborate among different players*: This area refers to the level of influence or social incentive/ pressure to collaborate and promote users' sustainable behaviour. Some indicative assessment questions to better identify which will be the related impacts are : *Will this scenario increase the number of ideas suggested to promote more sustainable behaviour on clients and users approved by them? Will this scenario increase the number of cooperative solutions and incentive measures ?*

Table 31: Economic dimension: willingness to collaborate.

Consequence indicator	Description	Unit of measurement
Users sustainable behaviour	Number of ideas suggested to promote more sustainable behaviour on clients and users approved by them.	Number (#)
Cooperative solutions and incentive measures	Number of solutions and incentive measures offered collaboratively	Number (#)

2 Sustainability dimension: Environmental

2.1 *Consequence area – climate change*: This area concerns the changes related to climate change.

Table 32: Environmental dimension: Climate change consequence indicators.

Consequence indicator	Description	Unit of measurement
Greenhouse gas emissions (GHG)	CO2 equivalent or GHG emission produced by urban distribution activities	% of GHG emissions produced by last-mile operations

2.2 *Consequence area – air quality index (AQI)*: This area concerns the level of increase/ decrease of the air quality index of a city as a result of urban logistics operations. The AQI is a number used to report the quality of the air on any given day. The index is based on measurement of particular matter (PM10 and PM2.5), Ozone (O3), Nitrogen dioxide (NO2) and Sulphur Dioxide(SO2)

Table 33: Environmental dimension: air quality consequence indicators.

Consequence indicator	Description	Unit of measurement
Air quality index	The amount of expected increase/ decrease or the air quality index[31].	European air quality index

2.3 *Consequence area – Noise*: This area concerns the amount of expected increase/ decrease of the noise emissions in a city, as a result of urban logistics operations.

Table 34: Environmental dimension: noise consequence indicators.

Consequence indicator	Description	Unit of measurement
Noise	Noise level produced by logistics operation, for both day and night	Decibels

2.4 *Consequence area – Energy needs*: This area refers to the expected increase/ decrease of energy to perform logistics operations (transport, handling).

Table 35: Environmental dimension: energy consumption indicators.

Consequence indicator	Description	Unit of measurement
Energy consumption	Average level of energy consumption on a daily basis from any source for logistic operations	Litres/ day KwH/ day

3 Sustainability dimension: Social

3.1 *Consequence area – Jobs created*: This area concerns the potential changes to the structure, types of employment and to the social security levels and benefits. Some indicative assessment questions to identify which are the related impacts are: *Do you expect changes in the current levels of urban mobility employment? Do you expect changes in the current levels of urban mobility employment?*

[31] https://www.eea.europa.eu/highlights/european-air-quality-index-current

Table 36: Social dimension: Employment consequence indicators description.

Consequence indicator	Description	Unit of measurement
Quality of the jobs	Full-time employment in urban freight transport	number of employees
Quality of the jobs	Gig economy[32] (external contractor) employment	% of total employees

3.2 *Consequence area – Data privacy and cybersecurity concerns*: This area concerns the potential data privacy and cybersecurity requests from consumers due to the increase level of digital technology for last-mile deliveries, including drones, autonomous vehicles, mobile applications asking for personal data and bank accounts. Some indicative assessment questions to identify which are the related impacts are: *Do you expect more people will be concerned of the increased level of drones/ autonomous vehicles; Do you expect more people will be concerned of how their personal information and bank accounts are used, stored and protected?*

Table 37: Social dimension: Data privacy and cybersecurity concerns consequence indicators.

Consequence indicator	Description	Unit of measurement
Cybersecurity and data privacy level	Number of cybersecurity and data privacy requests	Number of requests (#)

Consequence area – Social acceptance: This area concerns the level of acceptance from local stores and citizens (neighbourhoods). Some indicative assessment questions to identify which are the related impacts are: *Do you expect an increase in local stores'/ retail's sector turnover? Do you expect the changes will increase the neighbourhood liveability?*

Table 38: Social dimension: Social acceptance consequence indicators.

Consequence indicator	Description	Unit of measurement
Neighbourhoods quality of life	Number of people satisfied with the area where they live	% citizens
Shop/ retails benefits	Number of local stores/ retails increasing the daily sales (turnover)	% local stores increasing sales

[32] *https://www.eurofound.europa.eu/observatories/eurwork/industrial-relations-dictionary/gig-economy*

The Consequence matrix

The following table presents the final list of consequence areas and indicators along with their continuum performance. The second column in the table indicated the sources that were used for selecting the most appropriate continuum performance for each indicator.

Table 39: Environmental dimension: CIs continuum performance.

Expected impacto n	Source	Increase			Not impact	Decrease		
		High	Medium	Low		Low	Medium	High
Environmental dimension: Climate change consequence area								
GHG emissions	LEAD document of agreement Part B, page 10, table 10	>50%	25-50%	<25%		<25%	25-50%	>50%
Environmental dimension: Air quality index consequence area								
Air quality Index	LEAD document of agreement Part B, page 10, table 10	>50%	25-50%	<25%		<25%	25-50%	>50%
Environmental dimension: Noise consequence area								
Noise	LEAD document of agreement Part B, page 10, table 10	>50%	25-50%	<25%		<25%	25-50%	>50%
Environmental dimension: Energy needs index consequence area								
Energy consumption	LEAD document of agreement Part B, page 10, table 10	>50%	25-50%	<25%		<25%	25-50%	>50%

Table 40: Social dimension: CIs continuum performance.

Expected impacto n	Source	Increase			Not impact	Decrease		
		High	Medium	Low		Low	Medium	High
Social dimension: Employment consequence area								
Jobs created	LEAD document of agreement Part B, page 10, table 10	<5%	5-2.5%	<2.5%	-	<2.5%	5-2.5%	<5%
Quality of the jobs		>50%	25-50%	<25%		<25%	25-50%	>50%
Social dimension: Data privacy and cybersecurity concerns consequence area								
Cybersecurity and data privacy level	Consensus building among the LEAD partners (T1.4)	>50%	25-50%	<25%		<25%	25-50%	>50%
Social dimension: Social acceptance consequence area								
Neighbourhoods quality of life	LEAD document of agreement Part B, page 10, table 10	>50%	25-50%	<25%		<25%	25-50%	>50%
Shop/ retails benefits		>50%	25-50%	<25%		<25%	25-50%	>50%

Table 41: Economic dimension: CIs continuum performance.

Expected impact n	Source	Increase			Not impact	Decrease		
		High	Medium	Low		Low	Medium	High
Economic dimension: Costs consequence area								
Operational delivery cost	LEAD document of agreement Part B, page 10, table 10	>5%	1-5%	<1%	-	<1%	1-5%	>5%
Total delivery cost	Consensus building among the LEAD partners	>10%	5-10%	<5%		<5%	5-10%	>10%
Economic dimension: Idle time consequence area								
Traffic congestion	LEAD document of agreement Part B, page 10, table 10	>20%	10-20%	<10%		<10%	10-20%	20%
Economic dimension: Urban space allocation consequence area								
Logistic space	LEAD document of agreement Part B, page 10, table 10	>10%	5-10%	<5%		<5%	5-10%	>10%
Economic dimension: Willingness to collaborate among different players consequence area								
Users sustainable behaviour	LEAD document of agreement Part B, page 10, table 10	>2	2	1				
Cooperative solutions and incentive measures		>5	5-3	<3				
Economic dimension: urban freight transport service level consequence area								
Urban delivery price	LEAD document of agreement Part B, page 10, table 10	>5%	5-1%	<1%		<1%	1-5%	>5%
Urban delivery time		>5%	5-1%	<1%		<1%	1-5%	>5%
Urban delivery reliability		>10%	10%-5%	<5%		<5%	5-10%	>10%