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Tools for achieving CO_2-free logistics in cities by 2030

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Brussels	Brussels Mobility	Procter & Gamble Services	Vrije Universiteit Brussel
London	Transport for London	TNT Gnewt Cargo	University of Westminster University of Gothenburg
Oslo	Oslo kommune	Steen & Strøm	TOI
Paris	Mairie de Paris		IFSTTAR DLR
Rotterdam	Gemeente Rotterdam	PostNL	TNO
Rome	Roma Capitale	Poste Italiane MeWare SRL	Università degli studi Roma Tre
Southampton	Southampton City Council	Meachers Global Logistics	University of Southampton
Networking and outreach partner			
POLIS			

Executive summary

The CIVITAS 2020 project CITYLAB was set up to develop knowledge and solutions that result in roll-out, up-scaling and further implementation of cost effective strategies, measures and tools for moving towards the European Union's goal of emission free city logistics in major urban centres by year 2030. The project has explored the living lab approach as means of bringing multiple stakeholders together in developing and rolling out sustainable and efficient urban freight transport solutions. On top of that, the project has had a strong knowledge-generation component with surveys, data collection, synthesis and analysis.

This deliverable presents recommendations for future implementation of CITYLAB solutions to achieve CO_2-free logistics in cities by 2030 and brings together:

- experiences from trend analysis
- cooperation structure between businesses, cities/municipalities and other stakeholders
- strengths and weaknesses from the implementation processes and evaluations observed in the living lab implementations
- priority actions to be set out in European cities

The path towards zero-emission logistics operations in major urban centres by 2030 requires a combination of measures. The total demand for freight transport must be reduced, logistics must be made more efficient to increase load factors and reduce the vehicle movements, and a shift to low- and zero-emission vehicles must be supported. Analyses made in the CITYLAB project indicate that logistics improvements may contribute to emission reductions only around 10% in urban areas. This means that the logistics improvements themselves cannot solve the emission challenges, there is an obvious need to increase the use of zero emission vehicles as well. What is key, however, is that many of the logistical improvements also act as facilitators for the introduction of zero emission vehicles on top of their direct contributions to emission savings. For instance, procurement practices, ensuring space for logistics facilities, and more coherent planning of urban freight activities – they may all enhance the speed and likelihood of the uptake of zero emission vehicles. The lessons from CITYLAB have led to a particular emphasis on ensuring space and facilities for logistics activities as a key requirement for making the private sector able to run their urban freight operations in a sustainable and efficient way.

In CITYLAB we have observed that there are many obstacles and challenges preventing change. There is not necessarily a lack of knowledge about measures that may contribute to more sustainable and efficient operations, but more often a lack of focus and priority in the public sector. The core of the CITYLAB roadmap is therefore focused on setting up regimes and an environment that supports sustainable urban logistics operations: i) to have clear goals and a plan for reaching them; ii) making sure that data are in place to understand the current situation and analyse changes; and iii) having appropriate public-private collaboration mechanisms for definition and realisation of innovative solutions.

Based on the lessons from the CITYLAB implementations, we recommend specific measures that are different, but complementary:

- Reducing the demand for transport by changing procurement practices
- Developing new space and logistics facilities to promote efficient logistics operations and use of clean vehicles
- Increasing load factors through collaboration and sharing
- Supporting growth in the use of zero emission vehicles such as electric vans and cargo bikes.

List of Abbreviations

B2C	Business to customer
BuyZET	Procurement of innovative solutions for zero emission urban delivery of goods and services
CITYLAB	City Logistics in Living Laboratories
CLLL	City logistics living lab
DSP	Delivery and servicing plans
FREVUE	Freight Electric Vehicles in Urban Europe
FQP	Freight Quality Partnership
HGV	Heavy Goods Vehicles
LGV	Light Goods Vehicles
LL	Living lab
LMO	Large municipal organisations
LSP	Logistics Service Provider
MAMCA	Multi-actor multi-criteria analysis
P&G	Procter & Gamble
SCC	Southampton City Council
SULP	Sustainable Urban Logistics Plan
SUMP	Sustainable Urban Mobility Plan
SPICE	Smart procurement for better transport
SSDC	Southampton Sustainable Distribution Centre
TIDE	Transport Innovation Deployment for Europe
TCR	Transfer cities and regions
UCC	Urban consolidation centres

1 Introduction

An environmentally and financially sustainable urban freight transport system is a prerequisite for liveable cities. However, goods, waste and service trips in urban areas impose negative traffic and environmental impacts and take place in space shared with many other actors including public transport operators, private car users, taxis, cyclists and pedestrians. In the 2011 white paper on transport (European Commission, 2011), one goal was to “achieve essentially CO_2-free city logistics in major urban centres by 2030”, while the green paper ‘Towards a new culture for urban mobility’ (European Commission, 2007), highlighted the importance of the urban dimension of freight transport, and the need for efficient interfaces between long and short-distance freight transport. Possible solutions proposed include the use of smaller, more efficient and cleaner vehicles, improved load planning, consolidated distribution, zones with access regulations, and institutional reforms with increased integration of multiple stakeholders in local policy-making.

The European Commission's target of essentially CO_2-free city logistics in urban centres by 2030 requires considerable work in identifying the right combination of sustainable and cost-efficient freight measures that will most effectively reduce freight related emissions and congestion in cities. CIVITAS 2020 project CITYLAB was therefore established with the objective to develop knowledge and solutions that result in roll-out, up-scaling and further implementation of cost effective strategies, measures and tools for CO_2-free city logistics in urban centres by 2030. This deliverable summarises main project findings and sets out a roadmap for how to move towards emission free city logistics in the future – based on the lessons learned from the project.

The rest of this deliverable is organised as follows. In Chapter 2, the CITYLAB approach and main findings and lessons are summarised. Chapter 3 presents the roadmap for how CITYLAB solutions may contribute to emission-free city logistics in urban centres by 2030. Finally, conclusions and needs for future research are discussed in Chapter 4.

2 The CITYLAB contributions

The CITYLAB project was set to develop knowledge and solutions that result in roll-out, up-scaling and further implementation of cost effective strategies, measures and tools for moving towards the European Union's goal of emission free city logistics in major urban centres by 2030. The core of CITYLAB has been a set of living laboratories, where cities work as contexts for innovation and implementation processes for public and private measures contributing to increased efficiency and sustainable urban logistics.

Interactive problems, such as urban logistics, are particularly difficult to tackle because of their complex, novel and interdependent nature and because they involve not a single decision but a series of dimensions on how to carry out the government's policy (Howlett, Perl, & Ramesh, 2009). Naturally, such problems involve several different stakeholder groups who need to collaborate to develop a sustainable solution. Hence, CITYLAB has explored the formation of living labs in seven European cities, bringing together local/regional authorities, industry partners and research partners in working towards common goals.

The term 'living lab' commonly refers to a local experimental project of a participatory nature. Their aim is to actively involve all relevant stakeholder and user groups to encourage participation, hear all views, promote innovation and 'out of box' solutions, set project goals and agree actions. The focus is on practical implementation, learning and improvement.

The project focused on **four axes** that call for improvement and intervention. Within these axes, CITYLAB supports **seven implementations** that are being tested, evaluated and rolled out. The cities involved as living labs are London, Rotterdam, Brussels, Southampton, Oslo, Rome and Paris. The city of Amsterdam was included as an extension of the Rotterdam living lab. If the four axes for intervention are not explicitly tackled in the EU, the rising populations and densities of cities will produce such an increase in freight transportation that the economic and environmental sustainability will no longer be guaranteed. This, in turn, will endanger the future growth potential of European cities.

The four axes and the related CITYLAB implementations, cities and industry partners are shown in Table 1. An implementation is defined as the process of preparing and putting into practice a new service or a new way of operating or organising logistics activities.

Table 1. CITYLAB axes for intervention and implementations.

Axes for intervention	Implementation	City	Industry partner
Highly fragmented last-mile deliveries in city centres	Growth of consolidation and electric vehicle use	London	TNT and Gnewt Cargo
	City centre micro-hubs and cycle freight deliveries	Amsterdam	PostNL
	Increasing vehicle loading by utilising spare capacity	Brussels	Procter & Gamble
Inefficient deliveries to large freight attractors and public administrations	Joint procurement and consolidation for large public institutions	Southampton	Meachers Global Logistics
	Common logistics functions for shopping centres	Oslo	Steen & Strøm
Urban waste, return trips and recycling	Integration of direct and reverse logistics flows	Rome	Poste Italiane, Meware
Logistics sprawl	Logistics hotels to counter logistics sprawl	Paris	SOGARIS

Compared to many projects that involve short-term demonstration of urban logistics solutions, the CITYLAB implementations were one component of a broader and more ambitious project aiming to **build long-term partnerships at the city level**. The roles of the implementations in CITYLAB were to:

1) **Implement innovative ideas** that propose a way of intervening to make sure that the expected increase in freight transportation can be dealt with in an **economic and environmentally sustainable** way.
2) Initiate or support city logistics Living Labs on the local city levels, contributing to **building partnerships** between research, industry and authorities.
3) Extract detailed **insight and understanding** as to how the implementations can be prepared, organised and supported to achieve their intended objectives, and determining their **transferability potential** to larger areas and other cities.

In this chapter we summarise main experiences from the project and extract the most important lessons for moving towards emission free city logistics in major urban centres within 2030.

2.1 City logistics living labs

Policy development can be seen as a decision-making process that helps address identified goals, problems or concerns. At its core, policy development entails the selection of a destination or desired objective. The actual formulation of policy involves the identification and analysis of a range of actions that respond to these concerns (Howlett et al., 2009). Thus, strategies and objectives in cities and among private stakeholders is key to guide city logistics policy-making and the future of city logistics. Such strategies can be included in Sustainable Urban Logistics Plans (SULP). The idea of SULPs is to ensure a coherent approach to urban logistics, and it can be seen as a logistics component of a Sustainable Urban Mobility Plan (SUMP). Several European cities and city regions are now working on Sustainable Urban Logistics Plans (SULPs), bringing together local actors, improving planning, and initiating actions needed to improve the situation.

The SULP itself or specific actions identified in the SULP can be developed using Freight Quality Partnerships (FQPs).

FQPs can be defined as "*a long-term partnership between freight stakeholders concerned with urban freight, that on a formal or informal basis meet regularly to discuss (and sometimes find solutions to) problems and issues that occur in the urban area"* (Lindholm & Browne, 2013).

FQPs aim at bringing stakeholders together to discuss challenges and potential solutions, and there are many successful examples in Europe (see e.g. Lindholm & Browne, 2014). However, Lindholm and Browne (2013) also highlight some of the challenges of FQPs, which include slow implementation of solutions, a lack of understanding of the other stakeholders' interests and perspectives, and a lack of resources to fund, but also attend meetings.

The living labs are not replacements of SULP and FQPs, but it contains elements of these approaches. A city logistics living lab act as a new form of collaborative governance together with existing partnerships and freight plans. They may also have a role in going beyond the SULPs and FQPs to foster innovation and implementation of solutions for more efficient and sustainable city logistics (CITYLAB, 2017c). Such new forms of interactive governance involves a multi-actor process of interaction to formulate and implement shared objectives through the exchange of ideas, rules and resources (Torfing, Peters, Pierre, & Sørensen, 2012). The formulation and implementation of new ideas exchanged outside of the

organisational and institutional border can be a result of a collaborative process between actors who have the necessary motivation, creativity, ideas, knowledge, transformative capacities, political authority and resources to develop new policy solutions (Bommert, 2010; Klijn, 2008; Sørensen & Torfing, 2011; Torfing, 2016). Even though it focuses on innovation there needs to be a match between the "best practice" of the industry stakeholders and the innovation happening in the living lab process to ensure that the development is not hindered.

In practical terms, a living lab is a working partnership where local government along with industry, retail, commerce, services and academic partners collaboratively develop new approaches and policies to promote sustainable logistics. As issues arise, changes in policy occur and new concepts emerge, the parties involved in the logistics living lab can easily alter their focus and address and evaluate new ideas. The main objective of the city logistics living labs is to foster long-term co-operative relationships between local authorities, industry and academia to enable pro-active implementation of sustainable logistics measures along with monitoring and evaluation tools to enhance freight policy in urban areas. Living labs actively involve all relevant stakeholder and user groups to encourage participation, hear all views, promote innovative thinking and "out of box" solutions, set project goals and agree actions. A city logistics living lab is organised around four key principles: a practical real-life setting with implementations in the field, multiple stakeholders, co-creation of innovative solutions and end-user involvement and iterative learning and development (CITYLAB, 2018i)[1].

Within a city logistics living lab the first step is to set up initial communication channels.

- to directly contact known stakeholders.
- to disseminate findings to the wider industry and the public.
- and to provide a simple way for relevant stakeholders to sign up or comment.

The next stage involves a series of informal meetings or online discussions between the living lab participants to:

- share information about current freight operations.
- agree common objectives.
- and develop new ideas and projects.

The final step is to evaluate the effectiveness of the actions undertaken within the living lab, disseminate the results and replicate the success stories elsewhere (CITYLAB, 2018i). The success of a proposed solution is related to its acceptance level among stakeholders, ex-ante behavioural analyses, which investigate stakeholders' behaviour and perceptions before the implementation takes place, play a key role in the living lab approach. These analyses lead to the identification of barriers/opportunities and strategic/operational pre-requisites for innovative solutions to propose (CITYLAB, 2018j). Overall a city logistics living lab can: i) enhance existing and develop new mechanisms for stakeholder collaboration; ii) identify objectives based on industry needs and city frameworks and iii) provide support for policy and improve the political interests in urban freight (CITYLAB, 2017c). Depending on the issue which a living lab aim to target the stakeholders included differ. Table 2 shows the stakeholder groups used in CITYLAB.

[1] More information about city logistics living labs can be found in Deliverable 3.4 "The living lab handbook".

Table 2. Classification of stakeholder groups in CITYLAB.

Authorities	Local authorities
	Regional authorities
	National authorities
	Society
Industry	Shippers
	Receivers
	Transport operators
	Property owners
Research	Academics, research institutes

2.1.1 The benefits of city logistics living labs

For a city logistics living lab to be successful it is crucial that all partners see a potential benefit in participating. In summary, the potential benefit lies in the increased stakeholder understanding, new knowledge on ways to collaborate and improved approaches for innovation support (CITYLAB, 2017c).

Different stakeholder groups benefit differently from participating in a city logistics living lab (CITYLAB, 2017c, 2018g). From the authorities' perspectives the added value of such a collaborative environment is that it results in:

- Higher policy coherence due to the bottom-up insights;
- A common perspective on key issues between local authority and industry;
- Identification and alignment with front runners, e.g. in developing privileges or cooperating in media coverages;
- Increased knowledge on city logistics and a better understanding of the real-life challenges;
- More investments and opportunities for innovation within city logistics;
- Support for planning and opportunities for evaluation of the effectiveness of selected policy measures;
- Opportunities for continuous interaction between local authorities and other stakeholders rather than using individual meetings;
- An opportunity to exchange practices and collaborate across municipal agencies;
- Increased stakeholder understanding stakeholders, improved relationships and new cooperation mechanisms.

From an industry perspective a living lab can provide:

- Opportunities to participate in policy formulation;
- A place to advise and inform on the challenges at hand;
- Improved business cases through ideas and opportunities when other business partners;
- Possibility for roll out of their innovation;
- Improved rate of innovation uptake;
- Increased stakeholder understanding, improved knowledge and valuable experiences of other private industries, improved relationships and new cooperation mechanisms;

- Innovation support through sharing of experiences, awareness and attention to city logistics;
- Reduced focus on short-term results at the expense of long-term interests;
- Changed role of private industry as other businesses are no longer seen as competitors but as partners working together to achieve a common goal.

For researchers the added value of participating in a living lab has been a:

- Cost-efficient ways to have access to data and user experiences;
- Opportunity to validate research findings;
- Providing input on logistics innovations for local authorities;
- Increased stakeholder understanding, provided new and improved relationships and new cooperation mechanisms;
- New opportunities for research.

One key finding is that city logistics living labs provides an opportunity to build relationships and establish joint initiatives that otherwise would not have taken place. Some of the direct benefits of closer relationships are summarised in Figure 1, showing by stakeholder category some of the observed collaboration benefits of a city logistics living lab (CITYLAB, 2017c).

		From collaboration with		
		Cities	**Industry**	**Research**
Benefit to	**Cities**	Increased interaction within local authorities. Exchange of practices and better understanding of city logistics.	Learn from industry experiences and get knowledge on their responses to plans and policies.	Support for analysis of data in planning and evaluation of selected policy measures. Help to raise awareness of urban freight issues.
	Industry	The possibility to affect policies, innovation support and present their view to the authorities	Transfer of knowledge between industries and cross-industry cooperation. Improved business cases.	Get help to provide evidence to cities and participation in knowledge transfer.
	Research	Access to data, collaboration opportunities and information on policies.	Access to data, knowledge on innovations in city logistics.	Participation in wide networks providing good visibility of results.

Figure 1. The added value of CLLL by stakeholder category.

If others aim to use this approach, the identification of success factors is crucial. As emphasised in CITYLAB Deliverable 2.3 the intention of identifying success factors is to capture essential issues that must be addressed during implementation and establishment of the city logistics living lab in order that it proves successful and meets its intended objectives and strategic goals (CITYLAB, 2016). Success factors of having a city logistics living lab are:

- The excessive focus on short-term results at the expense of long-term interests are reduced since all stakeholder's work towards a commonly defined objective;
- To define the objectives for the city logistics living lab on industry-led needs and city frameworks;

- Adjusting the living lab approach to the context of each city and their needs on city logistics;
- Applying the living lab principles at any level either city, neighbourhood, business, street, building or measure.
- Designing collaborations within a living lab to increase the understanding of urban freight within the local authority and to identify the issues relating to these activities.

FOR A CITY LOGISTICS LIVING LAB TO BE SUCCESSFUL IT IS CRUCIAL THAT ALL PARTNERS SEE A POTENTIAL BENEFIT IN PARTICIPATING.

2.1.2 Industry and city-led living labs

In CITYLAB the implementations had been pre-selected during the proposal phase of the project. All of them had a strong collaborative component, meaning that the solution is not in the hand of one stakeholder only. Thus, the implementation of the solutions was assumed to benefit from stakeholder collaboration. However, we observed that there are differences in involvement of local authorities depending on the nature of the pre-selected implementation on which the living lab was focused to support. The analysis of inputs from the various CITYLAB cities show that the nature of the solutions and measures being implemented affect the importance of support from local authorities and the need for a city logistics living lab with all three stakeholder groups represented (CITYLAB, 2017c).

A living lab may be set up to develop a specific product or service and run over a relatively short time period or may be more far reaching and run over a longer period to take advantage of latest technologies and to adapt to changing environments. The application and scope of living labs are wide-ranging: they can be designed to look into a single specific issue in a specific location or have a much broader remit, considering logistics across the whole city. We can also distinguish between:

- an industry-led living lab where, for example, a freight operator, wants to develop a logistics innovation with emphasis on improving services they directly control – we refer to this as a *logistics service living lab*
- a city-led living lab where local government want to cooperate with freight industry stakeholders to transition towards more sustainable working methods – we refer to this as a *city logistics transition living lab* (CITYLAB, 2018i, 2018a).

The differences between these two are summarised in Table 3.

Table 3. Industry or city-led city logistics living lab.

Industry-led living lab	City-led living lab
Short-term perspective targeted at specific solutions.	Long-term perspectives targeted at societal problems.
Detailed oriented and narrower thematically. Often linked to a company's objective or business goals.	Thematically shared ambitions within the living lab. These are linked to the city and / or country's objectives or goals.
Medium-term collaboration between a limited number of stakeholders. There is a strong focus on the participation of the end-user in the co-creation process.	Long-term consensus oriented collaboration between all relevant stakeholders. Co-creation of actions ensures the needs of societal end-users.
Iterative cycles which are focused on the development of the solution for a given issue.	Several different solutions are trialled in parallel, including different stakeholders, but all contribute to the final living lab ambition

Industry-led living lab	City-led living lab
Clearly defined end-users (innovation developed in this lab should meet their needs).	End-users depend on the concrete solution trialled
Usually driven by industry	Usually driven by public authorities and knowledge institutes, thus, they are accountable to the public.

Industry-led living labs can be more efficient in terms of implementing new initiatives since fewer stakeholders are represented which can reduce the conflict of interests. However, these living labs often have a different perspective than a city-led living lab. The latter is more obliged to include as many interests as possible represented in the society. Also, a public sector officer might walk back from an initiative when confronted with an elected member with a conflict of interest or just fear of de-selection. Industry-led city logistics living labs are often organised to produce a certain innovative urban freight solution and has therefore other objectives and targets compared to a city-led living lab process (CITYLAB, 2017c). Following this, there are also differences in the importance of policies and political support for the living lab to be functional. These elements are less pressing in an industry-led living lab where the focus is more on the customers and its end-users (CITYLAB, 2017c).

THERE ARE MORE PARTIES REPRESENTED IN A CITY-LED LIVING LAB COMPARED TO AN INDUSTRY-LED LIVING LAB BUT OFTEN AT THE EXPENSE OF THE EFFECTIVENESS.

In CITYLAB, Rotterdam, Paris and Southampton are defined as city-led living labs contributing to zero emission city logistics while Amsterdam, Rome, Oslo, London and Brussels are industry-led living labs focusing on concrete solutions and services trialed and up-scaled using living lab principles.

2.1.3 Barriers and challenges

Overall, when discussing city logistics and deciding to organise a city logistics living lab, political/institutional support and limited resources are the most challenging barriers to overcome. Several of these barriers focus on the municipality and their opportunities to facilitate stakeholder cooperation (CITYLAB, 2018g). Political support is often subject to the voters, and as urban freight often is an issue that doesn't occupy citizens, getting political support for involvement in urban freight is a challenge. From several industry stakeholders it was emphasised that having political support before setting up a city logistics living lab was valuable for developing new urban freight innovations.

In public administrations, one challenge is that a limited workforce has to cover a broad set of topics, and sometimes urban logistics does not get sufficient attention due to other pressing mobility issues. Still, when a city participates in a living lab and has urban freight policies in place, it is more likely to give priority to city logistics.

2.2 Trends and developments

CITYLAB performed a review of trends and developments impacting urban logistics, reported in the Observatory of strategic developments, to identify key areas where a city logistics living lab and its innovative solutions can be useful (CITYLAB, 2018b, 2018f). Important trends observed are e-developments in retail, on-demand economy and instant deliveries, new data

and data collection methods, growth in crowd shopping and shared services and demand for and access to new delivery vehicles (Taniguchi, Thompson, & Yamada, 2016). Of these CITYLAB have assessed four trends related to e-developments and instant deliveries.: 1) logistics sprawl, as freight facilities move further away from city centres, 2) service trips and instant deliveries, 3) growth of e-commerce and fast delivery options and 4) circular economy. Collaboration in these areas is needed to help counter commonly observed negative environmental impacts on emissions, congestion, safety.

Logistics sprawl means relocation and concentration of logistics facilities towards suburban areas. The number of logistics facilities (in their diversity: warehouses, fulfilment centres, distribution centres, cross-dock terminals) is increasing in cities, especially cities of some logistics importance as large consumer markets and/or logistics hubs processing the flow of goods generated by the global economy. These facilities are generally located in suburban areas, but a new niche market of urban warehouses is emerging (CITYLAB, 2018b).

Both e-commerce and logistics sprawl generate a rise in freight vehicle movements in urban areas, dominated by small vehicles, while medium to large lorries are relatively less important. These vehicles performing delivery operations are visible in neighbourhoods and at times of day when they were not identified before: residential neighbourhoods, residential building blocks, side streets, in the early evening and on week-ends. Emerging new types of vehicles (clean delivery vehicles, two and three wheelers) are now visible in urban centres.

Innovations in the urban supply chains include diverse forms of pick-up points and click-and-collect solutions, while the recent but extremely rapid rise in technologies and algorithms supporting instant deliveries (on-demand deliveries within less than two hours) brings with it a flourish of new companies connecting customers, suppliers and independent couriers, often using bicycles.

The overall impact of these new trends on energy and carbon emission related to urban freight is difficult to assess. Urban freight in general, for the Paris region in particular, brings the following environmental impact: the share of traffic-related CO_2, NO_x and PM_{10} due to urban freight is 2.5 times larger than the share of vans and trucks in the regional traffic. The contribution of urban freight to air pollution is larger in the city of Paris. Social costs of air pollution caused by road traffic in general amount to 0.9% of the regional GDP in 2012. Some of the new trends bring more CO_2 emissions, such as the relocation of logistics facilities far away in the suburbs, as deconsolidated shipments are delivered to urban consumers and businesses in smaller and more numerous vans. Some trends bring less CO_2 emissions, with a rise in cleaner vehicles and innovative solutions such as drop-off/pickup points or bike supported instant deliveries. Substitution patterns between personal mobility and professional freight mobility can be a good, or a bad, thing for CO_2 emissions, depending on the initial circumstances and the way personal shopping was done before online orders.

What is certain is that these changes bring diversity in the urban traffic flow. Instant couriers are using all sorts of transport modes, including foot, bicycles, electrically assisted cargo cycles, motorbikes, and various types of vans and lorries. This can negatively impact traffic management, road safety and conflicts in road uses, congestion, air pollution. Also, the trends we have looked at bring new types of urban jobs, with many unresolved legal issues and poor working conditions in many instances. New types of logistics buildings bring architectural diversity and innovation in cities, but also complaints about noise, aesthetics, as well as congestion and pollution at entrance and exit points.

These environmental and social impacts have been so far poorly documented and researched. Consumers are the main drivers of the changes we have observed, but they are also the residents or visitors of urban areas, and for that they carry an important share of the burdens, as well as the benefits, of the new landscape of urban logistics (CITYLAB, 2018b).

Service trips are trips in commercial traffic induced by service-oriented activities. According to the German KiD 2010 service traffic accounts for 11.8% of traffic in terms of trips and for 19.9%

in terms of kilometres travelled. There are differences in terms of vehicle types and economic sectors but few variations in terms of spatial types.

In service-related traffic there are on the one hand vehicles which are characterized by only a few stops and little road performance per day. On the other hand, many cars visit numerous customers and participate a lot in traffic. Four corporate factor groups (internal structures, internal processes, external structures, and external processes) play a role in travel behaviour in service traffic. Company-related factors, especially corporate structure, are decisive for corporate vehicles' travel patterns. Further efforts are needed to identify proper ways for the possibility to influence service traffic generation. In general, the strategy of avoid-shift-improve could be applied to service traffic. The premise will be not to avoid traffic rather than to improve traffic. Research on other surveys and studies in Europe on service traffic revealed that there are only few of them. Furthermore, they are different in terms of definition of service traffic, in terms of spatial coverage and in terms of observed objects. Nevertheless they add further knowledge on trip patterns in service traffic (CITYLAB, 2018b).

To deal with today's environmental issues, a new model emerges: the circular economy. The European Commission perceives circular economy as a means of increasing environmental quality, while strengthening and sustaining the industry, in particular by securing supplies of raw materials through greater recourse of material from waste recycling. The circular economy promotes responsible consumption, by advocating actions to extend the life of products, waste management actions, etc. For the circular economy to be as effective as possible, it must be applied to all sectors and by all actors. The awareness is growing; consumption patterns are changing, and businesses, for the most part influential - because they can afford it - are feeling the trend of the circular economy. In addition to adapting to this trend, many are the actors who try to impulse this approach. Focusing on urban freight, the circular economy can mean modal shifts, the reuse of tram cars (into cargo trams), a change of motorization, an optimization of the efficient flows in delivery. In a broader sense, the circular economy has impacts on urban freight, with new types of supply chains required by reverse and return logistics. In some cases, circular economy can mean more urban freight transport, while the total reorganization of a product life cycle represents a net reduction in energy consumption associated with this product's life (CITYLAB, 2018b).

A proper understanding of these trends and developments is needed for proactive planning and policy making. Dealing with logistics sprawl, fragmentation of freight flows, and the need for new logistics facilities and initiatives for increasing load factors and collaboration are therefore prioritised among the CITYLAB implementations described in the following section.

2.3 The CITYLAB implementations

The city logistics living labs in the CITYLAB cities supports and evaluates seven different implementations. The implementations focused on: 1) highly fragmented last-mile deliveries in city centres, 2) inefficient deliveries to large freight attractors and public administration, 3) urban waste, return trips and recycling and 4) logistics sprawl. An implementation is the process of preparing and putting into practice a new service or a new way of operating or organising logistics activities. This section describes the implementations as well as the impact and main findings from these solutions.

London: Growth of consolidation and electric vehicle use

Gnewt Cargo is a growing Logistics Service Provider (LSP) running delivery operations exclusively with full-electric vans. These vans are servicing clients mainly in the Central London Congestion Charge Area. The main objective of this action was to determine how to expand the solution, and identify clearly what are the effects of growth of the multi-carrier consolidation and delivery operations. The main operator is Gnewt Cargo and the main client of the London

Implementation action is the major parcel carrier TNT UK. The benefits of the solution are not only relevant for businesses but also for the public sector:

- Zero CO_2 emissions and zero exhaust emissions from 60-100 electric vans replacing diesel vans for the same client and the same urban parcels delivery business. Electricity is purchased from a regenerative energy provider. The only residual air pollutant emissions are dust and particles from tyre abrasion and road dust resuspension.
- Higher load factor: Instead of many vans, fewer bigger trucks are used to transport the goods from the TNT depots to the Gnewt Cargo depot.
- Less empty returns: For the last mile trip of Gnewt Cargo, electric vans are starting full at departure from a depot in Central London. The (rather empty) return trip to the Gnewt central London depot is very short given its proximity to the delivery area
- Reduced number of journeys: the goods can now be delivered to central London on board larger trucks coming from the TNT depots in the Midlands and Luton to the depot of Bermondsey where the Gnewt Cargo vehicles are loaded. In the case of TNT, the number of vans replaced by one truck is about 4.
- Reduced mileage: the observed trips reduction leads to a corresponding 67% reduction in total distance per parcel.
- Off-peak trips: The trips between the TNT depots and the depot of Gnewt Cargo occur at night and during the early morning hours.

The greatest operational difficulty encountered during the implementation was that none of the Gnewt Cargo depots in Central London were accessible by a large truck, so TNT was obliged to use smaller 7.5t urban trucks to deliver parcels to the Gnewt depot (CITYLAB, 2018d).

The climate impact of the changed routes occurring in the TNT distribution system is a 100% CO_2 reduction, because no diesel truck is used to transport the goods between the TNT depot and the Gnewt Cargo depot (Allen et al., 2017; CITYLAB, 2018d).

THE BUSINESS MODEL IS VIABLE, BUT THERE ARE BARRIERS TO GROWTH SUCH AS I) ACCESSIBILITY TO DEPOT BY A LARGE TRUCK, II) OPERATIONAL GROWTH REQUIRE A CHANGE IN SUBCONTRACTOR AND NEW CONTRACTS AND III) SHARING OF DEPOTS, VEHICLES AND CUSTOMER DATA. COOPERATION BETWEEN TFL, LONDON BOROUGHS, CRP AND CLFQP HAS BEEN BENEFICIAL.

Amsterdam: City centre micro-hubs and cycle freight deliveries

The Amsterdam implementation aimed to improve last mile logistics in the dense city centre by making better use of available infrastructure. The initial idea for the implementation was to transport parcels into the city by a vessel (a floating depot) with a mechanism to lift the goods onto the quays and distribute with cargo bikes from there. This appeared to be difficult. The solution implemented combines micro-hubs and cycle freight deliveries. PostNL vans in the city centre of Amsterdam are partially being replaced with special e-freight bikes. Within this implementation several new designs of these freight bikes were tested. The best one will be purchased when the implementation is transferred to other cities. The e-freight bikes distribute mail and parcels from micro-hubs located in the city centre. Because the square metre price in city centres is high, the depots need to be optimally utilised and therefore the hubs are being shared with other activities of PostNL. The micro hubs (for example abandoned stores or existing PostNL hubs) are shared with activities like daily mail (CITYLAB, 2018d).

The freight e-bikes have been implemented since 2017 and until now, 7 shared micro-hubs have been opened which were already being used as for example post office or public mail delivery. Each micro-hub is supplied by a truck twice a day. The first trip includes mail that will

be delivered to business client in the morning. Once the electric freight bicycles have delivered all mail to the clients, they return to the micro-hub and are being recharged. In the afternoon the electric freight bicycles start a second shift to empty all public mailboxes and to go to all the business clients to pick-up post and parcels to be sent. With this concept, PostNL implemented two main improvements:

- The use of micro-hubs in the city centre to consolidate the last-mile freight flows to and from the city centre.
- The use of cycling infrastructure and electric freight bikes in Amsterdam to reduce pressure on the road network and improve their quality of service.

The main challenge in Amsterdam is to find sufficient employees to deliver by freight bike. Another challenge is to increase the utilization of the freight bikes by extending the operations towards the delivery of packages, food, local products and evening deliveries while maintaining sufficient time to charge the bikes (CITYLAB, 2018d).

The hourly rates are lower for bikes compared to vans. Including the additional costs for the micro-hub it is estimated that the implementation saves approximately 1k Euro per day and 220 kg of CO2. Time savings during the trip because of good cycling infrastructure and parking opportunities means that bikes can handle 5% more orders, saving about 5 trips per day (CITYLAB, 2018d).

FLOATING DEPOTS DO NOT EASILY CREATE A VALID BUSINESS CASE DUE TO TECHNICAL FUNCTIONALITY AND A COST INCREASE COMPARED TO CONVENTIONAL DAILY PRACTICE.

THERE IS A STRONG BUSINESS CASE FOR THE IMPLEMENTED SOLUTION WITH MICRO-HUBS AND CLEAN VEHICLES.

Brussels: Increasing vehicle loading by utilising spare capacity

The aim of the implementation is to test whether fill rates can be increased by unlocking spare capacity of service-driven companies to cost-efficiently supply consumer goods to small stores and reduce the generated impacts of distribution and shopping. The main concept, introduced by Procter & Gamble (P&G), was to introduce a new online sales channel for reaching smaller stores and using spare van capacity from existing providers to replenish these stores. The goal was thus to reduce or eliminate inefficient storeowner pick-ups, and substitute these by utilising the spare van capacity of service-driven companies, whereby load factors of these vehicles are increased. A webshop was developed and operational with a product assortment and prices. Several service-driven companies expressed their interest to be involved. The first distributor chosen was Febelco, a distributor of pharmaceutical products, who has a dense network and uses vans to deliver to their customers (pharmacies) up to three times per day.

A sales representative introduced the concept to the stores and helped them place their first orders. The storeowners were explained how to order the products online. Febelco subsequently delivered the goods. When a storeowner placed his order, the distributor notified Febelco that a delivery is coming. The information included the delivery address, opening hours and the number of cases. The products were transported from the distribution centre of the distributor to the one of Febelco, located near Brussels. Febelco added the store to one of its routes in the Brussels Capital Region; the store was added as a regular stop and the software calculated the optimal routing, including this additional stop.

Few stores were willing to order online during the implementation. After several deliveries by Febelco, it was therefore decided not to continue with the other service-driven companies that committed themselves. In a second attempt, shops in Antwerp were approached, but they were not interested, either. The participating storeowners generally found it a convenient solution,

but it was simply not a habit to order online. Instead they continued going to the wholesaler on own account. This is also reflected in the current supply of storeowners, they indicated that they do not order online at other webshops (CITYLAB, 2018d; Kin, Verlinde, & Macharis, 2017).

Compared to business as usual, the deliveries by Febelco, had no additional kilometres since the five stores were located exactly on-route between the pharmacies. Consequently, there are no emissions (CITYLAB, 2018d; Kin, Spoor, Verlinde, Macharis, & Van Woensel, 2018).

TO FIND SERVICE-DRIVEN COMPANIES WITH SPARE CAPACITY AND A DENSE NETWORK USE COMPANIES THAT CAN PICK-UP PRODUCTS FROM A CENTRALLY LOCATED DISTRIBUTION CENTRE.

THIS SOLUTION REQUIRES A CHANGE IN PURCHASING BEHAVIOUR.

STOREOWNERS: ADOPTION WILLINGNESS DEPENDS ON PRODUCT PRICE AND THE WILLINGNESS/ABILITY TO PAY AND ORDER ONLINE.

MANUFACTURER: THE SOLUTION (RE-)ESTABLISHES DIRECT CONTACT WITH THE STOREOWNER AND ENSURES PRODUCT AVAILABILITY.

Southampton: Joint procurement and consolidation for large public institutions

The aim of the Southampton implementation is to reduce numbers of freight vehicle movements and to use less-polluting vehicles, where feasible, focusing on the freight transport generated by large municipal organisations (LMOs) (e.g. local authorities, hospitals, universities). The main focus was on the role large municipal organisations could play in reducing vehicle impacts by investigating the scope for consolidating incoming freight. The approaches taken to date have been:

- Promoting and undertaking 'delivery and servicing plans' (DSPs) in the style adopted by Transport for London (2015) across a range of business and municipal organisations across Southampton to enable them to review and rationalise their procurement processes and mitigate the negative impacts of freight and service vehicle movements.
- Making use of the 'Southampton Sustainable Distribution Centre' (SSDC) for consolidation of incoming deliveries, off-site storage and other value-added facilities (e.g. office space).
- Using electric vehicles to replace current diesel operations in large municipal fleets as part of a wider programme to consolidate freight and service vehicle activity.

Although take-up to date is difficult, this is not unexpected from large municipal organisations where complexity and size of operations and numbers of people involved, both internally and externally, do not lend themselves to quick decisions being made. Tight financial constraints and other competing considerations, some higher priority, also make progress difficult (CITYLAB, 2018d).

A DSP was undertaken for the University Hospital Southampton NHS Foundation Trust, including a week-long (Mon-Fri) survey of their three main goods-in points in May 2015 (funded by SCC). This revealed the extent of freight operations there: 900 incoming vehicles during the survey week, of which 71% were vans and 18% lorries, which came as an unpleasant surprise for management there who had estimated about 1/3rd of the actual vehicle numbers and led to interest in consolidation opportunities.

When undertaking scoping studies for consolidation the estimated after case of the St. Mary's hospital Isle of Wight NHS Trust, showed that total visits would reduce by around 21%, to 9,000 visits per year, based on the assumption that timed deliveries (e.g. before 10am) and local (Isle of Wight) suppliers would be not be suitable for consolidation (CITYLAB, 2018d). Consolidation of deliveries to university students living in halls of residence was estimated to have a potential to reduce the total number of delivery visits by 35%, from the current 13,512 to 8,765, that is

5,405 (= 40% of 13,512) direct by couriers with 3,360 consolidated deliveries via the consolidation centre (14 halls x 40 weeks x 6 days/week) (Cherrett et al., 2017).

IT IS IMPORTANT TO HAVE A ROBUST CONTRACTUAL COMMITMENT BETWEEN THE LARGE MUNICIPAL ORGANISATIONS (LMO) AND THE OPERATOR OF A CONSOLIDATION CENTRE.

A GOOD UNDERSTANDING OF EXISTING CONTRACTUAL COMMITMENTS BETWEEN THE LMO AND SUPPLIERS AFFECTED BY ANY PROPOSED CHANGES IS NEEDED.

A DEDICATED CONSOLIDATION CENTRE MAY NOT SURVIVE FINANCIALLY DUE TO INITIAL SLOW TAKE-UP AND LACK OF VOLUME; BETTER IS TO BE A PART OF AN EXISTING AND THRIVING FREIGHT LOGISTICS BUSINESS THAT CAN ADAPT TO CHANGING VOLUMES.

Oslo: Common logistics functions for shopping centres

The aim for the Oslo implementation action is to improve the conditions for efficient deliveries, return logistics, e-commerce and waste management to major traffic generators, e.g. multi-tenant shopping centres, and thus reduce the impact of freight movements. Having common logistics functions in a shopping centre means to have a dedicated function for handling freight from vehicle arrival to the individual tenants within the centre (and back in the case of returns and waste). With such functions, dedicated local staff takes over the responsibility for the goods from the driver as soon as the freight is unloaded from the vehicle. The freight may then either be brought to a temporary storage facility or immediately brought to the shops. The in-house movements of freight from the freight reception area to individual tenants is performed by dedicated staff from the common logistics function and is thus decoupled from the driver and the vehicle. Rather than staying at the shopping centre to deliver freight to the individual tenants, the driver and vehicle may leave as soon as the freight has been unloaded and the necessary scans or signatures have been handled. The dedicated in-house common logistics service offers receipt of deliveries, temporary storage space and in-house movements of goods and waste (CITYLAB, 2018d).

To improve the efficiency of freight deliveries, the implementation supports planning of common logistics functions in a new shopping centre in Oslo. Collection of data on efficiency suggests that common logistics functions may significantly reduce the dwell times of vehicles in the centres. Introducing an intermediary between the logistics service providers and the receivers of goods also introduces a potential for sustainable urban logistics measures such as off-hour deliveries and consolidation of freight flows to the shopping centre (CITYLAB, 2018d).

It takes on average 2 minutes for the drivers to unload and deliver one pallet to the common logistics function buffer storage. However, it takes up to 30 minutes for a driver to deliver one pallet to the most remote stores in the mall without a common logistics function. On average it takes 10-15 minutes to deliver a pallet without common logistics function. Common in-house logistics functions therefore generate significant time savings for drivers, especially the ones delivering multiple pallets. Common in-house logistics improve the efficiency of in-house deliveries by consolidating deliveries before transport to the shops. This give fewer individual transports inside the shopping centres. The solution also gives better waste handling and increased degree of waste sorting. Surveys during the implementation period indicated that store employees were satisfied with the solution and 69 % were extremely satisfied. Also, if logistics service providers can reduce the stoppage time by several hours (and assuming they turn the engine off while parked[2]), local emissions will be reduced (CITYLAB, 2018d).

[2] If engines are running, reduced dwell times instead cuts fuel consumption and also CO_2 emissions.

IT IS IMPORTANT TO INCLUDE REAL-ESTATE OWNERS IN LAST MILE LOGISTICS SINCE THEY DEFINE THE INFRASTRUCTURE USED FOR DELIVERIES.

IT IS KEY TO ENGAGE STAKEHOLDERS IN THE PLANNING PROCESS TO DESIGN THE COMMON LOGISTICS FUNCTION.

THE DIVISION OF COSTS AND BENEFITS BETWEEN STAKEHOLDERS IS CHALLENGING. IT IS RECOMMENDED TO INCORPORATE COSTS OF COMMON LOGISTICS FUNCTIONS INTO THE RENT IN NEW SHOPPING CENTRES.

IMPROVED MANAGEMENT OF WASTE IS ONE MEANS OF FUNDING THIS SOLUTION.

Rome: Integration of direct and reverse logistics flows

The Rome implementation aims at improving and optimising recyclable materials collection and reverse logistics. It pursues two specific joint objectives: (1) increase recycling; (2) reduce transport negative externalities. The Living Lab implementation in Rome is an innovative system for integrating forward and reverse logistics flows in urban areas (Gatta & Marcucci, 2016; Gatta, Marcucci, & Pira, 2017). The main idea is to involve the national postal operator, already delivering mail/parcels all around the city, in the pick-up, via electric vehicles, of recyclable materials stored in given facilities of large attractors (e.g. hospitals, universities, shopping malls, etc.) during the same transportation route and exploiting an IT alerting system. The implementation integrates waste collection in an already existing frequent distribution system (e.g. mail delivery) with spare capacity on return trips, aimed at recycling urban waste.

The innovative initiative proposed, when up-scaled, is expected to produce positive environmental impacts due to the: (i) increase of freight vehicles load factors, (ii) reduction of vehicle movements (i.e. dedicated trips), (iii) increase of electric vehicles usage, (iv) enhancement of public awareness towards recycling and (vi) increase of its total amount. Per collection (≈ 2kg plastic caps transported)[3] the results indicate that it was possible to avoid dedicated trips of 3.5 km which means that the environmental cuts were: 2.75g of NO2; 0.29g of PM2.5 and PM10; 677g of CO2 and 0.004g of SO2. When up-scaled to hazardous materials collected at “domus ecologiche” a total of 17,236 kg of CO_2 can be annually saved if considering the involvement of 25% of the condominiums in Rome (CITYLAB, 2018d).

WASTE MANAGEMENT REQUIRES INVOLVEMENT OF SEVERAL MUNICIPAL AGENCIES E.G. TRANSPORT AND THE ENVIRONMENTAL DEPARTMENT.

IT IS KEY TO CONSIDER THE TYPE OF MATERIAL, TRANSPORT OPERATOR, COLLECTION SITE AND COLLECTION BOXES AND TO DEVELOP AN APPLICATION-BASED ALERT SYSTEM FOR WHEN TO COLLECT THE MATERIALS.

Paris: Logistics hotels to counter logistics sprawl

The Paris CITYLAB implementation action aims to address the negative consequences of “logistics sprawl” in order to reintroduce logistics terminals in the dense urban areas. Warehouse location has a direct impact on distance over which goods are transported in urban areas. By moving warehouses outside cities, it increases the kilometres travelled by vans and trucks to satisfy city supply and delivery. The issue becomes more topical as the expansion of e-commerce increases the volume and frequencies of parcel deliveries in dense urban areas that increases the tension on urban freight systems. The implementation in Paris allowed us to assess the (environmental, social, economic and regulative) impacts of two urban warehouses, called “logistics hotels” at different stages of implementation with different

[3] The following environmental and transport indicators relate to savings per month: -185 vehicle kilometers; -148.53g NO2; -15.60g of PM2.5 and PM10; -36,576g of CO2; -0.22g of SO2.

partnership structures and functions: Beaugrenelle Urban Distribution Space at operating phase; Chapelle International Logistics Hotel at construction phase.

The project provides a framework and guidelines to city practitioners to assess costs and benefits of (re)introducing logistics terminals in dense urban areas while assessing regulatory, technical and economic challenges when constructing logistics buildings in cities.

Results from Beaugrenelle shows that a middle size logistics hotel in operation provides valuable inputs for operators and cities willing to promote urban freight terminals to deal with "logistics sprawl" and its negative effects. For the City of Paris, the Chapelle International project is a show case of urban innovation satisfying the needs of sustainable development to develop environmental friendly activities and to promote social inclusion and diversity. The first assessment reveals several issues that may impact the operation of the mixed function facilities: the regulatory and technical complexity, the economic viability of the business model and the engagement of stakeholders. It is clear that a strong political voluntary and coordination is essential to the implementation of such innovation. The fact that these projects are developed by Sogaris, a semi-public institution mainly owned by Paris Municipality and Ile-de-France authorities, shows the support of local government. This is particularly important for Chapelle International as an innovative concept of which the level of uncertainties and thus risks are high. The support of local government has played an important role in securing funding and partnership building of the project. The assessment study for Beaugrenelle released in January 2017, shows an important decrease in freight vehicle km and emissions due to the logistics hotel. Most of the reduction comes from the logistics hotel concept: having a consolidation centre in the city centre reduces last miles for delivery and first miles for pick-up. By comparison, less benefits from the logistics hotel come from the use of electric vehicles (CITYLAB, 2018d).

THE ISSUES THAT MAY IMPACT THE OPERATION OF A MIXED FUNCTION FACILITY IS THE REGULATORY AND TECHNICAL COMPLEXITY, THE ECONOMIC VIABILITY OF THE BUSINESS MODEL AND THE ENGAGEMENT OF STAKEHOLDERS.

A STRONG POLITICAL VOLUNTARY AND COORDINATION IS ESSENTIAL TO THE IMPLEMENTATION OF SUCH INNOVATION.

2.4 Lessons from the CITYLAB implementations

Overall, the CITYLAB implementations cover many different segments and types of freight flows. However, the main experience from each CITYLAB implementation is summarised in Table 4. Experiences from the individual implementations, their processes and impacts have been summarised in various deliverables. In this chapter, we elaborate on the political context, resources required for implementation and community support.

Table 4. Summarised assessment of the CITYLAB implementations.

Implementation	Political context	CO_2 reduction potential	Resources required for implementation	Community support
Growth of consolidation and electric vehicle use	Very important	High	High	High
City centre micro-hubs and cycle freight deliveries	Less important	Medium	Medium	Medium

Implementation	Political context	CO_2 reduction potential	Resources required for implementation	Community support
Increasing vehicle loading by utilising spare capacity	Less important	High	High	Low
Joint procurement and consolidation for public sites	Very important	Medium	Medium	High
Common logistics for shopping centres	Less important	Low	Medium	Medium
Integrating direct and reverse flows	Important	Medium	Medium	Medium
Logistics hotels to counter logistics sprawl	Very important	Medium	High	High

Sources: CITYLAB, 2017b, 2017c, 2018b, 2018c

2.4.1 Political context

To support the city logistics living lab and the implementation of an innovative solution the practical real-life setting, often linked to the political context, is important. Even though some of the living labs in CITYLAB have been industry-led the implementations are linked to cities' objectives on city logistics. The relation between these two are described in the section below.

The 2007 objective for London on urban freight was to provide safe, reliable and efficient movement of freight and servicing trips to, from, within and, where appropriate, through London to support London's economy, in balance with the needs of other transport users, the environment and Londoners' quality of life'. The new Mayor in London has identified air quality as a priority with projects and programs planned to achieve a reduction in emissions from road transport. This has been important support for the implementation in London since it is about reducing the number of vehicles carrying out delivery and servicing activity by using consolidation techniques can help to reduce congestion, improve air quality and safety (CITYLAB, 2017c).

In Amsterdam air quality is the city's main policy trigger with the aim for the majority of vehicle types to be emission free by 2025 and larger trucks and coaches to be clean. Planned or current initiatives include low emission zones, bans on large vehicles (>7.5T) from the city centre, incentives for electric vehicles (e.g. parking on sidewalks and subsidies). The city is also interested in introducing a congestion charge; however, that is not currently permitted in national legislation. This work has triggered the implementation of cargo bikes using centrally located micro-hubs in Amsterdam.

The main ambition for the Brussels Capital Region is to progressively decrease the number of vehicle movements and emissions from freight vehicles in Brussels Capital Region, achieving 30% reduction in vehicles movements and 100% emission reduction by 2050. The Brussels implementation also contributes to the overall city ambitions by looking into alternatives to increase load factors and improve vehicle efficiency, thus establishing measures for more sustainable urban freight transport (CITYLAB, 2017c).

For Southampton City Council (SCC), a major motivating factor is the need to improve air quality while maintaining economic prosperity, as 2013 data gathered by the World Health Organisation indicated that NOx levels in air were measured above the stated safety limit of 40 µg/m³. These data have been used by the UK government to target Southampton and four other poorly performing cities/towns to take remedial actions. As freight transport is recognised

as a significant contributor to air pollution along key transport corridors it is naturally in the interests of SCC to consider any schemes that may reduce freight transport and its associated negative impacts on air quality. This has been very supportive for the Southampton implementation resulting in several ideas and alternatives for joint procurement and consolidation for public sites (CITYLAB, 2017c).

The City of Oslo aim to work closely with citizens, businesses, knowledge institutions, and other public authorities to develop and implement good climate solutions as emphasised. They also aim to facilitate a city logistics system where traffic demand is reduced, and where all new cars and light freight vehicles in Oslo shall use renewable fuels or be plug-in hybrids from 2020. The industry initiated implementation relates to this by aiming to improve the conditions for efficient deliveries, return logistics, e-commerce and waste management to major traffic generators, e.g. multi-tenant shopping centres, and thus reduce the impact of freight movements (CITYLAB, 2017c).

The major objectives for the city of Rome to work on urban freight transport are twofold: improve / maintain accessibility and reduce negative impacts (emissions and pollution). This is done through:

- Aggregation of transport operators;
- Increased load factor;
- Switching power supply of the freight vehicles;
- Rationalization of areas of goods loading / unloading.

Following this the implementation in Rome, focusing on reverse and integrated logistics, has contributed to parts of the objective for the city (CITYLAB, 2017c).

The long-term urban freight transport ambition for the city of Paris is to reduce overall emissions of the territory and activities by 75% in 2050 compared to 2004. The overall goal of the city council is to have 100% of deliveries to be non-diesel by 2020. The Paris implementation address the negative consequences of “logistics sprawl” to reintroduce logistics terminals in the dense urban areas. The ambitions of the municipality have been key in developing the logistics hotels. The municipality has been actively working with private partners to develop logistics hotels, a new concept of logistics real estates adapted to city centre locations, accessible for trains, large trucks and electric vehicles (CITYLAB, 2017c).

The objectives above have been specified in local urban freight plans or strategies and have been driving factors for the interests and support of the implementations. The plans important for the implementations in the CITYLAB cities are summarised in Table 5. These are just a selection of the local plans which directly include urban freight, however, other plans can be important such as health or traffic safety.

Table 5. Planning context of the CITYLAB implementations.

Implementation	City	Urban freight strategy/plan
Growth of consolidation and electric vehicle use	London	The Mayor’s Transport Strategy and the London Freight Plan
City centre micro-hubs and cycle freight deliveries	Amsterdam	Clean air for Amsterdam Set of Measures - towards an emission free 2025
Increasing vehicle loading by utilising spare capacity	Brussels	The Strategic Plan for Goods Traffic
Joint procurement and consolidation for public sites	Southampton	Elements of urban freight included in the Oslo Climate and energy strategy

Implementation	City	Urban freight strategy/plan
Common logistics for shopping centres	Oslo	Urban freight included in the air quality strategy and Local Transport Plan
Integrating direct and reverse flows	Rome	Included in the Mobility Master Plan and the ongoing Sustainable Urban Mobility Plan
Logistics hotels to counter logistics sprawl	Paris	The Paris Charter for Sustainable Urban Logistics

In summary, a clear political will and the support of local government has played an important role in securing funding for implementing new solutions. Public sector involvement, often across municipal agencies, is key in several of the implementations (Paris, Rome, Southampton, London). The challenge of being dependent on the public sector is their ability to connect their visions to policy actions. Strong political voluntary effort and coordination is essential to the implementation of urban freight innovations. The ability and willingness of local authorities to implement policy measures to positively drive forward sustainable logistics practice has been crucial in some of the implementations (CITYLAB, 2018d).

2.4.2 Resources required

It is important that the implementation does not require too large financial, physical or human resources. Having sufficient capacity among stakeholders to develop the implementation is crucial for success. This issue is often linked to having sufficient human resources allocated to urban freight within the municipality. Connected to the capacity issue is the need to have financing when testing and developing innovations. However, this is mostly an issue for the local authorities and the research partners, as the industry very often themselves can provide the funding if they find cooperation beneficial.

One finding is that it has also been crucial to make small adjustments to the business models as the implementation has developed over time (London, Amsterdam, Oslo, Brussels, Southampton). Minor adjustments can make a large difference e.g. the shop owners were more positive to the common logistics function when the costs were included in the rent before deciding to locate to the specific shopping centre compared to an increase in the rent afterwards. This reflects the willingness of organisations to make operational changes to logistics practices in favour of sustainability when the outcome, although positive, will inherently impact (potentially negatively) on customer/client experience (CITYLAB, 2018d).

2.4.3 Community support

The involvement of multiple stakeholders based on co-creation of innovative solutions and end-user involvement is a key principle of the city logistics living lab. It is therefore important to assess the community support based on the different stakeholders' perceptions of the implementations. For CITYLAB this was done using a multi-actor multi-criteria analysis (MAMCA) to evaluate and visualise stakeholder support for CITYLAB's urban freight transport solutions (Macharis, de Witte, & Ampe, 2009). The following five types of stakeholders provided their opinions: shippers, receivers, transport operators, society/authorities and shopping centre owners (CITYLAB, 2018e). Table 6 shows a selection of the findings. More detailed analysis from the different CITYLAB cities can be found in CITYLAB (2018e).

Table 6. The implementations and who takes the lead.

Implementation	Lead by private company or public sector organisation	Community support
Growth of consolidation and electric vehicle use	Public and private	Society and receivers preferred this alternative in all cities. Shippers identified this alternative as the worst option.
City centre micro-hubs and cycle freight deliveries	Private	Society and receivers preferred this alternative in all cities. Shippers identified this alternative as the worst option.
Increasing vehicle loading by utilising spare capacity	Private	Receivers and society gave this alternative the lowest score (except in Brussels).
Joint procurement and consolidation for public sites	Public and private	This alternative received moderate score by all stakeholder groups.
Common logistics for shopping centres	Private	Among receivers and transport operators this implementation received a moderate score in all cities. Shippers gave this solution the highest score in all workshops (except for London).
Integrating direct and reverse flows	Public and private	Among receivers and transport operators this implementation received a moderate score in all cities. Shippers assessed this solution to be the second-best alternative.
Logistics hotels to counter logistics sprawl	Public and private	The score for this alternative varies across the cities both for the receivers and shippers. Transport operators gave this alternative the lowest score.

In summary, there is not one alternative that stands out for one stakeholder group across cities. Despite the many differences, across cities and stakeholders, there is most support for the ‘integrated reverse logistics’ alternative, followed by the ‘common logistics in shopping centres’ alternative, the ‘last-mile carrier with electric vans’ alternative and the ‘e-freight bikes and micro-hubs’ alternative.

The ‘urban warehouse with electric vans’ alternative scores slightly less and the ‘online platform with use of spare transport capacity’ alternative scores worst overall. It is most remarkable, though, that rather similar alternatives like ‘last-mile carrier and electric vans’ and ‘urban warehouse and electric vans’ were not evaluated in the same way in most cities and by most stakeholders. Based on the comments and feedback that was given during the workshop, we assume this has got to do with the fact that it we clearly mentioned that the parcel company did not have to pay the market price for renting the urban warehouse in the ‘urban warehouse and electric vans’ alternative. The second important difference between the two alternatives is that in one case, the parcel company operates the centrally located warehouse while they subcontract to a specialised urban last-mile carrier in the other case.

We also observed that there is a tendency to prefer the local implementation in some cities (Amsterdam, Brussels, London and Oslo), which can be expected since some of the participants are project partners or were involved in the local implementation. Finally, both in London and Southampton, it was mentioned that the alternatives under consideration can be combined in one city (CITYLAB, 2018e).

To investigate stakeholders’ perceptions towards the solutions implemented in the other living labs a transferability analysis, focusing on behavioural perspectives, was performed (CITYLAB, 2018h). The main findings indicate that the implementations in Amsterdam,

Brussels and Rome was perceived as good candidates for being transferred (respectively to Rome, Paris and London), while less so for London and Southampton (respectively to Oslo and Amsterdam) (CITYLAB, 2018c).

The experimental and innovative practices when developing new solutions in city logistics needs to be supported by industry to ensure that the development is not hindered. For this group of stakeholders' changes that might impact the conventional supply chain environment with its existing critical mass affect their opportunities for achieving real profitability.

All CITYLAB implementations have been developed using elements of the living lab approach. The Paris implementation would not have been possible without a living lab approach, this experience has provided important guidance and experiences to the other CITYLAB living labs. In the London implementation finding a suitable location for a centrally located depot was a barrier for upscaling. However, introducing additional participants, from the City of London, reduced this challenge. New locations for a centrally located depot was identified because of the public-private partnership using similar techniques as a living lab approach. Collaboration between stakeholders at city level was important in Southampton and Rome. In Southampton the different solutions investigated are a result of urban freight stakeholders working together based on living lab principles. In Rome it is the other way around; the implementation there has spread the idea of a living lab and this way of working is now being used to develop other solutions within the area of city logistics. The implementation in Oslo would be possible to achieve without a living lab, however, there are several things which could have been sized, designed or installed with the wrong dimensions since real-estate developers sometimes have limited knowledge on city logistics. The initial idea of a common logistics function, the result and the design of the solution was changed due to the living lab. In Amsterdam the cargo bikes were developed together with the bikers (end-users), which is a key element in an industry-led living lab. This was also the case for Brussels and the store-owners was included in the development of the solution. However, as the results indicate that it was challenging for them to order online the collaboration could have been improved to avoid that challenge.

2.5 CO_2 reduction potential

In the context of city logistics, the goals of a living lab will usually relate to environmental concerns (e.g. improving air quality) or to operating more efficiently. To measure whether these goals are met when implementing a new solution, it is necessary to quantify the CO_2 reduction potential.To be able to generalise the lessons from CITYLAB to a broader context than the specific CITYLAB implementations, CITYLAB Deliverable 2.3 (CITYLAB, 2016) linked the implementations to more generic initiatives, and these generic initiatives were used to analyse the CO_2 reduction potential from the solutions represented by the CITYLAB implementations. The CITYLAB implementations were found to represent the following initiatives:

- Consolidation centre/mobile depot
- Electric vehicles
- Improved loads on delivery vehicles
- Use of non-road modes
- Procurement practices by receivers
- Generating return vehicle loads (reducing empty running)
- Common internal logistics for major multi-tenanted buildings
- Partnerships working between companies in supply chain
- Partnership working between city authority and private sector companies
- Urban distribution property and land use planning interventions

CITYLAB then performed a survey among urban freight experts to get an understanding of the outlook for reductions in vehicle kilometres and CO_2 emissions from alternative measures in a year 2030 perspective. The survey, differentiating between Light Goods Vehicles (LGVs) and Heavy Goods Vehicles (HGVs), combined information on:

- Expected relative contribution of the measure
- Size of the total market that the measure applies to
- Expected general development in vehicle kilometres until 2030

By combining this information, it is also possible to derive the expected contributions to the overall CO_2 reduction potential in European urban areas. Figure 2 shows the expected reduction in vehicle kilometres for HGVs and LGVs from the selected set of initiatives that are linked to the CITYLAB implementations. The initiatives are sorted by the average contributions to HGV and LGV vehicle kilometre reductions. Tables with a full overview for all measures can be found in CITYLAB (2017a).

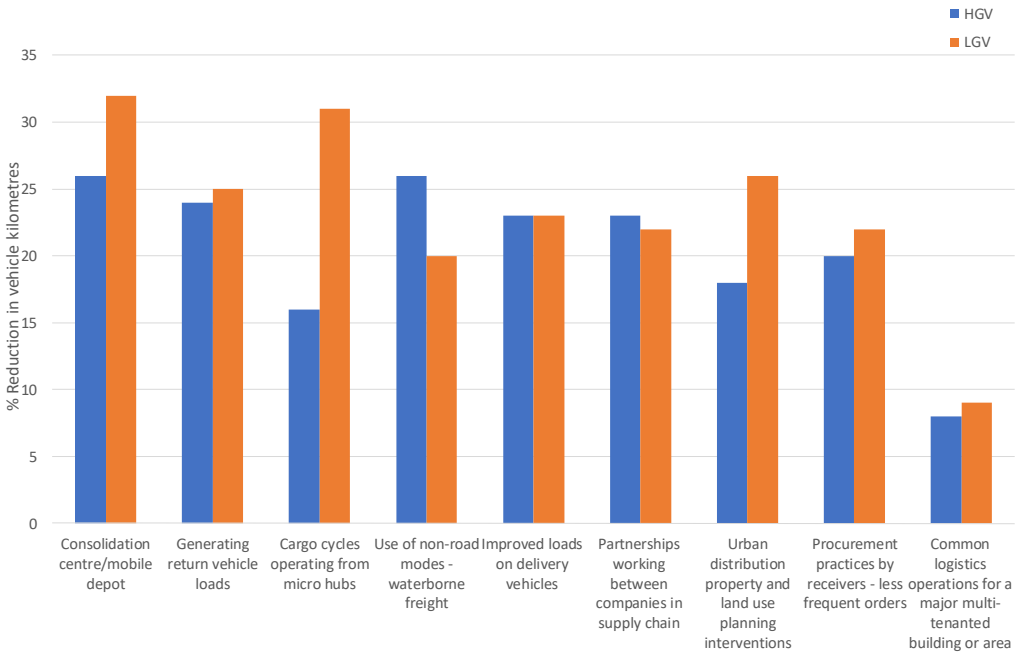

Figure 2. Percentage reduction in HGV and LGV vehicle kilometres from individual initiatives. Source: (CITYLAB, 2017a)

Figure 2 indicates that the initiatives are likely to have a stronger relative impact on the vehicle kilometres of LGVs than HGVs. This is probably due to an impression that the movements of HGVs are better planned and optimised, and that there are more significant inefficiencies in the LGV movements.

If we combine the expected reductions in vehicle kilometres with information on the total market in which an initiative may have affect, we obtain estimates on the contributions to reducing total CO_2 emissions from the individual measures. Figure 3 shows the expected contributions to CO_2 emission reductions from the same initiatives as those shown in Figure 2. The initiatives are sorted by the average contributions to HGV and LGV emission reductions. Tables with a full overview for all measures can be found in CITYLAB (2017a).

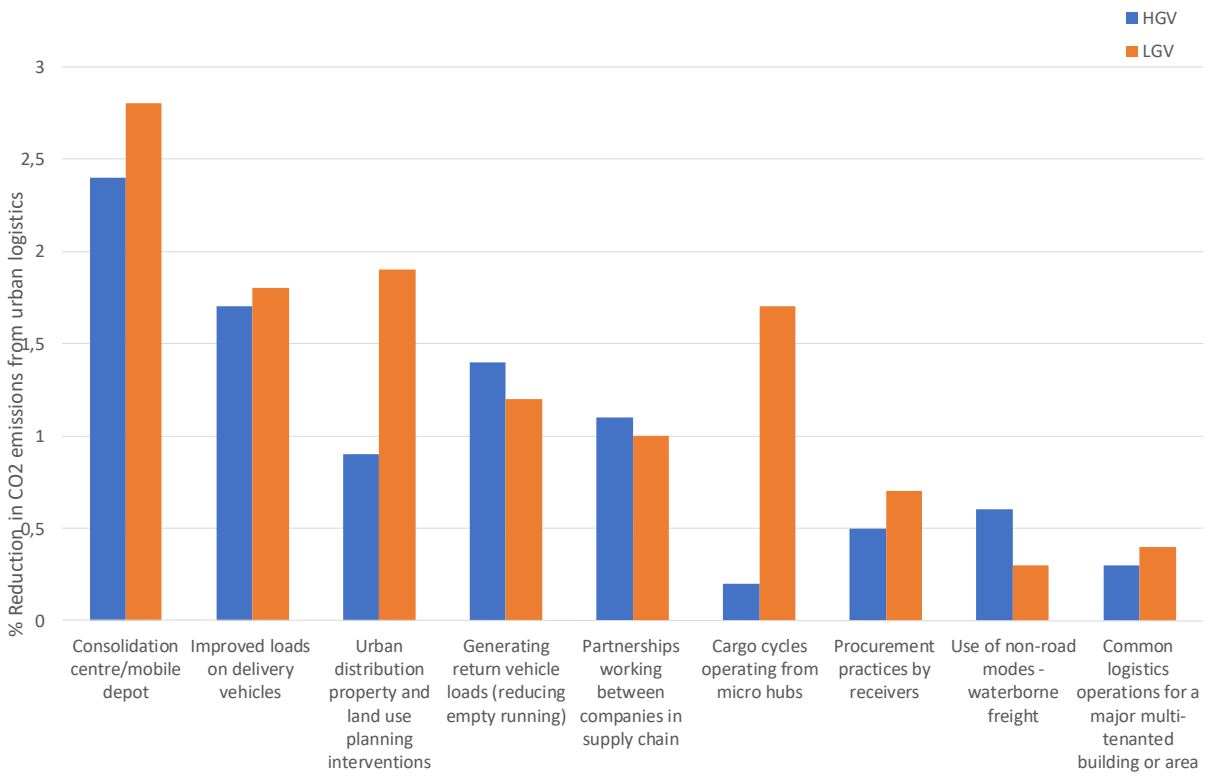

Figure 3. Potential percentage reduction in CO_2 emissions from HGVs and LGVs from individual initiatives. Source: (CITYLAB, 2017a).

If we combine all the information from the survey, we find that the direct expected CO_2 reduction potential from the non-vehicle-technology-related measures is limited. The respondents of the survey indicate that the non-vehicle related initiatives in total may reduce CO_2 emissions from HGVs by 11% and LGVs by 7% by 2030. This is however being offset by an expected growth in volumes, expected to be 11% for HGVs and 24% for LGVs. Vehicle-related initiatives, including use of CO_2-free vehicles, improvements in fuel efficiency of conventional vehicles and greater use of biofuels in diesel, was estimated to potentially reduce HGV emissions by 57% and LGV emissions by 68%. The net effect of all potential initiatives and expected growth is 57% reduction for HGVs and 51% for LGVs.

Two important conclusions arise from this analysis:

1. It might seem that it will not be possible to reach the target of CO_2-free city logistics. However – the geographical scope of the survey was broader than main urban centres, and therefore, the results do not contradict the possibility for reaching the EC target.
2. The results suggest that the direct contribution from logistics improvements and increased load factors to reducing CO_2 emissions is limited. A very important point, however, is that several measures aimed at logistics improvements are also facilitating the use of zero-emission vehicles.

For measures not focusing on vehicle technology, their contributions to reducing overall CO_2 emissions in the future depends on their ability to:

- reduce the demand for transport (e.g. number of shipments)

- reduce vehicle kilometres travelled and improve the utilisation of the transport capacity
- promote low- and zero-emission technologies

The CITYLAB roadmap, presented in Chapter 3, combines these three perspectives in the prioritisation of actions to be made.

2.5.1 Implementation tool quantifying impact of initiatives

To make the initiative impact quantifications described above available to policy-makers they have been matched with the RPI Initiative Selector Tool. The Initiative Selector is a webpage that, for a given set of inputs, return suggestions of potential initiatives that could be implemented for a given problem. The Initiative Selector can be found at http://coe-sufs.org/wordpress/initiativeselector.

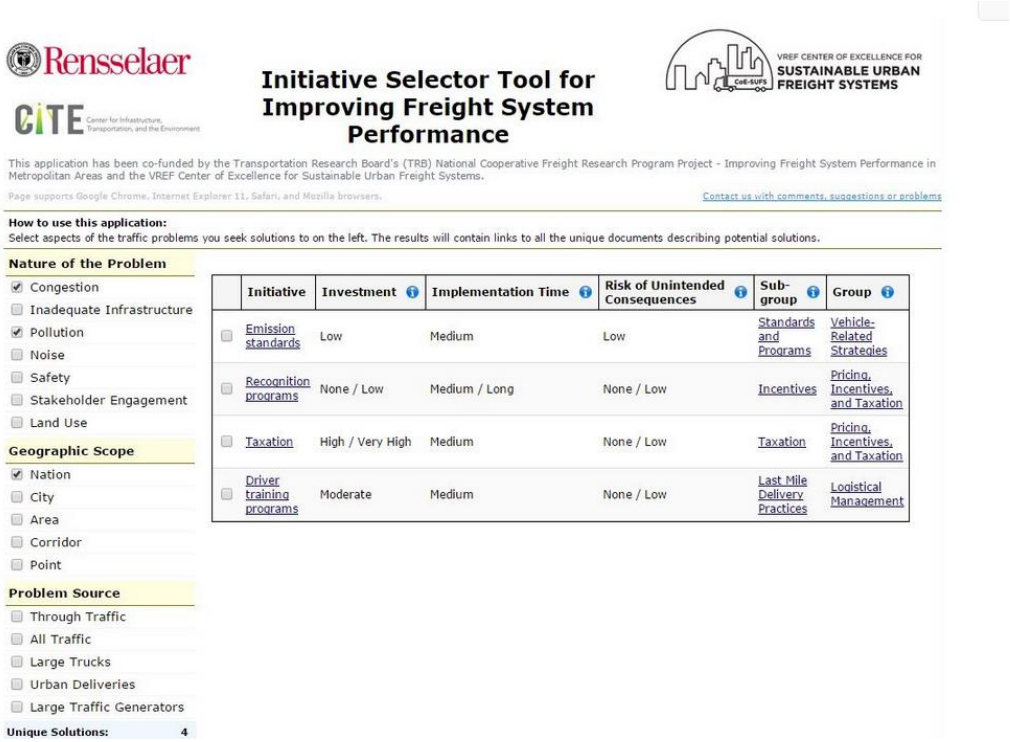

Figure 4. The Initiative Selector Tool.

Figure 4 shows an example from the Initiative Selector. On the left side of the screen there are three categories a user can choose from: 1) Nature of the Problem, 2) Geographic Scope, and 3) Problem Source. The user can select multiple choices for each criterion. As the user enters their criteria identifying the problem, the table in the centre of screen is populated with possible initiatives that could be used to solve the problem, along with some key identifiers about the initiative, such as the investment level, length of time for implementation, risk of unintended consequences, and the group and sub-group the initiative belongs to (Center of Excellence for Sustainable Urban Freight Systems, 2018).

The impact quantification added to this tool is based on respondents estimates of the extent to which they expected a range of urban freight transport initiatives to affect the total vehicle kilometres travelled and hence total CO_2 emissions from LGV and HGV freight operations in European urban areas by 2030 compared with now. These initiatives were grouped into three categories. Those that have the potential:

- to reduce HGV/LGV vehicle kilometres travelled for goods collection/delivery (and hence reduce fuel use and thereby CO_2 emissions)
- to reduce LGV vehicle kilometres travelled for servicing activities (and hence reduce fuel use and thereby CO_2 emissions)
- to lead to the retiming of HGV/LGV trips and to reduce vehicle queuing at delivery/collection points, thereby improving vehicle flow speeds and reducing stop-start operations (and hence reduce fuel use and thereby CO_2 emissions)

In the case of urban freight initiatives aimed at retiming goods vehicle trips and reducing vehicle queuing at delivery/collection points, these would not be expected to reduce vehicle kilometres but have the potential to reduce vehicle fuel use (due to fewer stop-start operations and improved vehicle flow speeds, as well as to reduce total vehicle peak-time traffic). For these retiming initiatives respondents were therefore asked to estimate the expected reduction in fuel use (and thereby CO_2 emissions) that the initiative could lead to. The quantifications from CITYLAB are included in the following way: https://coe-sufs.org/wordpress/rldcp/.

2.6 Transferability of the implementations and city logistics living labs

It is important to carefully assess whether a specific solution, successfully implemented in a city, might be suitable for another local context: as said, transferability is about understanding the context conditions for innovation (CITYLAB, 2018h). Transferability analysis is defined as the process of verifying the chances of a successful implementation of a measure, which was successfully implemented in a pioneer city, to an adopting city at operational level (TIDE, 2013). Successful in this case not only means savings in CO_2 but also the economic feasibility of solutions. To allow statements on the likely success of the transfer of solutions from on city to another a transferability analysis has been conducted. For CITYLAB the approach described in TIDE (TIDE, 2013) was used with an adoption to fit the project.

“Adopter” or “Transfer” cities are defined as cities potentially adopting a solution previously tested in another city. “Transfer” is understood as the ability to replicate/copy/adopt implementations and measures previously tested elsewhere, successfully in a given city, while achieving comparable results (Barrera, 2013; TURBLOG, 2011). Important steps of the CITYLAB transferability analysis are[4]:

1) the identification of success factors of the implementations;
2) the identification of the level of importance of success factors;
3) assessment of success factors in the context of the adopter city and
4) draw conclusions about the potential of transferability through consideration of the rated success factors.

For the identification of success factors of implementations, the main components that can contribute to the success (or failure) of a measure must be identified so that their relevance to the transferability can be assessed in terms of policy, finance, stakeholder involvement, technical requirements, demographic issues, institutional and legal frameworks. These components must be further broken down into characteristics (or sub components) relevant for the transferability. The identification of components and characteristics of a measure in the context of transferability depends on the experience of the pioneer city. TIDE gives a starting list of components and characteristics which can influence the transferability of a measure.

[4] The identification of success factors of implementations as well as the identification of the level of importance of success factors is performed from the perspective of the pioneer city. The assessment of success factors is performed from the perspective of the adopter cities.

CITYLAB Deliverable 2.3 (CITYLAB, 2016) identified success factors for logistics initiatives connected with the implementations.

The identification of the level of importance of success factors requires the identification of the relative level of importance (i.e. high/medium/low) of each characteristic. The experience of the pioneer city and advice from experts are valuable in this process. In CITYLAB the identification of the success factors for the implementations was derived from data collection in the implementing CITYLAB cities. The respective partners from municipalities and industry were needed to rate the level of importance of each success factor.

The assessment of success factors in the context of adopter city comprises a subjective assessment of the effort, which has to be made for implementing the measures in the context of each adopter city. Discussions with experts and city representatives (pioneer and adopter cities) are suggested. The CITYLAB approach proposes an assessment of the success factors in the context of each adopter city. The assessment has to be conducted in a survey.

The results indicate that that which CITYLAB implementation to successfully transfer to the other CITYLAB living labs differs and mitigating strategies should be developed to overcome the main barriers. The most successful transfer to each city are linked with an arrow in Figure 5[5] (CITYLAB, 2017b). Regarding success factors for transferability there is difficult to find common elements since both the implementations and cities have very different conditions for transfer (CITYLAB, 2018h).

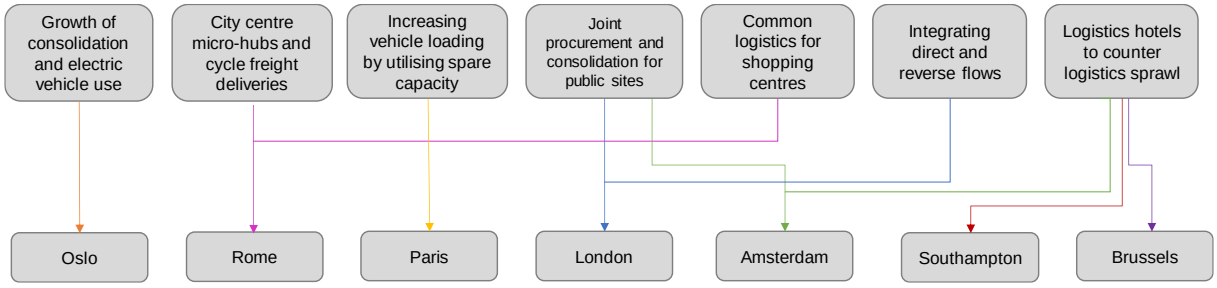

Figure 5. Transfer of CITYLAB implementations to CITYLAB living labs.

This assessment can also be undertaken to ensure transfer to living labs outside of a certain project. In CITYLAB this group of cities is named transfer cities and regions (TCR). These cities were Delft, Madrid, Manchester, Rogaland Region, Budapest, Flanders Region, Pisa, Prague and Turin. As part of the transferability they assesed the local attitude towards and the success factors of their preferred CITYLAB implementation. They weighted the likely support or constraint for transferability (from -2 to +2) of the characteristics of your preferred CITYLAB implementation, and motivate this assessment. How this group of cities would like to proceed with the CITYLAB solutions is included in Table 7. A group of follower cities was also identified (Gothenburg, Mechelen, Antwerp, Gdynia, Graz, L'Hospitalet, Milan, Skedsmo and West Midlands). Other approaches for assessing transfer potential and adjust a city logistics solution to another city context are MAMCA, bilateral talks or interviews, questionnaires, workshops and site visits. In the end, sufficient knowledge transfer is key in implementing a solution in another context (CITYLAB, 2018h).

[5] More detailed explanations of the methodology behind this approach can be found in CITYLAB Deliverable 5.6 "Assessment of roll-out potential of CITYLAB solutions to other CITYLAB living labs".

Table 7. Transferability of the CITYLAB implementations to other cities.

City	How the transfer cities want to proceed
Budapest	Will work further on contacts with logistics companies
Prague	Will start a study on the potential for different sustainable urban freight transport solutions in Prague with the CITYLAB implementations as inspiration.
Delft	Started a Living Lab one year ago. They would like to change access regulations to stimulate the use of an operational freight hub.
Brussels-Capital Region	Have identified a need for detailed information on regulations in all European cities and their impact.
Paris	Will test the 'truck within a truck' concept regarding public space and the impact of freight vehicles on traffic safety.
Rogaland Region	Would like to use MAMCA and plan/implement a solution with cargo bikes and micro-hubs.
Madrid	Would like to proceed with the CITYLAB solution of Paris Beaugrenelle, but they are also open to other CITYLAB solutions. City of Madrid and SEUR would like to use MAMCA in the future
La Rochelle	Would like to use MAMCA for the development of their new freight plan.

Source: (CITYLAB, 2018e)

There has also been significant interest from other cities in transferring the city logistics living lab approach of CITYLAB. To transfer and set up a city logistics living lab in other cities it is important to:

- Define the living lab ambition, objectives and scope
- Create the core living lab leam
- Select an appropriate living lab governance model
- Analyse existing city logistics conditions
- Identify potential ideas and cases to develop within a living lab
- Test and evaluate the measure implemented (CITYLAB, 2018i)

As can be seen in most early cases of transfer and transfer attempts, the action of transfer requires additional solutions and strategies. A simple one to one replication is not always easy, and there is in most cases a series of activities complementary to those tested and piloted in original implementation actions.

3 Moving towards CO_2-free city logistics

This chapter presents the CITYLAB roadmap for moving towards CO_2-free city logistics in major urban centres by 2030. The starting point for the roadmap is the experiences obtained throughout the CITYLAB project.

3.1 CITYLAB roadmap

CITYLAB has explored new logistics solutions and collaboration practices in seven living laboratories. Based on the new knowledge generated we have developed a roadmap for moving towards emission-free city logistics by 2030.

The urban logistics activities are usually performed by private companies, but the public sector is affecting the conditions under which the private companies operate. A roadmap for city logistics therefore has to cover both public and private sector actions. The CITYLAB roadmap therefore combines 1) better integration of city logistics in urban policies, and 2) actions and solutions that may increase load factors, reduce vehicle movements and reduce emissions.

The roadmap is illustrated in Figure 6, and explained below the figure.

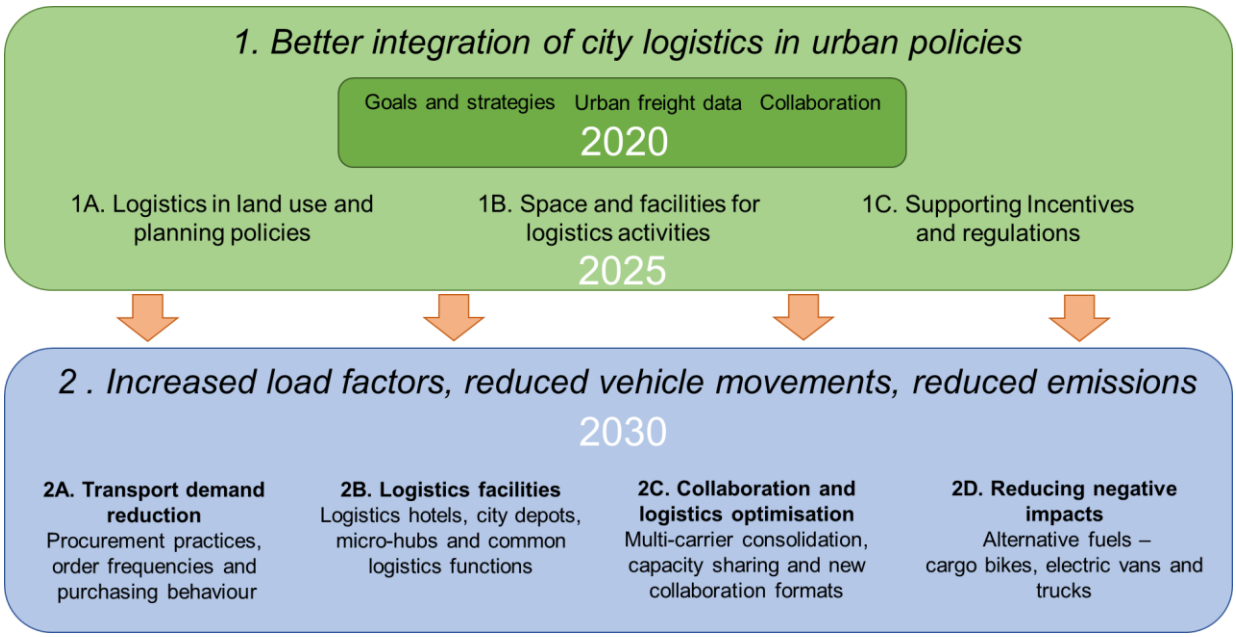

Figure 6. The CITYLAB roadmap.

3.1.1 Better integration of city logistics in urban policies

The lower part of Figure 6 shows recommended actions for local and regional authorities in urban areas to achieve better integration of city logistics in urban policies.

There are many examples of local and regional administrations becoming aware of the need to improve sustainability of urban logistics by looking for “quick fixes” and “low hanging fruits” to get immediate payoff and visible results. There is nothing wrong with these alternatives, but to reach the goal of basically emission-free city logistics in major urban centres by 2030, more long-term efforts are needed.

Sustainable Urban Mobility Plans have obtained increased attention during the last decade, and the first action set out in the Action Plan on Urban Mobility (Commission of the European

Communities, 2009) was to accelerate the take-up of SUMPs. The central goal of a SUMP is to improve the accessibility of urban areas and to provide high-quality, sustainable mobility and transport to, through and within the urban area (European Commission, 2013). The European Commission (2013) emphasised that urban logistics should be among the different components of a SUMP, and that a SUMP should present measures to improve the efficiency of urban logistics, including urban freight delivery, while also reducing related externalities including GHG emissions and noise. Thus, the concept of Sustainable Urban Logistics Plan (SULP) has been launched, to deal with the urban logistics component of a SUMP. A Sustainable Urban Logistics Plan (SULPs) is a holistic planning strategy for urban freight that ensures efficient and sustainable logistics operations within urban areas (Fossheim & Andersen, 2017). What is described in this subchapter could serve as important components within a SULP.

To achieve better integration of city logistics in urban policies the inner part of Figure 6, defines three initial steps for anchoring and prioritising city logistics in urban policy-making. These steps are important facilitating actions for more specific policy measures aimed at improving sustainability and efficiency of logistics. The steps should be realised as soon as possible.

Goals and strategies. There is a need to define clear goals for what the city wants to achieve in the city logistics domain, supported by strategies to reach these goals. The goals should be in line with European and national goals, but may be extended and made stronger based on local ambitions and needs.

Urban freight data collection. CITYLAB and many other initiatives have struggled with a lack of available urban freight data. Many operators have good routines for monitoring their own operations, but there are fewer good examples of system-wide and city-wide data collection efforts. Data are needed both for assessing status, but also for understanding trends and developments, and for comparing and benchmarking different urban areas. CITYLAB has developed an observatory of strategic developments. European-wide indicators and data collection procedures should be defined and used.

Establish public-private collaboration formats. Another key component is to develop useful public-private collaboration practices. The need for collaboration has been recognised for a long time, and remains important as many solutions depend on support and involvement of a range of stakeholders – both public and private. CITYLAB has introduced the living lab approach to city logistics with an aim to make stakeholders not only talk together but work together. The experiences from the living labs show that defining such local collaborations working towards common goals may be a helpful approach in realising urban logistics innovations. A city logistics living lab can be developed to realise actions that have been prioritised in a SULP.

At the next level, three main public sector actions for integrating city logistics in urban policies are defined. These actions require that the goals and strategies for the cities and urban areas are set out, urban freight data are established, and that collaboration take place. Changes are time-consuming, and a very limited resource if sustainable solutions are to take effect within year 2030. We therefore consider that the three prioritised actions have to be realised within year 2025.

1A. Include logistics in land use and planning policies

Local and regional authorities have many tasks and responsibilities, and it is difficult to prioritise urban logistics. Urban logistics is seen as a private matter left to the market to solve. CITYLAB and many other projects find, however, that more active involvement of local and regional authorities is needed. Considering the negative externalities of freight transport such as emissions, noise and contributions to emissions, urban logistics cannot be considered a purely private matter. Local and regional authorities can affect the performance of urban logistics in so many ways that they need to have a plan for how to deal with this topic. As explained above,

SULP development is one way of ensuring consistent and predictable treatment of urban logistics. Below we give some examples of more specific topics that should be considered.

The establishment of logistics hotels in Paris is a part of long-term planning of the city; the requirements for rail and logistics facilities were decided more than 10 years ago. In 2006, there was a first sustainable charter for logistics with a commitment, which was followed by an operational charter in 2013, which included 16 project sheets outlining policies for urban logistics in Paris. Among the topics covered were the logistics hotels, modernisation of delivery zones, developing fleets of electric vehicles, and dealing with E-commerce and home deliveries. The charter has a strong emphasis on involvement of all the relevant stakeholders, and there is an operational monitoring committee for the charter projects that will bring together all partners annually. The Paris zoning ordinance (Plan local d'urbanisme 2016) has incorporated lessons from the logistics hotels, and has opened more urban land to future logistics, potentially multi-uses (CITYLAB, 2017c).

The work in the Oslo living lab with common logistics functions for shopping centres has showed that early planning of logistics, i.e. planning for deliveries and reverse logistics before a building is constructed, is crucial for the efficiency of operations. This supports a conclusion that a plan for freight deliveries should be presented as part of the process of obtaining building permits (CITYLAB, 2018d). In Rotterdam, the green deal for zero emission city logistics has led to a living lab collaboration focusing on knowledge development forming the basis for later actions. The target is to guide all the relevant city logistics stakeholders to achieve zero emission city logistics in the inner centre of Rotterdam by 2020 (CITYLAB, 2017c).

1B. Ensure space and facilities for logistics activities.

The CITYLAB project has explored and supported various measures aimed at improving the sustainability and efficiency of urban freight transport operations. In most cases, the issue of access to space has appeared to be vital. For instance, clean vehicles have shorter ranges than conventional ones, and require reloading of shipments closer to the final receivers of goods. Also, the rapid growth in B2C e-commerce gives rise to new logistics solutions with new and different requirements for space in urban areas. For use of carbo bikes, finding appropriate locations for micro terminals and city depots is usually the key challenge that has to be solved, and also for the Gnewt cargo operations in London, the most important challenge has been the lack of affordable space close to the city centre. The greatest operational difficulty encountered during the implementation was that none of the Gnewt Cargo depots in Central London were accessible by a large truck, so TNT was obliged to use smaller 7.5t urban trucks to deliver parcels to the Gnewt depot. For the shopping centre in Oslo, making space available for common logistics functions during the planning phase was identified as crucial (CITYLAB, 2018d).

1C. Incentives and regulations

A third important issue in relation to integrating city logistics in urban policies is to understand how the public sector may accelerate sustainable urban logistics in general, and the take-up of low- and zero emission vehicles in particular. So far it seems that battery electric vehicles will be the most relevant technology in urban logistics during the next decade.

There are many companies willing to test and acquire electric vehicles, but rapid growth requires first of all that suitable vehicles are available in the market, and that the total cost of ownership is not higher for electric than for conventional vehicles. The FREVUE project found that the current generation of electric freight vehicles are not commercially viable, but still the public sector can play a role in accelerating the take up of these vehicles through incentives and regulations.

The evaluation of the CITYLAB implementation in London, studying growth potential for deliveries with clean vehicles, identified several examples on how the public sector may promote clean vehicles (CITYLAB, 2018d):

- The exemption from the daily Central London Congestion Charge for 100% Battery Electric vehicles.
- Another support is the UK government grant for the purchase of electric vans.
- Specific access rules for electric vehicles and cycles for certain urban areas such as pedestrian zones and other restricted areas
- Authorisation to use restricted parking and permit bays and for loading bays in central areas
- Consistency in rules for electric vehicle parking and stopping areas across different London Boroughs

3.1.2 Ways to increase load factors, reduce vehicle movements and reduce emissions

The blue-coloured part of Figure 6 deals with specific measures and actions directly contributing to increased load factors, reduced vehicle movements, and reduced emissions. We have defined four main categories of measures, incorporating lessons learned from the implementations in the CITYLAB living labs. These measures are different, yet complementary, as they are mutually reinforcing.

2A. Transport demand reduction: Procurement practices, order frequencies and purchasing behaviour

The procurement practices of companies and institutions may have a significant impact on freight vehicle movements.

Every year, over 250 000 public authorities in the EU spend around 14% of GDP on the purchase of services, works and supplies (European Commission, 2018). There has been increasing attention on how this procurement power can be used to obtain societal goals and promote sustainable innovation. Projects like BuyZET (Procurement of innovative solutions for zero emission urban delivery of goods and services) and SPICE (Smart procurement for better transport) are among the initiatives that have contributed to the increased attention to sustainable transport in procurement, but many other initiatives exist as well.

There are two main ways in which public procurement can be used to promote sustainable urban logistics solutions; cleaner vehicles and increased load factors. First of all, there may be requirements related to vehicle technology for deliveries to the public sector institutions, for instance requirements for Euro 6 engines and even zero-emission technology. On top of this, a lot can be achieved by procurement of low- and zero emission vehicles in municipal fleets.

The other path is to increase the loads on vehicles delivering to the public sector, which again has two main dimensions. One is to reduce the order frequencies and increase lead times, which makes it possible to plan fewer deliveries to public sector institutions. The other one is to consolidate deliveries to public sector institutions without reducing ordering frequencies themselves. This can for instance be achieved by directing flows to public sector institutions through a hub such as a consolidation centre.

In CITYLAB, the Southampton Living Lab investigated public sector procurement and deliveries to large institutions such as hospitals and universities. It was experienced that it is not straightforward to make changes, but this does not mean that that we should stop working on the procurement. One of the actions in Southampton was to a make a Delivery and Servicing Plan (DSP) for one of the hospitals. As part of this, the number of vehicle movements associated with deliveries to the hospital was registered. It appeared that there were three times as many vehicle movements as the number anticipated by the hospital management.

2B. Logistics facilities: Logistics hotels, city depots and micro-hubs, common logistics functions in multi-tenant shopping centres

CITYLAB has studied, tested and implemented various logistics facilities aimed at improving the last mile performances. These facilities have not primarily been targeting consolidation of flows across supply chains, but rather improving existing chains. However, the concepts may also be used further for consolidation across supply chains.

In Paris, the logistics hotels have gained a lot of interest, and other cities are already planning to replicate the idea. Evaluation of the Beaugrenelle logistics hotel showed that the operations of Chronopost saved 52 % of vehicle kilometres compared to the situation without the logistics hotel, and the emission savings were also in the range of 35-55 %.

The PostNL operations with cargo bikes and micro-hubs in Amsterdam has proven successful, and PostNL have been able to make profit from an early phase. It should be emphasised that PostNL has been in a very good position to utilise such operations, as their history as a postal operator has provided the company with access to many central facilities that other logistics operators don't have.

The operations of Gnewt cargo in London depend on having access to space in the city centre for reloading freight to the clean vehicles with limited range.

In Oslo, the new common logistics function for dealing with deliveries to and from multi-tenant shopping centres are appreciated by all stakeholders as long as they are introduced from the very beginning. The solution also represents a decoupling of the freight receivers from the transport leg, and may thus lead to an increase in off-hour deliveries and also consolidation of shipments earlier in the supply chain.

2C. Collaboration and logistics optimisation: Multi-carrier consolidation, capacity sharing and new collaboration formats

One way of increasing load factors is to identify new ways of combining flows that so far have not been dealt with together. This is a very challenging issue, as there are many significant barriers to horizontal collaboration between competitors. Such barriers have been very visible in the many attempts to establish urban consolidation centres (UCCs) in Europe. Despite the appealing nature of joining multiple deliveries in fewer vehicles, there have been very mixed experiences with UCCs. This is partly caused by the extra costs introduced from having an additional handling of freight, but also because some logistics providers are reluctant to lose their direct contact with customers.

Despite such challenges, the expected benefits from sharing capacity represents a potential that should be further explored. The vision of the physical internet is one example of private sector – supported work towards increased integration of services and sharing of facilities and transport capacity. Increased emphasis on sustainability and potential public sector regulations and interventions will also encourage new collaboration initiatives (ALICE, 2015).

An interesting aspect of the CITYLAB implementation in London, is that Gnewt cargo in their role as a carriers' carrier have been able to deliver shipments from different supply chains during the same distribution routes, leading to additional consolidation of flows and fewer vehicle movements.

CITYLAB has also explored two ambitious ways to utilise spare transport capacity in the network. In both cases it was observed that the changes introduced were too comprehensive for a short-term change. In Brussels, Procter & Gamble wanted to utilise spare capacity in vehicles of service-driven companies to serve small, independent retailers who usually bring goods in their own account vehicles to their stores in a very inefficient way. This required P&G to set up a new online sales channel to reach their customers, and that appeared to be a difficult step. It was simply not possible to make the shop owners change their purchasing habits, partly because for tax reasons they were not willing to pay online.

In Rome, Poste Italiane had an ambition to combine postal deliveries with collection of clean waste. In a trial phase, they collected plastic caps from the campus of University of Roma Tre. The volumes handled were small, but the service tested was technically feasible and environmentally sustainable. There were however many barriers to scaling up and extending the solution. Dealing with waste management is a complex task and requires involving, at a public level, both the Transport and the Environmental Department of the city. The challenge is to connect their visions and policy actions. The integration of forward and reverse logistics will most likely be included as a medium to long term objective within the Sustainable Urban Mobility Plan in Rome currently under discussion.

What the Brussels and Rome experiences have in common, is that too comprehensive changes were introduced at one time. In both cases, potential savings in terms of vehicle movements and emissions were documented, and despite the difficulties experiences, finding new ways to sharing capacity should be a prioritised topic.

2D. Reduce negative impacts: Alternative fuels - cargo bikes, electric vans and trucks

CITYLAB has focused on non-vehicle technology based strategies, measures and tools to achieve essentially zero emission city logistics in urban centres by 2030. Still, these strategies, measures and tools involve take-up and use of zero emission vehicles such as cargo bikes and electric vans. The analyses in Chapter 2.5 also clearly show the importance of zero-emission vehicle technology in reaching the goals of emission free city logistics.

During the last years, there has been a steady growth in the supply of cargo bikes and smaller electric vans. The access to zero emission trucks is so far very limited, but a lot will happen during the next years.

3.2 Actions needed for implementation of roadmap actions

For a logistics initiative to move from an idea to full scale operations it needs to be successfully implemented and integrated as part of an overall policy mix. This section elaborates important actions to be performed in order to support the roadmap development and large-scale implementation of solutions supporting emission free city logistics operations by 2030. The things we have identified that need to be achieved are based on experiences from the implementations in CITYLAB. When implementing new measures, a living lab can make the implementation process easier and reduce the conflict of interest between stakeholders involved. Studies conducted showed that the success or failure of many programs often depended on the commitment and skills of the actors directly involved in implementing programs (Howlett et al., 2009).

Since different stakeholders have different roles and needs, the recommended actions are organised by stakeholder group, and three main categories of stakeholders are covered:

i) The European Union and authorities at national level set out main goals and priorities for the overall transport policy. Even though they are not directly involved in urban logistics, they have a significant role in providing goals, guidelines and joint efforts across urban areas;

ii) Local and regional authorities are responsible for the urban environment and play key roles in creating the environment in which the transport operators perform their operations;

iii) Industry stakeholders covering transport operators, receivers, shippers, real estate owners and many other stakeholders are the ones ordering and executing city logistics operations.

Recommended actions for European and national authorities are presented in orange boxes, actions for local authorities appear in pink boxes, while actions for industry are in grey boxes.

3.2.1 2020: Creating an environment supporting sustainable city logistics

This first step refers to providing opportunities for policy innovations driven by information flows rather than by hierarchical or collective decision-making within international institutions. At the micro-level it is triggered by mechanisms of social learning, copying or mimetic emulation (Shipan & Volden, 2008). For implementing the roadmap actions, it is important to create a foundation for talking about city logistics. We have experienced that there often are individuals in public administrations with an interest in urban freight transport and that contribute to projects and initiatives. However, if there is no political priority and no anchoring of the importance of the topic higher up in the hierarchy, the degree of commitment and effort that can be invested is limited. Therefore, for local and regional authorities to take an active role, there is a need to define clear goals and strategies for what the city wants to achieve in the city logistics domain. The public agencies should also make sure to recruit staff with logistics competence to have that competence in-house and be able to work collaboratively with the businesses with appropriate knowledge.

Define goals and strategies for freight and logistics to make sure that they can take an active role in working on logistics issues.

Data is needed for understanding status and to form a basis for assessments and evaluation. A set of indicators should be established at European level to facilitate monitoring of freight and logistics in urban areas. Having this data and being able to compare the situation across cities is a way of establishing the maturity of the city adopting the action and whether transferability from a solution in one city to another is feasible.

Establish European-wide indicators and data collection procedures for improved and consistent understanding of urban logistics status and development.

Finally, establishment of cooperation platforms is key, as public-private collaboration is needed both for efficient public sector behaviour and joint elaboration of measures. CITYLAB has developed a guidebook for establishing Living Labs (CITYLAB, 2018g). Other useful resources on freight forums, freight quality partnerships and other collaboration practices are for example Allen, Browne, Piotrowska, & Woodburn, 2010; Browne & Lindholm, 2014; Central London Freight Quality Partnership, 2016; Jedliński & Kijewska, 2016; Lindholm, 2014; Lindholm & Browne, 2014.

Develop and enhance collaboration practices with a broad set of private sector stakeholders. Freight forums, frontrunner groups, freight quality partnerships and Living labs have proven useful. When discussing city logistics and the changing nature of deliveries it is important to broaden the stakeholder base. In denser cities it is key to remember the importance of urban real-estate developers when dealing with urban freight transport initiatives.

3.2.2 2025: The framework for making changes in city logistics

Local and regional authorities can affect the performance of urban logistics in many ways and a formalised framework for urban freight policy is needed. Municipalities need a plan on how to deal with this topic. All urban areas with more than 75 thousand inhabitants should therefore develop a sustainable urban logistics plan (SULP), either as part of a Sustainable Urban Mobility Plan (SUMP) or as a self-sustaining plan. In simple words, a SULP should ensure that

the public sector act as a facilitator and not a barrier to efficient and sustainable logistics operations in urban areas. Topics that should be dealt with include logistics issues in real estate planning and for building permits, capturing needs of logistics operators in planning, and including consideration of freight and service trip generation when deciding on location of establishments.

Provide stronger requirements for city logistics planning and guidelines for SULP development in all major urban areas.

Encourage and support the Europe-wide uptake of sustainable urban freight initiatives through a more coordinated approach to relevant regulations and laws.

Following this, cities could benefit from making a plan for space for logistics activities to make sure that all parts of an urban area can be reached in an efficient way and also facilitating the use of low- and zero-emission vehicles. Possible ways forward include improving the utilisation of the urban space by using existing locations for logistics activities such as in-house common logistics functions in shopping centres, empty shops or combine logistics facilities with other urban activities. Multi-purpose use of space depending on time of the day is another opportunity to serve different functions.

CITYLAB has experienced that it may be very difficult to obtain centrally located logistics space at market price. The public sector may have a role in helping out on development of appropriate space or making different types of public space available for logistics – possibly in collaboration with real estate agents and property developers.

Ensure a plan for logistics space. Search for and reserve available inner-city space for logistics activities to allow transfer to clean vehicles.

Improve the utilisation of the urban space by having mixed-use of centrally located areas combining activities for city logistics with other urban activities.

Involvement of companies is needed throughout these steps, as the knowledge and views of companies will improve the public sectors ability to capture logistics needs and involvement also is expected to increase the support from the private sector. Companies could be involved in charters for city logistics, partnerships, networks, frontrunner groups and various forums. One of the ambitions of Living Labs is to increase the shared understanding of the current status and the need to work together for developing win-win solutions (Quak, Lindholm, Tavasszy, & Browne, 2016).

Keep a wide focus. Policy makers should focus not solely on companies that provide a freight transport service, but also on vehicles of service-driven companies. Include own account trips by store owners in freight policy planning.

Contributions are also needed from the industry in order to lay the foundations for sustainable logistics practices. They have to rethink business practices, be open for collaboration, and help build a community where data and knowledge is shared between public and private actors.

Join charters, partnerships, networks, frontrunner groups or forums to be active in this the work on city logistics plans and policy.

Rethink and improve business cases through sharing of ideas with other business partners.

Use their competence as project leaders in working groups on certain actions in plans.

Provide data and input to the plans and contribute in the planning process e.g. through public hearings or stakeholder meetings.

3.2.3 2030: Implementing sustainable solutions

The sections 3.2.1 and 3.2.2 have outlined facilitating actions that help achieve scale in sustainable and efficient solutions for future city logistics operations. The 2020 and 2025 actions are about developing collaboration, providing a framework and improving the skills of those in charge of the implementation. This section is about the specific on-going and future implementation process of the recommended industry actions.

The public sector needs to be sure about the impact of the measures or policies as there can often be unforeseen negative consequences. Their responsibilities when implementing the actions in this roadmap and including them in a city logistics policy for the city is to have knowledge about the relation between the implemented measure or solution and other existing measures, this is crucial for successful implementation. It is also important that the municipality investigates the order in which measures are being implemented. Are there other measures which needs to be implemented beforehand to provide a successful outcome and ensure coherent policy implementation? It is also important for the public sector to provide opportunities for scale - not just to leave it to the pioneers or frontrunners.

Ensure supporting measures and knowledge about its place in the overall policy mix and the impact of the policy or measure implemented.

A key responsibility for industry when implementing and designing new solutions is to find ways to share the benefits and potential costs of innovative city logistics solutions between the different stakeholder groups, i.e. avoiding that one stakeholder incurs increased costs while another receives most or all of the benefits from the change. Another suggestion to ease the implementation or the necessary change is to sub-contract urban last-mile deliveries to a transport operator specialised in last mile logistics. It is possible that this transport operator may perform the transport more effectively. If this third-party is also unbiased you may avoid the conflict of competition between transport operators.

Find ways to share the benefits and potential costs of innovative city logistics solutions between the different stakeholder groups.

This section is concluded with a few additional recommendations specific to the four directions of measures 2A-2D that will have to be implemented at scale within year 2030 to promote sustainable urban logistics operations and emission free city logistics operations.

Supporting 2A Transport demand reduction

Use procurement practices to support sustainable urban logistics operations.

Supporting 2B Logistics facilities

Promote and facilitate the idea of shared use of infrastructure among transport companies either as a shared urban depot or micro-hub.

For parcel deliveries to large residential developments, developers of such facilities should be required to develop sustainable delivery policies such as providing concierge services for package reception or out of hour external reception lockers.

Engage in cooperation between logistics service providers to share infrastructure and raise awareness of the need for urban logistics space among receivers and private business outside of the logistics industry.

Supporting 2C Collaboration and logistics optimisation

Manage procurement processes so that contracts include "sustainable delivery" clauses written in contracts to facilitate the greater consolidation of flows either by the use of physical centres or by organisational means.

Adapt possibilities for alternative consolidation concepts and engage in cooperation between logistics service providers to share transport capacity.

Supporting 2D Reducing negative impacts

Develop a European wide, coordinated approach to scale up successful electric vehicle and consolidation efforts, institutionalise a coordinated European growth of sustainable solutions.

Develop a strategy for accelerating use of low-emission commercial vehicles. May involve restrictions for conventional vehicles, low emission zones, local subsidies or privileges for zero emission vehicles, and use of procurement practices to support zero emission vehicles.

4 Conclusions and needs for further research

Conclusions

The CITYLAB project has explored the living lab approach as means of bringing multiple stakeholders together in developing and rolling out sustainable and efficient urban freight transport solutions. In addition, the project has had a strong knowledge-generation component with surveys, data collection, synthesis and analysis exemplified in the Observatory of strategic developments impacting urban logistics (CITYLAB, 2018a).

In conclusion, the path towards zero-emission logistics operations in major urban centres by 2030 requires a combination of measures. The total demand for freight transport must be reduced, logistics must be made more efficient to increase load factors and reduce the vehicle movements, and a shift to low- and zero-emission vehicles must be supported. Analyses made in the CITYLAB project indicate that logistics improvements may contribute to emission reductions only around 10% in urban areas. This means that the logistics improvements themselves cannot solve the emission challenges, there is an obvious need to increase the use of zero emission vehicles as well. What is key, however, is that many of the logistical improvements also act as facilitators for the introduction of zero emission vehicles on top of their direct contributions to emission savings. For instance, procurement practices, ensuring space for logistics facilities, and more coherent planning of urban freight activities – they may all enhance the speed and likelihood of the uptake of zero emission vehicles.

In CITYLAB we have observed that there are many obstacles and challenges preventing change. There is not necessarily a lack of knowledge about measures that may contribute to more sustainable and efficient operations, but more often a lack of focus and priority in the public sector. The core of the CITYLAB roadmap therefore concentrates on setting up regimes and an environment that supports sustainable urban logistics operations: i) to have clear goals and a plan for reaching them; ii) make sure that data are in place to understand the current situation and analyse changes; and iii) having appropriate public-private collaboration mechanisms for definition and realisation of innovative solutions. The lessons from CITYLAB have led to a particular emphasis on ensuring space and facilities for logistics activities as a key requirement for making the private sector able to run their urban freight operations in a sustainable and efficient way.

Based on the lessons from the CITYLAB implementations, we recommend specific measures that are complementary, but different to one another:

- Reducing the demand for transport by changing procurement practices
- Developing new space and logistics facilities to promote efficient logistics operations and use of clean vehicles
- Increasing load factors through collaboration and sharing
- Growth in the use of zero emission vehicles such as electric vans and cargo bikes.

Needs for further research

There have been a range of initiatives and projects contributing to increased knowledge of the urban logistics sector. CITYLAB, along with its sister projects NOVELOG, SUCCESS and U-TURN, have built on past efforts and led to new understanding of freight and service trips in urban areas and their impacts. Still, there are knowledge gaps that should be reduced and closed in the future. Some of the needs for future research are (CITYLAB, 2017d):

1. Public-private collaboration formats: CITYLAB has introduced Living Labs to city logistics. Still, more experiences are needed on effective public-private collaboration and on how living labs can support innovation transfer in city logistics. For research funders it is recommended to conduct further living lab test environment and continue organising consultations between research, cities and industry.

2. Private sector collaboration: Important questions are how collaboration between logistics service providers can be encouraged in an urban context and how the demand from shippers and receivers impact urban freight transport efficiency. It would also be interesting to know more about how service-driven companies operate in urban areas and how much spare transportation capacity they have, that could be utilised by others without causing too much trouble. Eventually, this is linked to the need for consolidating deliveries and the coordination between different large freight attractors to provide a critical mass to justify the cost incurred.

3. Supporting growth in zero emission vehicles. Low emission zones and how they can affect the use of zero-emission vehicles is important. As zero-emission vehicles are often seen as an important solution among local authorities in reaching CO2-free city logistics it is essential to research how to scale-up these modes of transport.

4. Labour and social issues: Changing operations of city logistics such as crowd logistics and the on-demand economy with employees themselves deciding to work based on marginal costs and for how long, makes labour conditions important. Looking at these changes there is a need to consider present labour regulations and laws.

5. Standardisation: Knowledge is needed on standardisation and coordination of legislation across cities and countries. The coordination needs to be at a minimum cost so that it is effective and fosters financial viability.

6. Urban logistics in a wider perspective: There is a need to investigate more efficient logistics including return logistics and waste management. When assessing urban logistics, it is also important to involve the regional dimension and the whole supply chain, and in particular efficient linkages to the overall multimodal transport system.

7. Ensuring wider take-up and use of experiences: A lot of knowledge has been generated in the city logistics domain through research and innovation initiatives and projects. In the future, it will be important to communicate the research results and the impact of city logistics measures to a larger group of stakeholders than is generally done today so that the most promising solutions become state-of-the art operations at a wider European scale.

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