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CITYLAB Handbook for City Logistics Living Laboratories

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Oslo	Oslo kommune	Steen & Strøm	TOI
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Why reading this guidance?

Interest in city logistics innovations increases due to the associated negative impacts on air quality, noise, livability, climate change and use of urban space. In spite of the many trialed solutions to address these issues, no large scale steps towards more sustainable city logistics processes are set. Even if experiments are proved financially and technically successful, scaling up, transferring and bringing significant impact is lacking. Increasing the knowledge-base on what works and what not - is limited, as thorough evaluations are often lacking. Most best practices are local, and the transferability to other regions is limited.

Therefore, a new approach that promises to increase the speed of the transition process and transferability as well as the rate of successful city logistics innovation uptake is necessary. The Living lab is such an approach, that allows for improving the co-creation processes, putting the end-users at the heart of innovation, realizing new business models, looking for new roles for traditional stakeholders in the innovation process, and a more directed innovation preparation and deployment process. This guidance to living labs in city logistics answers three key questions:

- *What are living labs in city logistics and why do we need them?*
- *How to set up living lab in city logistics?*
- *What are the experiences from operating living labs in city logistics?*

In this guide, we draw upon the experiences of eight European cities (Amsterdam, Brussels, London, Oslo, Paris, Rome, Rotterdam, Southampton) in setting up and developing City Logistics Living Labs and implementing various freight initiatives within the CIVITAS CITYLAB project. The living labs comprised local/regional authorities, industry and research partners working together towards their agreed goals.

Target audience

CITYLAB's Deliverable 3.4 "Practical guidelines for establishing and running living laboratories" aims at all stakeholders involved in city logistics processes and especially at those who are developing or planning to develop innovative city logistics products, solutions, or services. The guidance describes how to set up a living lab and how it enables a higher rate of innovation uptake.

For two reasons, this guidance is also relevant for city authorities. First, it highlights the importance of, what we call the ecosystem created on a city level, as a facilitator or a barrier for uptake and roll out of the city logistics innovations. Second, it provides guidance on how to set up and operate a city logistics transition living lab, aiming to move towards the zero emissions city logistics target.

Reading guide

Chapter 1 answers the question 'what is a living lab?'.

Chapter 2 explains why do we need living labs in city logistics?

Chapter 3 shapes the forms and elements of city logistics living labs.

Chapter 4 provide steps on how to set up a living lab in city logistics

Chapter 5 provides experiences from CITYLAB on operating living labs in city logistics.

Chapter 6 summarizes the added value from the city logistics living labs and shares key experiences from the living lab process.

Annex I gives a short summary of what the CITYLAB project is about and Annex II presents CITYLAB living labs. A shorter leaflet version of this document is available at http://www.citylab-project.eu/brochure/LL.pdf.

A living laboratory concept

Environmental, societal and economic sustainability is in the heart of the transition process that our society i undergoing today. Solutions to address these multi-facet challenges are complex in terms of different stakeholders and different interests involved. There is a need for a new approach to think over the long term goals and a new process to accompany transition path. Since 2006, the concept of living lab is recognized by the European Commission as a key tool for open innovation. Since then, living labs have spread over Europe in various waves, first focusing on new ICT tools but later extending to other fields, such as sustainable energy, healthcare, safety, mobility, etc. Nowadays a living lab can be referred to as a concept for achieving a long-term sustainable solution for a societal challenge by involving the actual end-user. It can also be a method to achieve a certain objective by connecting and involving the right stakeholders and follow an iterative design and learning cycle called co-creation. Finally, a living lab can also refer to the context, related to the organizational or geographical environment for the real-world experiments (Maas, van den Broek, & Deuten, 2017).

The term 'Living Lab' is nowadays frequently used, referring to a wide variety of local experimental projects of participatory nature. A shared definition or common understanding on what a living lab is, though, still lacking. Although over 6000 papers mentioning living labs were published between the nineties and mid-2017, no unambiguous and leading characterization of a living laboratory (or living lab shortly) has emerged yet (Maas, van den Broek, & Deuten, 2017). From all these papers, several key elements that are essential for a living lab can be determined:

- Experiments take place in a *real-world environment*. Living Labs are not about testing a new solution in a specifically designed environment, but about real-life experiments on a street or in a neighborhood, city, region or even country. 'Research in the wild' causes boundaries to change and fills in the need to take the complexity of the outside world into account.
- *Co-creation and end-user involvement* is essential for the process of innovation development. This implies a cooperative process where all partners, and especially the end-user, can influence the experiments Co-creation aims at creating an innovative product or solution that is mutually valued and accepted by all partners and, therefore, sustainable on the long-term.
- Involvement of *multidisciplinary competences* and *multi-stakeholder participation*, i.e. the of quadruple helix including the representatives of public authorities, knowledge institutes, industry partners and citizens are highly promoted within the living labs. This helps to extend the traditional boundaries of the developed innovations and encourage "out of box" solutions. Multi-method approach combines co-creation methodologies from all the disciplines, selecting the most fitting one
- An *iterative learning cycle,* referring to the process where innovations are developed following "plan-do-check-act" cycles. The evaluation's results improve the new experimental "plan-do-check-act" loop, allowing for continuous learning and adaptation, interaction between partners, building trust and inspiration for others to learn and innovate.

The outcomes of applying a living lab can vary from an object (e.g. a solar panel), a service (e.g. waste recycling services), a technology (e.g. decentralized sanitation), an application (e.g. electric cars as energy storing systems at home), a process (e.g. a participative neighbourhood development method), to a system (e.g. a new logistic waste collection system) (Steen & van Bueren, 2017).

Depending on the ambition and goals of living labs two main types are distinguished (Neef, Verweij, Gugerell, & Moen, 2017):

1. The objective of the *product oriented lab* is to develop a new concrete innovative object, service, process, etc. These living labs are focused on innovation itself and are organized around the learning process for the specific product (service, process, etc.). These labs are usually driven by private stakeholders and benefit most from the co-creation process with actual end-users of the innovation in development. The experiments of product oriented living labs often take place on a small geographical area, determined by the actors.
2. The *urban transition labs* focus on achieving sustainability by means of innovation and are usually initiated by public authorities or knowledge institutes. For these, innovation and learning are a mean to reach the sustainability objective. Urban transition labs can assist transition city-wide, or on the neighborhood, or even street level. These types of labs focus on aligning all stakeholders' interests and develop and test several solutions in parallel, all contributing to one major goal.

The three key objectives of the living labs, therefore, are (Neef, Verweij, Gugerell, & Moen, 2017):

- Create innovative (social or technologic) products, services, processes, systems or organizations.
- Improve economic and environmental sustainability by means of innovation.
- Share knowledge, insight and methods between stakeholders to learn from each other.

A supporting *ecosystem in the city* helps setting up and operating living labs. Such an ecosystem can take form of the sectoral policy on the city level; supporting grant programs for the development of the innovative solutions, by means of hubs, platforms or subsidies, etc.

Why do we need living labs in city logistics?

Living Lab set-up is mostly beneficial in the context where complex problems need to be addressed. Those are multi-stakeholder topics that address big challenges and where shared values are difficult to find, but have to be found. Usually these kind of problems are characterized with highly dynamic external environments and deep uncertainty in the outcomes of the solutions. They require a medium or long term approach, adaptive and pro-active planning and steering instead of a reactive attitude (CITYLAB, 2015).

City logistics is the system and process by which goods are collected, transported, and distributed within urban environments. It is a sector where solutions often ask for a multi-stakeholder approach, bringing together different, sometimes not aligned to each other interests. Due to the high dynamics in city logistics, it is unsure in advance what type of solution will best fit with problems faced.

Characteristics of the city logistics sector

Urban freight transport innovations are implemented within a context characterised with (Nesterova, Quak, Rooijen, Cherrett, & Mcleod, 2017):

- A multi-stakeholder environment with, often, conflicting interests;
- Growing negative impacts;
- Inefficiencies in the transport sector;
- No solution that fits it all.

Multi stakeholder environment: City logistics is a multi-stakeholder environment, where some stakeholders are directly involved in the supply chain processes and others are not directly involved but are part of the urban area and experience the urban freight traffic's impacts. The presence of these many stakeholders inevitably brings in the problem of the conflicting interests.

Box 1. City logistics stakeholders

- Supply chain actors: shippers, receivers, transport operators
- Public authorities
- Resource supply stakeholders: infrastructure providers, infrastructure operators and landowners
- Those affected by freight: other traffic participants, city residents and users, visitors and tourists
- Other stakeholders like: providers of vehicles, IT support systems, etc.

Source: CIVITAS WIKI Policy Note 5, 2015

Growing negative impacts: Urban logistics has economic, environmental and social impacts on the livability of people and functioning of the economy within cities. Its negative impacts become a real problem to local policymakers. On the other hand, urban freight transport is essential for cities to function as such. Negative economic impacts include congestion (i.e. inefficiencies, time losses and unreliable deliveries), use of resources and the costs of regulating and planning urban freight transport. Social impacts include health issues (due to bad air quality), reduced city accessibility, and the damage to buildings and infrastructure. Environmental impact includes the emissions of global pollutants, the use of fossil fuels and production of waste products.

Inefficiencies in transport sector: Majority of the goods within the cities are transported efficiently via large retail chains or logistics service providers using, where possible, large trucks. However, this accounts for a relatively small part of the urban freight vehicle movements. A high share or relatively unorganized and not optimized urban freight movements (characterized with low load factors and empty running) is often own-account transport activities performed in vans. This large group of unorganized small urban logistics operators is very diverse and difficult to reach and organize in most cities.

No solution that fits it all: Urban freight transport issues are complex to solve as there is usually no single problem-owner and many different stakeholders have different objectives and stakes. As a result, simple solutions that can be implemented by one stakeholder are not sufficient to deal with urban freight transport's grand challenges (Quak et al, 2015). And in a multi-stakeholder environment, as city logistics is, it is hard to find a solution that is mutually valued by all stakeholders. For example, a solution such as a delivery time windows might be beneficial for citizens with respect to livability but will cause additional costs for logistic service providers and reduce flexibility for companies.

Trends and challenges in city logistics

City logistics is a highly dynamic sector. Different on-going developments have an impact on it and create opportunities for the innovation. These external developments can be the immediate cause for stakeholders that are willing to test and experiment with innovations in a living lab.

Reshaping of the EU urbanisation profile: By 2025, more than 75% of Europe's population is estimated to live in urban areas and by 2050 the proportion is expected to increase to 84% (Verlinde, 2015). Even though there is no high population growth expected, the proportion of older adults will increase and they might tend to move from suburbs to city centres, closer to the professional, medical and other facilities. Next, urban culture is increasing again (shops, restaurants, museums, theatres and events) attracting people to stay and live in cities – even with families and kids. As a result, the demand for a higher quality of life in the cities increases. The urban freight system should reorganize to more efficiently support this urban culture, and integrating new services into the traditional businesses.

Growth of e-commerce and home delivery: Being a service, the development of city logistics is highly dependent on developments in the major market sectors which it is servicing, i.e.: retail, express, courier and post services, hotel, restaurant and catering, construction and waste. Currently, the growth of e-commerce and home deliveries is reshaping the urban freight logistics market. Verlinde (2015) states that by 2025, 20% of retail will happen through online channels, which will change the urban freight flow patterns and urban freight transport. New solutions to efficiently manage deliveries and services in urban areas as well as new knowledge and collaboration are greatly needed.

Societal trends: Next, two major developments can be observed in society. On the one hand, more-demanding customers require better reliability, compliance, information and delivery options, like same-day delivery. This development results in a less efficient transport operation with lower rate of vehicles utilization and more driven kilometers, increasing emissions and congestion. On the other hand, there is an increasing political and societal pressure to reduce emissions from urban freight and improve liveability of urban areas. The increasing number of people living and working in cities increases demand for transportation of goods, but tolerance on the consequences and its impact is reducing. This puts pressure on supply networks to innovate in order to have lower pollutant emissions and noise, less congestion while increasing safety, and on the other hand customer intimacy requires high service levels and customization (Annual outlook city logistics, 2017).

Technological trends: A range of technological trends will have an increasing impact on city logistics. Cheap computers and sensors, combined with new wireless technologies allow for the continuous traceability and development of the Internet of Things. This allows for

continuous tracking of packages and vehicles, resulting in improved transparency of the supply chain. Autonomous vehicles and warehouses are two examples of developments that will make supply networks more cost efficient. The pressure on emissions stimulate the use of alternative fuel sources, for example battery electric vehicles.

Why do we need a new approach in developing city logistics innovations

City logistics is dynamically developing sector which gets increasing attention from public authorities due to its negative impacts on the livability of the cities and quality of life of the citizens. Many solutions are trialed to make urban logistics processes and transport more sustainable. However, a significant change towards more sustainable urban freight transport has not yet occurred:

- Many 'best practices' are very local and are often not transferred to other areas/regions;
- Even if proved to be successful, transport innovations have a difficulty in scaling up;
- Failed initiatives are usually not evaluated and not reported, thus limiting the knowledge and improvement possibilities;
- Many initiatives or demonstrations show that an intervention is technically possible, but implementation in real life city logistics operations on the longer term is often limited.

To really make a change, address these issues and make a transition to a more sustainable and more efficient urban freight transport system another approach is necessary.

Living Lab concept offers a way to address complex multi-stakeholder topics: it changes the emphasis from the solution as an isolated object to the process of integration with its environment. Finding a solution becomes a process involving many stakeholders with different objectives and interests within a dynamic environment. It allows the creation of experimentation environments that are sufficiently connected with real world stakeholders and their business models, to allow near-simultaneous development and deployment. This requires a medium or long term approach, adaptive and pro-active planning and steering.

CITYLAB has explored the formation of living labs in eight European cities, bringing together local / regional authorities, industry partners and research partners developing city logistics innovations and assisting transition processes within the cities (See Annex I to read what CITYLAB project is about and Annex II to understand the seven CITYLAB living labs). The underlying assumption of the project is that forming living labs in city logistics, where important city logistics stakeholders collaboratively work together towards commonly established ambition and goals, would lead to the development of sustainable and scalable innovations in city logistics.

Living labs in city logistics

Setting up a living lab offers a new stakeholder collaboration mechanism, where new products or solutions are co-created with end-users within a real world environment. Depending on the initial objective of the Living Lab, these principles can be either used to find a solution for a concrete problem via development, testing and upscaling of an innovative product or service or to guide a transition process on the city / neighbourhood / street level. This distinction also applies to city logistics living labs:

- it is possible to apply the living lab concept on the level of individual companies, working out logistics innovations – *logistics service living labs*;
- next, it is also possible to apply the living lab concept on the city-wide framework, helping out cities in making a transition to, for example, zero emission city logistics – *city logistics transition living labs*.

Box 2. CITYLAB living labs

CITYLAB investigated and contributed to the application of the living lab principles within both types of living labs in city logistics:

- In Rotterdam, Paris and Southampton the project assisted city-wide transition processes contributing to zero emission city logistics;
- In Amsterdam, Rome, Oslo, London and Brussels concrete solutions and services were trialed and upscaled using living lab principles.

Logistics service living labs aim at concrete operational problems, such as: improving efficiency of shipping process, addressing new category of customers, developing and rolling-out new services. They are usually initiated by private city logistics stakeholders with the main emphasis on improving the services they directly control.

City logistics transition living labs are usually initiated by public actors or local interest groups with the objective to guide transition process in the specific geographical area (city, neighbourhood, street). A living lab is then an action-driven partnership where local governmental stakeholders cooperate with industry, retail, commerce, academic and societal partners and collaboratively develop new approaches and actions to promote sustainable logistics.

Real life setting

Living labs are functioning in the complexity of the real world environment. “Inviting the respective parties to engage in the living lab’s real-world experiment is a promising option because public authorities, companies, and others can be more willing to overcome established attitudes and obstacles as long as it is ‘only’ in an experimental setting (…). The experimental setting also encourages a critical attitude and the search for creative solutions” (Steen & van Bueren, 2017). For the city logistics system, this implies the urban area, where the geographical scope and location of the real life experiments will depend on the key goals of the (city logistics transition living) lab.

Real-life setting of the living labs in city logistics depends on the key goals of the living lab and on the whole.

Logistics service living labs focus on solving a specific stakeholder’s problem and on the users of the developed innovation. So the area is determined by the end-users of innovative solution

and can vary from a single building, street, neighbourhood(s) or group of customers. It can be limited by the policy regulated zone (e.g. low emission zone; congestion charge zone) or any other area or set of areas where this particular innovative solution can be trailed out and has potential to be upscaled.

Box 3. Real life environment for logistics service living labs

Gnewt cargo and TNT were looking for a solution to increase their urban freight transport with electric freight vehicles in inner **London**. The geographical area is limited by the congestion charge area, providing financial benefits for electric vehicles. This area became the natural geographical scope of the CITYLAB living lab implementation.

In **Oslo** the CITYLAB living lab implementation looked how to optimise the internal logistics for shopping centres and how to reduce the vehicle waiting time, thus decreasing surrounding congestion. Therefore, the real-life test environment of the living lab implementation has been limited to a shopping mall building and the neighbouring area.

For the city logistics transition living labs the city as a whole, or some particular neighbourhood(s) or street(s) can serve as an urban test environment. The city becomes an arena to trial out multiple experiments / innovations aiming at achieving one overarching goal. Usually this goal addresses the most urgent city topic for the medium to long term: for example reducing emissions and noise, improving accessibility and liveability of the area, reducing congestion, improving safety. With respect to city logistics, a zero emission city logistics in the city (center) can be such a living lab goal.

Co-creation

City logistics issues are complex to solve as there is usually no single problem-owner and stakeholders have various objectives and stakes.

The co-creation process in living labs is important for two reasons:

1. *it helps to align conflicting objectives and identify the common ambition in the process;*
2. *it aims to increase participation of the end-users in the development of the final product, and as a result increasing the chances of it uptake.*

Within logistics service living labs co-creation means actively engaging the end-users in the development of a new solution. This is a challenging process: as noted by Steen & van Bueren (2017), end-users “typically do not have a professional motive to participate in innovation processes and participate on voluntary basis”. However, active participation of the end-users in the development of logistics solutions leads to: “higher acceptance of the proposed solution/technology, faster time to market, likelihood of higher adoption rate” (Innovation Alcotra, 2011). Co-creation with an end user is necessary not only to increase the chances of the innovation update, but also to deal with conflicting interests and work out within “win - win” situation, agreeing and acting on the common goal.

Box 4. CITYLAB co-creation example

In **Amsterdam** CITYLAB implementation of light electric vehicles in combination with micro hubs, the PostNL employees became the end-users of solution. As a result of this solution operational routine of postmen driving conventional cars in the city centre have changed: postmen started driving freight bikes within a new operational environment. Postmen were actively involved in the bike design process and consultations for operational aspects. They were providing their experiences with electric bikes to the bike manufacturers in order to improve the electric freight bikes.

In the city logistics transition living labs there is no unique defined end-user group. The co-creation process focuses on collaborative work of quadruple helix stakeholders, working out the city logistics transition processes: local government together with industry, retail, commerce, services and academic partners collaboratively develop new policies and solutions promoting sustainable logistics. During co-creation sessions concrete solutions responding to the main ambition of the living lab are being developed.

Multi-stakeholder participation and multi-method approach

The living labs approach differs from other innovation approaches, as it is “no longer only about the technical aspects of innovation, but also about the user, business models, acceptance and policy” (Maas et al., 2017).

Multi-stakeholder participation and multi-method approach increase the value of co-creation process in the living labs. Involvement of the quadruple helix stakeholders in the living labs in city logistics have a clear added value for all the participants.

Urban freight transport involves many stakeholders: some are directly involved in the supply chain processes while others are not directly involved in the freight transport but are part of the urban real-life setting involved and experience the impacts from the urban freight traffic. These actors have different needs, requirements and priorities and that is difficult to organise urban freight transport in a way that meets the interest of all the stakeholders. Table 1 presents a first overview of city logistics stakeholders indicating their main interests in the context of the urban freight transport.

Table 1. Overview of urban freight transport stakeholders

Category of stakeholder	Stakeholders	Main interest in context of urban freight transport
Supply chain stakeholders	Shippers	Delivery and collection of goods at the lowest cost while meeting the needs of their customers.
	Transport operators (own account, third party providers)	Low cost but high quality transport operations and satisfaction of the interests of the shippers and receivers.
	Receivers (major retailers, shop owners, etc.)	On time delivery of products, with a short lead-time.

Category of stakeholder	Stakeholders	Main interest in context of urban freight transport
	Consumers	Availability of a variety of goods in shops in the city centre.
Resource supply stakeholders	Infrastructure providers	Cost recovery and infrastructure performance.
	Infrastructure operators (managers)	Accessibility and use of infrastructure
	Landowners	Profitability of local areas
Public authorities	Local government	Attractive city for inhabitants and visitors, with minimum inconvenience from freight transport, while also having an effective and efficient transport operation.
	National government	Minimum externalities from freight transport, while maximising economic efficiency and effectiveness.
Other stakeholders	Other economic actors located in the urban area (manufacturers, service providers, etc.)	Site accessibility and on-time deliveries.
	Residents	Minimum inconvenience caused by UFT.
	Visitors/tourists	Minimum inconvenience from UFT and a wide variety of products in the shops.

Source: MDS Transmodal Limited (2012)

Stakeholders are involved in the living labs depending on its ambition, goals and a problem that living lab addresses. Potential end-user is one of the first stakeholders to include in the process. Next, it is important to make sure that multidisciplinary competences are involved and interorganisational view is integrated. “It should be ensured that all stakeholders relevant in the context of the envisioned problem or solution are involved, regardless of the existing networks that might be embedded in the location or collaboration structures” (Steen & van Bueren, 2017). Living labs suggest that by being as open as possible to the additional competences one increase the value from the co-creation process.

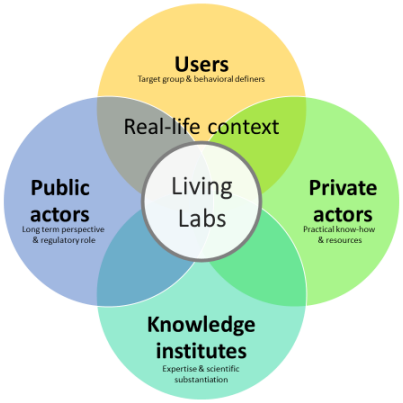
The core idea is that for logistics service living labs the value from the co-creation process increases due to involvement of additional multi-disciplinary competences and using methods from various disciplines: more “out of box” ideas are developed increasing the chance of a

successful living lab cycle. Inclusion of the quadruple helix stakeholders (Figure 1), when appropriate, also brings added value.

Box 5. CITYLAB example of multi-stakeholder participation

London CITYLAB implementation benefited from the active involvement of industrial and research partners as well as municipality. University of Westminster, a research partner in the living lab process, performed ex ante and ex post evaluations, based on which decisions about new cycles in the solution development were taken. Involvement of the municipality in the living lab process made it possible to efficiently find necessary space for the location of the Gnewt cargo hub(s) within congestion charge area. This is strategically important question for London, where there is a high space scarcity. The London Living Lab results are in line with the wider objective of local government to lower air pollution in transport. The cooperation between government, industry and researchers has proven highly successful in London.

Figure 1 Quadruple helix for living labs (Source: Steen & Van Buren, 2017)



In city logistics transition living labs the combination of the quadruple helix stakeholders is a pre-requisite to guide transition. The representatives from these stakeholder groups can form “frontrunner” groups, bringing together “visionary people from various disciplines who are willing and able to engage in a creative process towards a long-term conceived future for a sustainable city” (Nevens et al., 2013). The frontrunners develop transition ambition and objectives and the roadmap towards it in time. Together they set up sustainable, user-friendly, financially feasible and, in the end scalable and / or transferable city logistics solutions.

Box 6. CITYLAB example of quadruple helix actors involvement

In **Southampton**, the Southampton City council, Meachers Global Logistics, Southampton General Hospital and the two universities (Southampton Solent University and University of Southampton) came together with a common ambition to improve local air quality by promoting best practices in sustainable logistics and reducing their respective transport footprints. A Memorandum of understanding was signed stating partners’ commitment for this cooperation process. The University of Southampton acts as the neutral co-ordinator of activities. Existing business and personal relationships between the parties, emanating from the original memorandum of understanding have been key to continue the living lab and develop and explore new ideas: e.g. consolidation initiatives, joint procurement and electric fleet adoption.

Citizens, are more and more recognised as a source of innovation and not just as a user of it. In a traditional set-up, transport innovation is usually developed by technology provider in cooperation with transport operators and, if necessary, policy stakeholders. Societal partners, such citizens living in the neighbourhood or other road users are often not involved, or not even consulted, in this process. However, these are the parties that have a direct impact from the urban freight movements. Quadruple helix puts citizens in the driver's seats for innovation development and makes sure that social perspective is included in the developed innovation. Being involved in the living lab process, citizens are more accepting and supporting introduced innovations.

Iterative learning cycle

Within the living lab the development of innovation follows a cyclical approach, where plan-do-check-act phases are consequently used until the innovation is considered as ready to roll out, or the decision is taken to stop the process (Figure 2). During a cycle new ideas for the can be born and then developed within another implementation case.

Each cycle, within a living lab can be continued into a new loop with the improvement of existing solution until solution is finalized with either rolling out or quitting it. During a cycle a new idea for action in the Living Lab can be born and be developed within another implementation case.

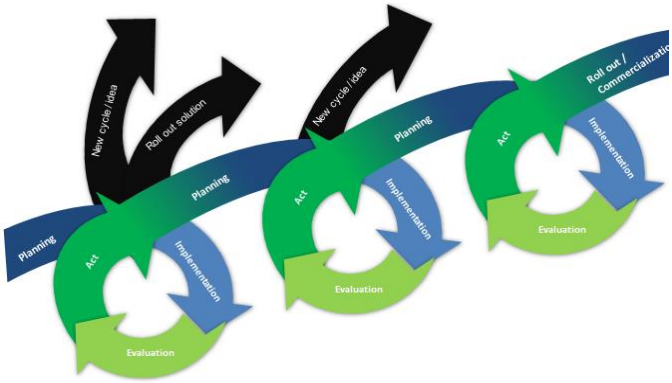


Figure 2. Cyclical process of innovation development within living lab (Source: CITYLAB, 2015)

Box 7. CITYLAB example of going through the cycles

In **Amsterdam** the CITYLAB living lab implementation went through several cycles. The first cycles have assessed an initial idea (developed prior to CITYLAB project) where parcels were navigated in the city by a vessel (the floating depot) and from there distributed by clean vehicles to final destinations; this turned out to be difficult for several reasons (e.g. moving of premises to start from, developing the floating depot, finding landing places at the canals, finding suitable volumes, etc.). In the following cycles, PostNL considered the possibility to use a floating depot pushed by a hybrid-push boat from where zero emission (ZE) vehicles (EV trucks or bikes) would deliver parcels in the 'de Pijp' in Amsterdam, supplying pubs, restaurants and hotels with fresh food items. Ex ante evaluations and end-user consultations have indicated that there is no yet a paying customer that is ready to support this. The next cycle that was tested in the real life and resulted in the local and national (by Post NL) upscale of the solution is partial replacement of PostNL vans in the city centre of Amsterdam with specially designed e-freight bikes that distribute mail and parcels from micro-hubs located in the city centre. The overall objective: more sustainable organization of PostNL's city logistics operations did not change during the cycles.

Data collection and data analysis play an important role within the living lab approach. In practice, very often only ex-ante analyses are performed assessing technological, operational and financial feasibility of innovative solutions. Ex-post evaluations are carried out less frequent, although these are really important to assess the efficiency of solution and to identify the improvements to be made. In the living lab approach failed cases can occur, e.g. an experiment does not work or does not contribute to the overall living lab objective. These failed cases do not mean that the living lab failed, but are seen as opportunities to learn from financially or operationally "unsuccessful" innovations. Knowledge transfer from unsuccessful innovation cycles is important as better decisions can be made in the future.

Box 8. CITYLAB example of going through the cycles

In **Rom**e the first living lab CITYLAB cycle looked into the organization of the sustainable reverse logistics process for plastic bottle caps within university area. The main purpose was to implement this solution in a real-life context and to investigate possible bottlenecks and market opportunities to upscale the service. Evaluation has shown that reverse flows limited to plastic caps exclusively do not offer a positive business case. That is why in the second living lab cycle new categories of waste materials are considered in order to increase the volume of reverse logistics flows and new potential clients are involved in the co-creation of the solution.

Logistics service living labs and city logistics transition living labs

As follows from the previous text, logistics service living labs and city logistics transition living labs differ from each other in several aspects. Table 2 summarizes the main differences between them.

Table 2. Logistics service living labs and city logistics transition living labs

Logistics service living lab	City logistics transition living lab

Short-term perspective targeted at specific solutions	Long-term perspectives targeted at big societal problem (grand challenge)
Detailed oriented and narrower thematically. Often linked to a company's objective or business goals.	Shared ambitions and goals of the living lab thematically and linked to the city and / or country's objectives or goals.
Medium-term collaboration with a strong focus on the participation of the end-user in the co-creation process	Long-term collaboration of quadruple helix stakeholders as part of the frontrunner group in roadmap development and co-creation of actions
Iterative cycles are focused on the development of the solution for one specific issue at hand.	Several different solutions are trialled in parallel, including different stakeholders, but all contributing to the final living lab ambition
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

Own set-up based on: CITYLAB, 2018a

Logistics service living labs are privately driven collaborations that aim to address concrete problems or challenges that private stakeholders are facing. These living labs usually focus on one specific problem and involve limited number of stakeholders. The attention is on the process of the solution co-creation with an end-user(s). Those are usually clearly defined from the beginning, as developed innovation in the living lab should meet their needs. Logistics service living labs have shorter ambition focus and are finalised once innovation roll out took place.

City logistics transition living labs are usually initiated by public actors or local interest groups with the objective to guide transition process in the specific geographical area (city, neighbourhood, street). Shared ambitions and goals of the living lab are often thematically and linked to the city and / or country's objectives or goals. Most often these living labs would address such logistics problems as: reducing emissions and noise; improving accessibility and liveability of the area; reducing congestion; improving safety. The main focus within these living labs is on the involvement of the quadruple helix stakeholders: a living lab becomes then an action-driven partnership where local governmental stakeholders cooperate with industry, retail, commerce, academic and societal partners and collaboratively develop new approaches and actions to promote sustainable logistics.

Importance of the city logistics ecosystem

Logistics innovations are developed within an ecosystem on the city level which can facilitate innovation development process or act as a barrier for it. Political and policy support for the urban freight, existence of efficient stakeholder communication and cooperation platforms, monitoring and evaluation of urban freight solutions and the existence of efficient knowledge transfer channels are defined as the key components of the logistics living lab ecosystem (Nesterova et al., 2018).

A City Logistics Living Lab usually does not start from scratch: it can draw upon existing city logistics actors, policies etc. Supporting factors for a City Logistics Living Lab include:

1. Clearly stated city logistics policy and plans.

Many cities do not yet have dedicated urban freight transport or city logistics plans. Often, at best, urban freight is mentioned within various policy documents such as those relating to urban mobility or air quality. An integrative approach to urban logistics, looking both into cross-sectoral cooperation, as well as integration of multiple city logistics stakeholders is necessary in order to assure the continuation of urban freight transport and city logistics policy. This approach can be reflected within sustainable urban mobility or logistics plans which are currently being supported by the EU, but also can be a part of the regular urban freight transport plan.

The development of a Sustainable Urban Logistics Plans (SULPs) can help cities in giving strategic priority to city logistics. SULPs support "local public decision-makers and stakeholders in "governing" city logistics measures and enhancing freight distribution processes towards economic, social environmental sustainability and efficiency" (Ambrosino, 2015). A step further - dedicated city logistics teams within public authorities will facilitate the coordination of the work on urban logistics challenges in a city.

Table 3. City logistics policy framework in CITYLAB cities

City	Urban freight strategy/plan
London	The Mayor's Transport Strategy and the London Freight Plan
Rotterdam	An urban freight roadmap: The Green Deal Zero Emission City Logistics
Brussels	The Strategic Plan for Goods Traffic
Southampton	Elements of urban freight included in the Oslo Climate and energy strategy
Oslo	Urban freight included in the air quality strategy and Local Transport Plan
Rome	Included in the Mobility Master Plan and the ongoing Sustainable Urban Mobility Plan
Paris	The Paris Charter for Sustainable Urban Logistics

Source: CITYLAB, 2018a

2. Established regular cooperation mechanisms and communication platforms.

Regular cooperation mechanisms and communication platforms between the main city logistics stakeholders facilitate knowledge creation and transfer and contribute to the development of sustainable urban policies. These stakeholder communication platforms, for example freight (quality) partnerships, should include at least local authorities, research institutes, industry, and where necessary, representatives of citizens. Depending on the ambitions and role of the communication platforms, different forms are possible: from working groups to freight quality partnerships.

Box 9. CITYLAB examples of stakeholder cooperation platforms

In **Paris**, the Paris Charter for Sustainable Urban Logistics (2013) brought together around 80 various representative organizations (e.g. shippers, carriers, 3PLs, store-owners, public authorities) to establish general goals for city logistics and plans to work towards them. The freight forum was created, which is now a main cooperation platform in urban freight transport.

In **London,** urban freight stakeholder cooperation is formalised within:

- Central London Freight Quality Partnership (CLFQP), a public/private partnership between the freight industry, local government, local businesses, the local community, environmental groups and others with an interest in freight. CLFQP is set up to develop a common understanding of, and to encourage innovative solutions for, freight transport and servicing activity in central London.
- Transport for London (TfL) co-ordinates the London Freight Forum, which brings together 160 logistics providers. It was set up to coordinate planning and preparations for the London 2012 Olympic and Paralympic Games and continued as a result of its perceived success. The forum comprises operators, businesses, trade associations, regulators and highway authorities, and provides the focus for ongoing engagement.

3. Freight data and information.

One of the biggest challenges in city logistics is a lack of detailed knowledge on what is really going on within different city logistics segments. Such information may be essential for good decision-making. Obtaining relevant data on urban freight transport is not an easy task due to predominance of small companies in a landscape of multiple city distribution actors, little interest or unwillingness of operators to provide the data, privacy issues, etc. Several European cities are currently testing and validating different city logistics data collection methods.

Existence of favourable city logistics ecosystem provides local authorities, industry partners and knowledge institutes with an opportunity to work more efficiently together on the local logistics problems. This ecosystem facilitates the knowledge transfer within the living labs, therefore new solutions can build up on the learnings from the previous trials. Supported by policies and using available baseline data as well as existing cooperation platforms, the innovations developed in the living labs have higher chances for the wider uptake and roll out.

Setting up the city logistics living labs

For setting up either a logistics service living lab or a city logistics transition living lab, a set of similar activities can be sketched. These steps are closely related to each other and most probably require several iterations before living lab takes a distinguished shape.

Box 10. Activities to set up a living lab

Activities to set up a living lab in city logistics:

- Define the living lab ambition, objectives and scope;
- Create the core living lab team;
- Select an appropriate living lab governance model;
- Perform analysis of city logistics ecosystem;
- Identify potential ideas and cases to develop within a living lab
- Develop a monitoring and measuring system for living lab experiments

From idea or problem to ambition and goals of the living lab in city logistics

For both types, the first step in living labs is to define clear ambition and objectives, agreeing on the main reason of the creation of the living lab and on what should be achieved as a living lab result. These steps are not as straightforward as it might look and may require several iterations with key living lab stakeholders. Multiple clients or stakeholders who all have separate ideas of how the living lab outcome should fit in and contribute to their strategic objectives. During this process potential conflicting interests between stakeholders should be considered and agreement and commitment for the common living objectives should be achieved.

The creation of logistics service living labs is usually initiated by a private party trying to address a specific problem. As a result, the living lab ambition focuses on finding a solution for a concrete problem. These ambitions are usually short term and the time necessary to develop the innovative solution is relatively limited.

Box 11. CITYLAB example of living lab ambition

In field research in **Brussels** and other cities P&G have identified that a large portion of nanostores (small independent stores) source their P&G products themselves by visiting a wholesaler or a retailer. At the retailer, they shop amongst “regular shoppers” which often implies a suboptimal sourcing for them: not the best suitable package sizes or unavailable products. Therefore P&G decided to explore if they would be able to directly supply these nanostores with products that are suitable for their stores. The ambition of the CITYLAB Brussels living lab implementation was to address this problem, integrating sustainability point of view (e.g., for example, avoiding creation of dedicated vans delivering nanostores stores in the city): directly supply nanostores with P&G products by exploring where underutilized transport capacity was existing and could be used: for example, filling the free capacity on service freight vehicles that circulate the city based on an appointment driven schedule.

The city logistics transition living labs mostly emerge from the existing and obstinate problems in the street, neighborhood or city. In this type of living lab, several actors together try to address the issues and to find common solutions. Often, the ambition of a transition living labs is related to a long term city development vision and is supported by all living lab participants. Based on the common and shared ambitions and goals the partners together identify actions and experiments to achieve the goals and ambition. A transition roadmap can be a good tool to jointly define the actions in time.

Box 12. CITYLAB examples of living lab ambition

For the **Southampton** City Council (SCC), a major motivating factor to work within city transition living lab is the need to improve air quality while maintaining economic prosperity. The data gathered by the World Health Organisation in 2013 have indicated that NOx levels measured in Southampton were above the stated safety limit of 40 µg/m³. The UK government asked Southampton and four other cities with poor air quality to take remedial actions. Freight transport is recognized as a significant contributor to air pollution and therefore SCC initiated a collaborative approach together with knowledge and industry partners to develop solutions aimed to reduce amount of freight transport activity in the city and associated to it negative impacts on air quality. (CITYLAB, 2017)

The long-term urban freight transport ambition for the city of **Paris** is to reduce overall emissions from freight transport by 75% in 2050 compared to 2004. The city council goal is to have 100% of deliveries to be non-diesel by 2020. The Paris implementation in CITYLAB addresses 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 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, 2017).

Once the ambition is agreed, the scope of the Living Lab within the real-world environment have to be made clear. The scope is identified collaboratively with the core team in order to create a common understanding on what will and will not be taken into account within the living lab.

Box 13. Identifying living lab scope

The following aspects can help to identify the scope of the living lab in city logistics:

- Area (which city area, the city centre, building, neighbourhood, etc …)
- Main policy / city objective and the influence of city logistics on it;
- Logistics specification (e.g. sector specific, or vehicle specific, …);
- Shipment specification (e.g. goods type, conditioned goods or pallets, boxes, etc.);
- Vehicle type specification (trucks, vans, intermodal, etc.);
- Users involved for execution of operations (including for example subcontractors);
- Users involved for planning of operations that are often outside the city (e.g. logistics service providers, shippers);
- Main customers, receivers and size of freight market (e.g. shippers or freight forwarders involved), as well as their power in the supply chain;
- Other stakeholders to involve.

The living lab initiator (physical person or a company) has a crucial role in setting up the living lab process and in giving a start to all activities. The initiator's role is to bring the participants together on a social as well as on a contents-wise level. The initiator needs to set up initial communication channels, establish contacts with interested stakeholders, engage missing stakeholders and guide discussions on common ambitions and goals. At the later stages, a living lab coordinator (or manager) might be assigned, who can differ from the person or organisation that initiated the living lab.

Creation of the core living lab team

The core living lab team is a group of people/organizations that are interested to collaborate on the development of the living lab. To create this team, the living lab initiator has to contact potential partners, keeping in mind: idea of quadruple helix (1); end-user involvement (2); and "out of the box" thinking as regards additional competences necessary (3). For the city logistics living labs considering the (1) category of stakeholders is specifically important, while (2) and (3) should be decided case by case for the individual implementations that might run in parallel and require different stakeholders. The reflection about the end-user participation in the co-creation process and end-user involvement in a core team should be carried out as soon as the ambitions, objectives and goals of the living lab are known. For the logistics service living labs (2) and (3) criteria of stakeholder inclusion is dominant over the first one. The final aim is to form a partnership with the capacity to set up a projects that support the living lab ambition.

Box 14. CITYLAB example of core living lab team creation

Rome CITYLAB living lab implementation looked into organisation of the sustainable reverse logistics process for plastic bottle caps within university area. The core living lab team was composed of: University of Roma Tre, City of Rome, Department for Transport, Mobility Service Agency, Poste Italiane, MeWare, Department for Environment, Concierge service at UoR, Mobility Manager at UoR, Students at UoR. Additional partners involved to reinforce co-creation process: ISPRA, Unindustria, FM Logistics, CNA FITA, Confcommercio, Confesercenti, Coordinamento Residenti CS, TakeMyThings. Participants of the core living lab team reported positive experiences from cooperation:

Giancarlo Tretola (MEW): *"We learnt how to support closed loop logistics, from an IT point of view, handling reusable containers and integrating delivery and picking up. We will improve the application generalization to any LSPs, any type of delivery and pickup and introducing a route optimization module, for minimizing travelled distance and maximizing average load factor."*

Fabrizio Caradonna (PIT): "*We consider this first implementation very important. Our strategic marketing department is interested in continuing it given its potential profitability once extended. We will explore possible avenues to secure financial subsidies from local authorities.*"

Linda Meleo (CoR): "*In 2018 we will publish the Urban Logistic Plan where considerations of cargo and logistics will be included taking inspiration from the results obtained in the Citylab implementation in Rome*."

Pinuccia Montanari (CoR): *"According to the recent action plan of DfE, we are interested in the circular economy to better manage 'post-consumption materials' and the need to reduce, reuse and recycle. Therefore, we want to collaborate with innovative projects such as Citylab and we are planning to open centres for 'creative recycling'."*

Source: CITYLAB, 2018b

Understanding the drivers, interests, culture and way of working of all parties related to the Living Lab is important and might help with their continuous involvement in and their commitment to the living lab for a longer period.

Once the core team is created, it is necessary to analyse what kind of external parties that could help living lab to achieve its goals are missing.

Once the core team is created, the roles and responsibilities within the living lab can be identified (e.g. coordinator/manager, participant, user, customer). Depending on the specific

question at hand stakeholders can have different roles within the same living lab. The most natural living lab coordinator for the logistic service living lab is the developer of the new service, whereas for the city logistics transition living lab, this role can be assigned either to the public authority or to the knowledge institute. It is also possible to have an unbiased third party to manage the living lab, reducing the possibilities for conflicting interests. This can be for example be a researcher, a process managers (external), or someone from a different municipal agency.

The above described steps should result in a clear understanding of each other's needs and goals, interests and commitment to the living lab core team, enabling working together in setting up a living lab.

Selecting the appropriate governance model

Having a formalised agreement on living lab cooperation is important in order to make living lab a priority for participating stakeholders and secure its continuity. Also, this is a way to clearly define roles and responsibilities within the living lab, partnership or network as well as a good opportunity to present the plans to the outside world.

There is variety of possible governance models for living labs, the key is to find a way that works for the living lab in each specific case: a memorandum of understanding, informal agreement, working groups set up, a covenant, etc. The forming of freight partnerships or frontrunner groups could be a good start for a city logistics transition living lab. Within the city logistics transition living lab context it is important to have a form of public private partnership, as public parties are responsible for city infrastructure, city access, and city space issues, as well as societal and environmental issues, whereas usually private partners are responsible for logistics operations. Without a good public private cooperation, these city logistics transition living labs are doomed to fail.

Box 15. CITYLAB examples of living lab governance models

The living lab in **Southampton** is set up around an informal Memorandum of Understanding (MoU) between the Southampton City Council and the University of Southampton on sustainable logistics. The main objective of this agreement is to reduce overall vehicle emissions and improving air quality standards. It is desirable to have as many stakeholders as possible sign up to the MoU.

The living lab in **Rome** is set up around the European research project CITYLAB. Initially there were limited opportunities of collaboration between urban freight stakeholders and Rome CITYLAB living lab implementation acted as an opportunity to start the work on reinforcement of cooperation between industry, research and city authorities on the question of urban freight.

In **Oslo** there was no formal agreement between the stakeholders included in the living lab. The working group and participating stakeholders were defined based on business decisions. However, additional stakeholders outside of the company were included through regular meetings and workshops.

The **Rotterdam** living lab is set up around the local covenant (a local Green Deal on Zero Emission City Logistics), which was signed by the city, research institute TNO and front running transport companies from varying logistics sectors.

Preparing the operation of the living lab

After the core living lab team is in place and its commitment to work on commonly agreed ambition and goals within living lab set up is formalised, the operation of the living lab can start. Initial preparatory steps will include: analysis of city logistics ecosystem; identification of

potential ideas and solutions to develop within a living lab and development of monitoring and measuring system.

Analysis of the city logistics ecosystem allows to identify early enough what are potential risks and opportunities from the direct living lab environment. Next to it, the analysis of legal and ethical issues as well as the elaboration on risks and mitigation measures can also be undertaken. It serves as a check whether the living lab goals can be developed and achieved in real life without raising legislative or ethical issues.

Box 16. Analysis of the city logistics ecosystem

- An existence of political and policy support, defined within urban freight strategies/plans and supported with a specific set of priority measures, creating 'a window of opportunity' for the innovations increasing the chances for wider uptake and roll out;
- Established regular cooperation and communication platforms between the main stakeholders involved in urban freight innovations;
- Tools available to monitor and analysis the data on urban freight or existing collected data that can be used for ex ante and ex post evaluations.

Additionally, living lab specific, the following aspects can be addressed:

- Trends and developments in policy (EU, national, regional);
- Trends and developments in client markets (i.e. retail, construction, waste, etc.);
- Trends and developments in other relevant industries (i.e. infrastructure provider, vehicle manufacturers, etc.);
- Trends and developments in space (urban planning, space available for logistics, property prices, etc.);
- Running initiatives of interest groups, government bodies, etc.;
- Technological innovations (i.e. trends in data sharing or on ICT equipment).

For product/solution oriented living labs direct innovative solution environment should be analysed as well: stakeholders, processes, products and technology in their current state.

The next step is to develop ideas about solutions to test in order to solve a problem or/and to reach living lab ambition. These ideas for action provide the initial direction for the living lab development. For the city logistics transition living lab it is necessary to identify a list of implementation cases contributing to achieve the global transition goal, as well as the responsible actor for actually implementing the case. It is necessary to check if proposed solution contributes to the ambition of the Living Lab; responds or addresses one of the goals and objectives of the Living Lab; is compliant with the needs of the users, customers and stakeholders; Is risk sensitive or not. Further, the checks are done whether proposed improvements or solutions fit the budget, available resources (both time and man power), fit to the operational process, technical capabilities or system maturity of the living lab. Again, although one partner will be guiding the process, it is important to involve users, customers and other stakeholders in the process. The final decision should be supported by all major partners.

Preparation phase is finalised with the development of the monitoring and measurement system. Evolution should encompass both individual experiments carried out in the living labs, as well as monitoring of the living lab operation itself.

Setting up of the living lab can be finalised with creation of an action plan that documents key agreement points: the ambition, goals, scope, key factors of city logistics ecosystem, risks and opportunities that were identified and which should be closely monitored throughout the whole living lab process. The pre-selected implementation cases are documented (which could be clustered by type and in time on a transition roadmap for the city logistics transition living lab) and the structure of the Living Lab is defined. Finally, the evaluation framework is described explaining the monitoring processes and methods to evaluate the implementations and the most important a decision making mechanism for the act phase.

Operation of the living labs in city logistics

Within living labs development of innovation follows a cyclical approach, where plan-do-evaluate – act phases are consequently used until the innovation is considered as ready to roll out or decision is taken to stop testing process. Each cycle, within a logistics service living lab can be continued into a new loop (when improvement of existing solution is necessary) or interrupted because the solution is considered as not interesting. During a cycle also a new innovation idea can be born and be than developed within another implementation case. One cycle within a Living Lab usually consists of the following phases:

- Setting up/Planning where the Living Lab vision, ambitions, objectives, main users and stakeholders are identified and where conceptual designs of implementation cases to be tested in the Living Lab are made. The goals of the Planning phase are to agree on the Living Lab approach and way of working, to build knowledge and define the exact goals and requirements for both the Implementation and Evaluation phases (this phase is described more in detail in the previous section).
- Real-life implementation or operation where concrete Living Lab solutions are prepared for operation and then implemented in real life environment. The goal of the Implementation phase is to deploy Living Lab solutions in the real life environment and gather the actual results. In this phase all arrangements are made in order to start and perform field experimentations.
- Evaluation where the results of the implementation are analysed based on the extended data collection and on the feedback from the users. The goal of the Evaluation phase is to evaluate the results and to compare them to original ambitions and targets as well as to the 'business as usual' situation.
- Act/Decision phase where, based on the lessons learned from the evaluation phase, a decision is made on the continuation of the Living Lab into a new cycle, what amendments will be made in this new cycle or decision to roll out the solution or to stop the living lab process.

Operation of the living lab

The goal of the operation phase itself is to deploy Living Lab solutions in the real life environment and gather actual results. Operation of the logistics service living lab starts with all the necessary preparations to implement the concrete implementation cases of the Living Lab in the real-life environment. For example, IT requirements have to be properly developed, if necessary technology has to be produced, requirements for interoperability and exchanging information platform among stakeholders need to be prepared, all administrative procedures are updated, licenses are arranged and, if necessary, the staff needs to be trained. Also, in the first implementation round of the Living Lab, baseline measurements need to be done in order to be able to compare the results of the solution with the before situation.

The following steps are proposed to be included in the preparation of the logistics service living lab:

- Operational preparation of the implementation case;
- Preparation of the test environment;
- Preparation for issues and events;
- Workshops for user instruction, kick off and learning curve; and
- Baseline measurement.

Living lab aims to co-create logistics solution together with an end-user, that is why that is necessary to include this actor in the preparation process from its beginning. Experience from the previous Living Lab projects shows that sometimes implementation cases are better delivered in smaller improvement cycles where ever possible, as it facilitates active

involvement of end-users and other living lab participants. Although a cyclical development approach has become more popular in recent years, not all users and Living Lab participants will be used to this way of working. They might be tempted to specify and develop solutions until they are perfect and include all user needs that were identified upfront. However, one should aim, where possible, to the smaller improvement cycles, providing more opportunities of interaction with an end-user and co-improving tested solution.

Within the city logistics transition living labs several solutions are tested and improved at the same time. Operation of the living lab than also need to consider how the knowledge from individual implementations is combined and transferred and to develop appropriate new goals for the new living lab cycle.

To evaluate the success of the Living Lab's solutions after the implementation, it is important to understand the performance of the Living Lab system before solution(s) were implemented. Measurement of the current status of the system is called a baseline measurement and these needs to be performed before the real-life implementation starts. Baseline measurement is at least performed for developed KPIs, adoption indicators and business models. Having the right performance indicators and making proper measurements of both the baseline and during Living Lab execution are essential for the Evaluation phase

Once everything is ready for real-life operation of implementation cases, the solutions and technologies are tested in the real world and input for evaluation is gathered. There should be a balance for the duration of the testing phase: to minimise the costs of the Living Lab, the Execution should be as short as possible; however, it should be long enough to obtain valid results of implementation of the case. During real-life implementation the care needs to be taken of:

- Management of the progress and scope (internal management);
- Management of stakeholder and user commitment (external management);
- Management of the environment (external management);
- Data collection.

Stakeholder cooperation and commitment needs to be managed throughout the Living Lab, both in case of the logistics service and city transition living labs. It is necessary to guarantee that stakeholders and users have the right expectations from the Living Lab and its outcomes and stay committed. Stakeholder and user management needs to be performed both on their expectations and concerns.

Management of stakeholder expectations starts with having a good understanding of the stakeholders expectations. Involving them continuously throughout different stages of the Living Lab will make sure that they have a clear understanding of what to expect during the operation of the living lab. It is necessary to make sure users and stakeholders provide feedback on their experiences with solution and support the implemented solution as fast as possible. Therefore, it is important to keep communicating regularly about the progress and to share information openly. Sharing of successes is essential for keeping up spirits and motivation but sharing of unforeseen risks and failures, especially when these affect expectations, are essential for keeping up trust.

Evaluation

The evaluation is performed in order to be able to draw conclusions on the success of the implementation. It includes establishing an evaluation framework, data collection and data analysis. Two levels of evaluation need to be developed: evaluation of the specific implementation case and evaluation of the Living Lab itself.

In evaluation of the implementation case, depending on the Living Lab ambition and scope the following performance indicators should be considered:

- Key performance indicators to evaluate efficiency of solution/technology
- Adoption indicators or users feedback on the solution/technology
- Impact on the business model and technological maturity of the solution/technology.

Key Performance Indicators (KPIs) are quantifiable and clearly defined measurements, that reflect the core goals and targets of the intended measure based on the stakeholders' perspectives. When selecting performance indicators, consider how to measure and quantify the indicators. When setting up KPIs it is recommended to consider what KPIs are relevant for which organisation that is involved.

Behavioural change is essential for a solution to become successful. Performance indicators such as load factor, emissions and costs may show a significant improvement, however, in the end, the behaviour of people determines whether these improvements can be achieved and sustained for a longer time. It is therefore important to include behavioural elements in the evaluation which are than reflected in user feedback. When doing so, both adoption in a sense of buying and using the innovation should be considered. Innovation adoption is a multidimensional process where individuals' behaviour is influenced by a variety of learning, social and technological conditions.

Apart from the adoption and the performance indicators, influences on the business models of the Living Lab participants can determine the success rate of the demonstration and more importantly the uptake of the results after the completion of the case in the Living Lab. A business model is a description of how a company or a set of companies intends to create and capture value with a product or service.

Finally, the parameters to evaluate the Living Lab cycle process have to be defined as well. It is advised to make the process evaluation a periodic process, e.g. checking within regular timeframes how the Living Lab is developing and how the experiences of the stakeholders are. This approach will help to capture the specific characteristics for each of the Living Lab phases as responsible actors will fill in the periodic evaluation forms when their memory is still fresh.

Data collection and data analysis and assessment of indicators are than performed according to the evaluation framework. The whole idea of the Living Lab is about involving the end user in the process as much as possible in order to increase possible adoption rate of the solution/technology. Discussion of the final evaluation results with major users, stakeholders and customers is therefore one of the most crucial steps in terms of the user-involvement process. This step also provides a direct input into the next Act Phase, as well as contributes to the shape and design of the new Living Lab cycle in case that will happen. Suggestion for discussion points are:

- What are external stakeholders', users', and customers' interpretation of results?
- Do they agree with them?
- Does this correspond to the results that were expected and how do these reflect the current needs?

Decision making and acting

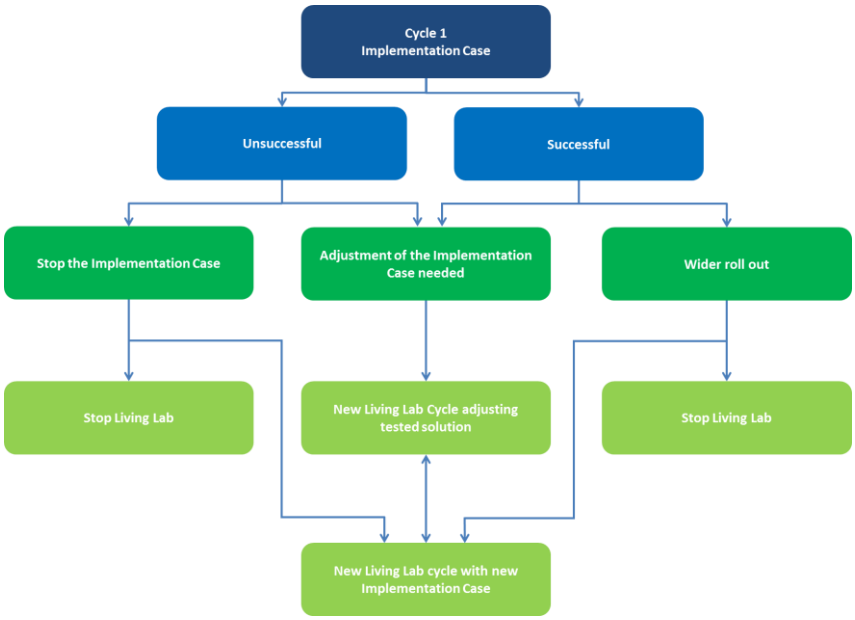
Following the planning, implementation and evaluation of the Living Lab solution, in this phase a decision is taken on whether the outcomes of the current Living Lab cycle are successful or not and what the next steps should be. The decision can, for example, take form as following:

- Rolling out of the solution;
- Disruption of the Living Lab; or
- New cycle entry with adjustments on the tested technology / solution, or the implementation of new case.

Next, the evaluation of the whole Living Lab cycle takes place and conclusions are made on whether the Living Lab setting is favourable in order to address the problems, what went good and wrong during the process and what kind of recommendations or improvements can be made for the future cycles.

There is a point in the Living Lab where a decision needs to be taken whether the implementation achieved its results or not, and whether it can be considered as fully implemented or not. If the solution is fully implemented, it can either be successful or unsuccessful. When all goals are sufficiently met, this means that the solution / technology is ready for further roll-out or commercialisation. If the outcome is not yet completely satisfactory, a decision should be made on whether the implementation case needs to be adapted or improved, or that the solution should be discarded. Furthermore, on the level of the Living Lab, a decision needs to be taken whether participants want to start a new cycle or they want to stop the Living Lab (cycle) (Figure 3).

Figure 3. Possible developments of the Living Lab cycle



In case if decision is taken to enter into the new living lab cycle, this can either focus on adjustment of the previously tested solution or may start up with new solutions to be implemented. Before entering a new cycle, some preparatory actions may be appropriate. First, the most important outcomes of the current Living Lab cycle need to be reported. In case of disruption of the Living Lab solution of the previous cycle, it is necessary to mention the main reason for the disruption and explain the underlying factors that made the implementation case unsuccessful. Second, an adjustment plan can be made specifying what parts of the Living Lab implementation case need to be reviewed and adjusted in the next cycle, based on the results of the evaluation. It might be important to go through each of the steps and see whether adjustments are needed, for example:

- Adjustment of scope or ambition of the Living Lab (for instance to make it more appropriate or acceptable for stakeholders);
- Adjustment of stakeholder groups (adding new stakeholders or adjusting the role of certain stakeholders);
- Adding new risks or outside events that need be taken into account in the next Living Lab cycle

When implementing new solutions, actions to be taken depend on what stage the new solution was developed. If it is a completely new idea than the new cycle might start from the preparation of this new implementation case.

In case if the preliminary decision on the potential rolling out or commercialisation of the logistics solution or technology has been taken a roll-out plan may be needed, developed in close cooperation with end-users and other key stakeholders.

When deciding to end the Living Lab cycle, some actions should be taken to wrap up the Living Lab. Interaction should be organised with the users, stakeholders and customers involved in order to get a clear picture why a decision of disruption was taken (e.g. Living Lab set up is not beneficial to achieve the goals of the project wants to reach; implementation case was unsuccessful and there are no more cases to try out). A workshop can act as a closing session for the Living Lab and should thus consider the lessons learned of the Living Lab as a whole. Furthermore it should be considered if continuation of some aspects of the Living Lab could be beneficial, such as, for example, stakeholder gatherings after the disruption of Living Lab or addressing the same goals but within other approach (e.g. traditional demonstrator). The main results of the Living Lab need to be properly reported as well, for the transferability and further learning for other interested stakeholders.

Added value of the living labs in city logistics

The creation of living labs in city logistics provides a new way to develop and address different trends and challenges. It supports an action driven cooperation forms fostering innovation deployment and improving communication and cooperation between stakeholders. Development of the shared vision, aligning individual interests to common goals and active involvement of the end-users as well as other competencies in the co-creation process helps to develop innovative solutions that are more user-friendly, more financially sustainable and adapted/tested within a real world environment.

During the three years of the CITYLAB project, valuable experiences were obtained on setting up, operating, or trying to start living labs in city logistics. This section presents some of the experiences in working with and developing of living labs in city logistics.

experiences in working with and developing of living labs in city logistics.

Ambition and scope of the living lab

- The setting up phase of the living lab is very important: here you discover things you might not have expected, as partnerships are relatively new and in this phase you learn other participants' values, interests and ideas related to the jointly developed ambition and goals;
- During operation of the living lab it is necessary to regularly check whether the ambitions and the scope of the Living Lab and the individual participants' ambitions and interests are still aligned. Critical changes in the living lab itself and its ecosystem that can influence the implementation process should be monitored. For example partners that were part of the common definition of the living lab's ambition and objectives can change jobs. As a result, the group has to get used to a new person, and a new person has to gain confidence in the process and the group;
- Take personal animosities between key figures of organisations into account. Identify the risk of non-compliance from either of the organisations and take mitigating actions when possible.

End – user participation and co-creation process

- Involve external stakeholders, users, customers as much as possible from the very beginning in the living lab process. Living labs should create value for all stakeholders, which makes it is easier to have stakeholders' commitment throughout the whole process.
- Convincing stakeholders to actively join a living lab from the beginning – where a lot of things still have to be defined and developed - requires some persuasiveness and vision.
- Co-creation with end-user is in the heart of the living lab approach. Participating in the development of the living lab solution, the end-user becomes more responsive in adopting these ideas;
- It is crucial for a city logistics living lab to be successful that all partners see a potential benefit from participating.

Involvement of different types of stakeholders

- When new partners are added to the living lab look critically at their expected role and possible contribution, as well as for conflicting interests, stakes and possible issues resulting from competition in real life.
- The complexity of managing a living lab increases considerably with the number of partners involved. There should be enough but not too many partners. Co-creation and stakeholder participation are important; but stakeholder should be active and the living lab meetings should not be large conventions with all stakeholders that were willing to join one or two meetings only.

- Involving different parties is critical: these actors should be openminded to others' knowledge and experience.

Changing usual ways of working

- Even if the collaborative mechanisms are already existing in the cities, it takes time to influence and steer towards the principles of working and innovating in a living lab;
- It is difficult for people to work in another way: the living lab approach requires a certain mentality change to more open-minded and open-end development of the solutions, whereas many professionals are used to plan projects and results in advance.

City logistics ecosystem support

- For several industry stakeholders having political support before setting up a living lab in city logistics was valuable for developing city logistics innovations. Lack of political and institutional support and limited resources are also often mentioned as challenging barriers to overcome.
- Political support to urban freight is often subject to the voters, and as urban freight often is an issue that doesn't directly occupy citizens, getting political support for urban freight is a challenge.
- There are difficulties in broadening the knowledge about the living lab approach within the municipalities and across municipal agencies.
- Limited ex-post evaluation of policy measures results from the political need for quick attention and limited funding available in municipalities for these activities. Sometimes it is necessary to apply for other funds (e.g. regional or national projects) and perform evaluation depending on the external funding decision.

Operation, evaluation and going through the cycles in living lab

- Minor adjustments can make a large difference. In some living labs it has been crucial to make small adjustments to the business models as the implementation has developed over time. 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.
- Evaluation should be an on-going process, both on the process of the implementation cases as of the city logistics living lab.
- Learning from the negative experiences in the act phase can also contribute to the positive experience. Not all of the solutions, developed within CITYLAB according to the living lab principles were directly successful. The first cycles in Rome, Amsterdam, London and Brussels of the implementations did not result in the implementation roll out, but have produced a valuable knowledge and strong cooperation structures to move forward for the next living lab cycles. As the result sustainable city logistics solutions developed within the London and Amsterdam implementations have rolled out. The Rome implementation within a second living lab cycle is extending the implementation in terms of flows involved, sites and alternative recyclable / reusable waste. The transferability effect is also achieved on the city level, where City of Rome wants to use CITYLAB case as a "test-case" to show all the benefits derivable from the adoption of a living lab approach where stakeholders collaborate, create, validate and test innovative technologies, services, products and systems. It intends to make use of the outcomes of the CITYLAB experience to identify the most prominent innovative freight solutions to be included in the upcoming Urban Logistic Plan and Sustainable Urban Mobility Plan (2018), with the local knowledge partner (UoR) providing support. This mentality switch in approaching innovative solutions is key for the future of the innovations in city logistics. The city logistics projects are no longer only

evaluated on the direct success from its implementation, but are seen in the broader perspective of added value from the establishment of stakeholder cooperation processes and contribution to the long-term goals of public authorities and market players.

- The living lab cycles for innovations should follow the natural development process and not be forced in fixed time frames. The living lab process is guiding the cycles.
- One should be able to recognize the act phase and go to next cycle.

City logistics transition living lab success factors

Success factors in establishment and operation of a the city logistics transition living labs in city logistics, as reported by CITYLAB cities (CITYLAB, 2018a) are:

- The excessive focus on short-term results at the expense of long-term interests are reduced since all stakeholders work towards a commonly defined objective;
- Define the objectives for the city logistics living lab on industry-led needs and city frameworks;
- Adjust the living lab approach to the context of each city and their needs on city logistics;
- Apply the living lab principles at any level either city, neighborhood, business, street, building or measure.
- Design 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.
- Successful living lab collaborations require that all partners see a potential benefit from participating.
- Integrate good examples (both in planning and in running actions) in the living lab if these contribute to the ambition and goals to give the living lab.

Living labs in city logistics put urban logistics on the strategically important place, attracting attention of the policy-makers, knowledge institutes, research partners and citizens. CITYLAB illustrated that different stakeholder groups benefit differently from participating in living labs in city logistics (CITYLAB, 2017, 2018c).

For the city authorities, urban transition living lab gives an opportunity to reach a bottom-up policy coherence, including in the policy and decision making process the needs and aspirations of local and regional stakeholders, industrial parties, transport operators and citizens. Overall, better knowledge and understanding of the urban freight in the city is created. Creation of frontrunner group with representatives from different sectors helps to gain a common perspective on the city logistics and better understand needs and requirements of transport stakeholders and logistics operators and barriers they are facing, thus, developing more efficient and targeted policies. Joint collaboration in the development of the solutions supports short and long term policy planning and, through evaluation, provides a feedback on the effectiveness of the policy measures. Municipalities “could support living labs by selecting zones where its efforts are aimed at creating room in the public regulations allowing bottom up initiatives and innovations” (Steen & van Bueren, 2017). Policy-makers bring in decision-making power into the living lab process as well as possibilities to create conditions facilitating development of innovations. They also can influence increasing of investments in the innovations for city logistics. Therefore, from the authorities’ perspectives the added value of such a collaborative environment results in:

- Higher policy coherence due to the bottom-up insights;
- A common perspective on key issues with key city logistics stakeholders;

- 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;
- An opportunity to exchange practices and collaborate across municipal agencies;
- Improved relationships and new cooperation mechanisms with city logistics stakeholders

City authority from CITYLAB: "The CITYLAB project has given us the chance to learn from leading European cities, and information from the project has been used to define measures needed to reach the goal of our climate and energy strategy".

For transport operators, logistics providers, retailers and other private stakeholders in city logistics processes, being part of the frontrunner group provides an opportunity to influence, at certain extent, the policy making process of municipalities. Next to it, it gives an efficient access to the most recent domain knowledge and evaluation of its own activity efficiency, providing an input for the improvement of the business cases and potential for the innovation uptake. It also gives opportunity to better understand other market players and their interests. Overall, if certain transitions are to take place, being a part of the frontrunner group, helps companies not to be forced into the changes, but to co-create the shape of these changes together with other parties. Living labs facilitate a cooperative mentality switch in the supply chains: potentially competitive businesses are no more seen as competitors but as partners working together to achieve a common goal. From an industry perspective a living lab provides with:

- Opportunity to participate and, at certain extent, influence policy formulation;
- A place to advice and inform on the challenges at hand;
- Improved business cases through ideas and opportunities when working with other stakeholders;
- 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;
- Changed role of private industry where businesses are no longer seen as competitors but as partners working together to achieve a common goal.

Industry partner in Southampton: "Working in CITYLAB has helped us learn more about deliveries to our shopping centres and how we may affect the efficiency of these".

Industry partner in Southampton: "Exploring options for collaboration is now firmly embedded in our business as usual strategic procurement process. Increasingly we are looking to creatively broaden the scope of collaboration beyond the healthcare sector and into wider public sector as well as other sectors. This is set to expand further as we continue to pursue value and not price."

Industry partner in London: "Just taking to other people and hearing the questions they ask gets the industry thinking of other ways the implementation could have been done or improvements to be made".

Industry partner in Oslo: "Municipal support is important when the industry decide to test a new solution or innovation, however, R&D is often more important when deciding on the preferred strategy for alternative solutions".

Both, city and industrial partners benefit from the added value brought by the research partners in the living lab process. Along with innovative ideas they bring in, research partners also provide a neutral opinion on the relevance, efficiency and sustainability of the tested solutions. Research partners can do a background literature and best practice research; undertake scoping and feasibility studies for the industry partners for minimal cost as part of managed student projects. They can act as secure data manager on behalf of the partners, undertaking ex ante and ex post analysis and providing longer term evaluation of any implemented measures. A research partner is also well positioned to be a neutral coordinator of the living lab in city logistics, specifically for the city logistics transition living labs. Being involved in the living lab, provides researches with cost efficient access to the first hand data and with an opportunity to validate their ideas with market players. New research ideas are generated via the stakeholder discussions and by going through the innovation cycles. More specifically, for researchers the added value of participating in a living lab has been in:

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

Knowledge partner from CITYLAB: "Collaboration is a key activity ensuring we deliver service excellence and value for money. Building effective relationships with partners within the HE sector and beyond, such as Local Government Authorities and the NHS ensures we are focused on delivering best practice. Currently 23% of our impactible spend is channelled through collaborative procurement arrangements".

Stakeholder collaboration developed within living labs provides an opportunity to build relationships and establish joint initiatives in city logistics that otherwise would not have taken place.

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Annex I. About CITYLAB project

The CIVITAS 2020 project CITYLAB 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 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.

The key objectives of CITYLAB were:

1) To improve basic knowledge and understanding on areas of freight distribution and service trips in urban areas that have received too little attention to date;
2) To test and/or implement seven innovative solutions that are promising in terms of impact on traffic, externalities and business profitability and have a high potential for future growth;
3) To provide a platform for replication and roll out of the implemented solutions.

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, using living lab principles. These four axes, the related CITYLAB implementations and cities involved 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 organizing logistics activities.

1. CITYLAB axes for intervention

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	Logistic hotels to counter logistics sprawl	Paris	SOGARIS

CITYLAB partner city of Rotterdam applied living lab principles to assist the transition process for the city for the sustainable logistics.

ANNEX II. CITYLAB implementation cases

Source: CITYLAB, 2018a. Tools for achieving CO2-free logistics in cities by 2030 (No. 6.4). CITYLAB. Draft version.

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 defined as 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, 2018).

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, 2018).

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, 2018).

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, 2018).

The hourly rates are lower 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, 2018).

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.

It was experienced that dew 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, where they indicated that they do not order online at other webshops (CITYLAB, 2018; 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, 2018; 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 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, 2018).

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, 2018). 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 LMO AND THE OPERATOR OF A CONSOLIDATION CENTRE.

A GOOD UNDERSTANDING OF EXISTING CONTRACTUAL COMMITMENTS BETWEEN THE LARGE MUNICIPAL ORGANISATIONS (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. 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 (CITYLAB, 2018).

To improve the efficiency of freight deliveries, the Oslo 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, 2018).

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 without a common logistics function. Such a solution can therefore be said to generate a great amount of time savings for drivers, especially the ones delivering multiple pallets. The time savings are so substantial that transport companies may be able to replan their routes and use a lower number of vehicles to serve the same number of clients within a day. Also, if logistics service providers can reduce the stoppage time by several hours (and assuming they turn the engine off while parked[1]), local emissions will be reduced. It is very difficult to calculate the exact contribution and the direct effects of these changes (CITYLAB, 2018).

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)[2] 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, 2018).

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

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

[2] 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.

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 of Paris CITYLAB will allow us to assess the (environmental, social, economic and regulative) impacts of two urban warehouses, called "logistics hotels" at different stages of implementation with different 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 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, 2018).

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

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