EUROPEAN COMMISSION

INNOVATION and NETWORKS EXECUTIVE AGENCY

HORIZON 2020 PROGRAMME for RESEARCH and INNOVATION

Reducing impacts and costs of freight and service trips in urban areas (Topic: MG-5.2-2014)

Grant agreement no: 635898

Deliverable 5.3

Impact and process assessment of the seven CITYLAB implementations

THE CIVITAS INITIATIVE IS CO-FINANCED BY THE EUROPEAN UNION

Document Control Sheet

Project no.:	635898	**Acronym**	CITYLAB
Project Title	City Logistics in Living Laboratories		
Work Package	WP5	**Title:**	Evaluation
Deliverable no.:	D5.3	**Title:**	Impact and process assessment of the seven CITYLAB implementations
Version	2	**Revision**	0
Issue Date	28 Feb 2018		
Dissemination Level	Public		
Future references	CITYLAB Deliverable 5.3 (2018). Impact and process assessment of the seven CITYLAB implementations.		

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London	Transport for London	TNT Gnewt Cargo	University of Westminster University of Gothenburg
Oslo	Oslo kommune	Steen & Strøm	TOI
Paris	Mairie de Paris		IFSTTAR DLR
Rotterdam	Gemeente Rotterdam	PostNL	TNO
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Executive summary

CITYLAB focuses on four axes that call for improvement and intervention:

- Highly fragmented last-mile deliveries in city centres
- Inefficient deliveries to large freight attractors and public administrations
- Urban waste, return trips and recycling
- Logistics sprawl

Within these axes, the project supports seven implementations that are being tested, evaluated and rolled out. An implementation is defined as the process of preparing, testing and putting into practice a new service or a new way of operating or organising logistics activities.

The objective of this report (Deliverable D5.3) is to present an assessment of the effects and consequences of the implementations as they are conducted. For each individual implementation, we summarise the process leading to the implementation and the outcomes. The information provided in this deliverable will be used by the subsequent evaluation deliverables.

For each implementation, we summarise

- Problem and aim
- Description of the solution
- Implementation process
- Effects and consequences
- Challenges ahead
- Lessons and generalisation of results

This deliverable provides a complete picture of the evolvement of the implementations during the CITYLAB project and final versions of the process and impact assessments.

1 Introduction

The objective of the CITYLAB project is to develop knowledge and solutions that result in roll-out, up-scaling and further uptake of cost effective strategies, measures and tools for emission free city logistics. In a set of Living Laboratories (“Living Labs”), promising logistics concepts are being implemented, tested and evaluated, and the potential for further roll-out and upscaling of the solutions is being investigated and explained. The Living Lab concept looks beyond the traditional set-up of pilots. It changes the emphasis from the solution as an isolated object to the process of integration with its environment. This environment facilitates cooperation between real-world stakeholders, forming favourable conditions which speed up development and roll out of innovative solutions. In a Living Lab, citizens, governments, industry and research partners can co-design and co-create new policies, regulations and actions through a shared long-term goal.

In CITYLAB, 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 deliverable assesses the effects and consequences of the seven CITYLAB Implementations as they have been conducted within WP4. For each individual implementation, we summarise the process leading to the implementation as well as the outcomes. The information provided in this deliverable will be used by the subsequent evaluation deliverables following later in the project.

CITYLAB focuses on **four axes** listed in Table 1 that call for improvement and intervention. Within these axes, the project supports **seven implementations** that are being tested, evaluated and rolled out. If the four axes for intervention are not explicitly tackled in the EU, the rising populations and densities of cities may produce such an increase in freight transportation that the economic and environmental sustainability will no longer be guaranteed. This, in turn, will endanger the future growth potential of European cities. The four axes and the related CITYLAB implementations are shown in Table 1.

Table 1. CITYLAB axes for intervention and implementations.

Axes for intervention	Implementation	City	Partner
Highly fragmented last-mile deliveries in city centres	Growth of consolidation and electric vehicle use	London	TNT and Gnewt Cargo
	Floating depot and city centre micro-hubs	Amsterdam	PostNL
	Increasing load factors by utilising spare van capacity	Brussels	Procter & Gamble
Inefficient deliveries to large freight attractors and public administrations	Joint procurement and consolidation	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	Rome	Poste Italiane, Meware
Logistics sprawl	Logistic hotels	Paris	SOGARIS

Each of the implementations are described in the following chapters. The chapters follow a similar structure, covering:

- Problem and aim
- Description of the solution
- Implementation process
- Effects and consequences
- Challenges ahead
- Lessons and generalisation of results

The implementation chapters are mainly verbal summaries of what has taken place in each location together with process and impact assessments, while the descriptions capture information collected by use of the CITYLAB indicators (CITYLAB, 2016). A fact sheet for each implementation is included as annex to the deliverable.

This deliverable is supplemented by Deliverable 5.4 “Sustainability analysis of the CITYLAB solutions” which cover perspectives such as (1) benefits and costs to society; (2) assessing the financial viability for the industry partners; and (3) integrating all stakeholders’ opinions in the evaluation process.

2 London: Growth of consolidation and electric vehicle use

2.1 Problem and aim

The main objective of this action is 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 main client of the London Implementation Action is the major parcel carrier TNT UK. TNT was purchased by FedEx in 2016, but continues to operate under its own brand. Gnewt Cargo was purchased by Menzies Logistics in 2017 but also continues to use its own brand and retains its client base in London. The city transport authority, Transport for London (TfL), is also a project participant.

The main questions to be answered in the CITYLAB Implementation Action London can be summarised as: What is the most promising business case and growth conditions for clean urban freight consolidation and single carrier deliveries for clients from the point of view of the operators in Central London? The challenge was also to try to reduce vehicle kilometres by using a transfer depot closer to the delivery addresses in central London, so as to tackle the problem of logistics sprawl in which logistics depots have been priced out of central and inner London and therefore have ever-increasing stem mileages.

Discussions among the companies involved and Transport for London identified the following barriers and challenges as important for sustainable urban freight solutions: i) little or no growth in most inner-city consolidation centres and electric freight vehicles (EV), ii) the conditions for such growth are not well understood and iii) there is a need to gain better understanding of business models for clean deliveries with electric vehicles and tricycles. The aim of the London implementation action is therefore to identify the best possible management solution for inner city distribution, consolidation and clean vehicle use, from the point of view of a local authority, a large carrier, and a small carriers' carrier (a freight carrier that only works for other carriers rather than directly competing with them for freight flows from customers). Multiple barriers currently exist when trying to expand the market share of electric vehicles used in urban freight distribution. The London implementation aims to tackle multiple problems, on the background of a still increasing diesel van growth trend in Europe, and of an already well-developed approach to design innovative tests.

Freight optimisation and efficiency increase have already been the aim of many types of demonstration. How to achieve this optimisation has been tested in several projects. The CITYLAB London implementation proposed to experiment with the viability of one freight transport operator sharing its van deliveries with another client to reduce stem mileage and hence total distance travelled, and on how to grow the number of electric vehicles in use.

The implementation intends to meet both public and private sector needs and policies at the same time.

The main public sector challenges tackled are climate change reduction and internalisation of external costs of transport such as congestions, accidents and health impacts of noise and air pollutant emissions (Figure 1).

Figure 1: Annual NO_2 concentration objectives passed or failed in London 2016. *Source: www.londonair.org.uk*

Reducing operating costs through operational efficiency improvements is also a big challenge in the freight transport industry, because profit margins are traditionally low, thus leaving limited opportunities for innovations and testing of new business concepts. This is the main reason why it is so difficult to organise very innovative tests under the condition of goods transport to real clients. The time pressure is very high and there is a very limited margin of manoeuvring left. So, while a simple switch of diesel vehicle to an electric one sounds not so difficult, the fact that 15% of the electric vehicle weight is taken by a battery may have a detrimental impact on business. A business leader is likely to assume a driver can carry 15% less goods on departure for the same working day. As a mitigation measure, the depot of the electric freight operator Gnewt Cargo was located within the city centre, allowing multiple trips and reloading at the depot during the day. But still, the market of electric vehicles has various payload and loadspace disadvantages. In 2017, electric vans sold on the UK market are all having a 4-5 cubic metre (m^3) capacity with 2.2t Gross Vehicle Weight (GVW) instead of the 15 m^3 capacity and 3.5t GVW of standard diesel vans.

The minimisation of risks is perhaps the number one concept when it comes to the hierarchy of strategies and tactics in place, since no business can take the risk of failure or bankruptcy. Financial risk is very relevant as for example one major parcel carrier active in London (City Link) collapsed and went into administration in 2014, generating turmoil in the parcel market.

Key assumption (work hypothesis of the London Action) to tackle these problems is that a well monitored market expansion, tested under real business conditions, would give convincing information for decision makers and would help expand the market.

2.2 Description of the solution

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. Four depots and a fleet of about 100 electric freight vehicles are in use. One main depot is based in Southwark on Wardens Grove near Great Guilford Street, another central depot is located in West Central Street near New Oxford Street. A third, smaller depot, is located on Princes Street near Regent Street. The depot of a client, DX, located in Marlborough Grove in Southwark, is also used by Gnewt Cargo (Figure 2).

The main clients of Gnewt Cargo are:

- carriers specialised in parcel services, performing mostly courier and home delivery services for online retailers and SMEs, and
- retailers that are sending ordered goods to their final clients residents.

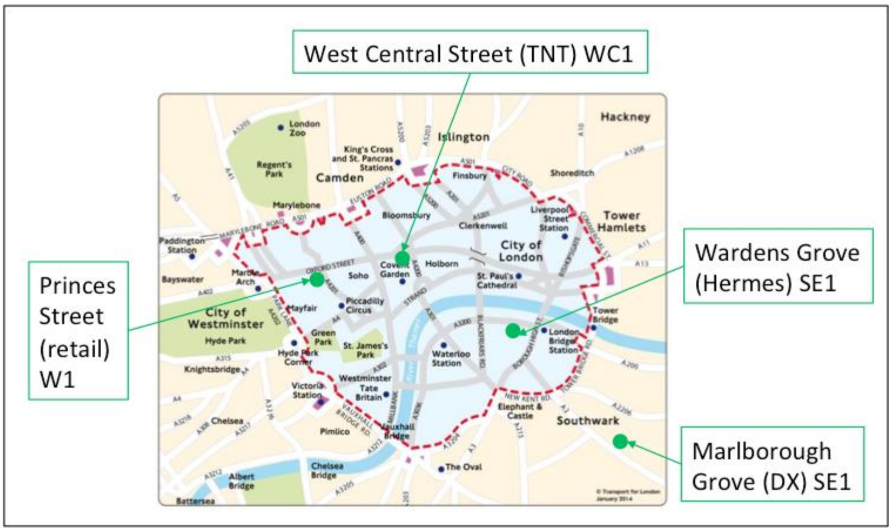

Figure 2: Locations of the Gnewt Cargo depots used for electric deliveries in Central London. *Source: Gnewt Cargo 2016-2017*

The main objective of this Implementation is to thoroughly assess the benefits and impacts of the activities of the single carrier consolidation of multiple clients with the case study of Gnewt Cargo business with the client TNT UK (Figure 3). These benefits and impacts are firstly ‘internal’ business impacts such as costs reduction and supply chain efficiency, and secondly ‘external’ impacts on urban freight situation in London, on traffic and on external environmental factors such as climate change, air pollution and noise.

The CITYLAB Implementation in London is performed for a duration of two years in order to consolidate the knowledge and to obtain a broader, more robust and less risky business case for the part of Gnewt Cargo dealing with carrier electric parcels deliveries, including its fleet and depot management in central London. As of today, very few trials has been performed and before/after data collection has occurred on this type of sustainable urban freight business, and none of these trials aimed to understand the impact of business growth. It is expected that the results demonstrate benefits that are also valid for any other freight business operating in London, and that other businesses will be able to transfer this knowledge to their companies and apply it successfully to their operations. The added value for the business community is therefore high.

The logistics model monitored involves only the activities focusing on consolidation and single carrier deliveries (Figure 3). A topical focus is set on scenario involving the consolidation of multiple clients, and the question of managing the part of the logistics business in London that is performed as independent carrier. Here the focus is on the management of depots and fleet from the point of view of an independent single carrier, carrying out operations of urban freight consolidation and distribution for multiple clients.

To understand the logistics system in place, it is necessary to contrast the situation before and after the demonstrator starts its operations (see Figure 3).

In Figure 3 “Before” (on the left-hand side) is a simplified model of the activities of three logistics service providers making their deliveries without Gnewt Cargo. In this model, 3 suppliers of goods are delivering themselves to their clients in the city centre and all trips are taking place during rush hour in the morning traffic. These suppliers have their depots located in the suburban area of London and this implies a long journey towards city centre during peak traffic (stem mileage). The fleet used in the parcels business is mainly light goods vehicles run with diesel fuel. Diesel is the main energy source for commercial fleets in UK.

The challenges of this “Before” logistics model are:

- **Low load factors:** Despite missing data on the average load factor, the tendency observed in European studies seems to suggest that the average load factor is decreasing by weight and by volume. According to the European Environmental Agency report on Transport in Europe, freight vehicles are around 45-60% from capacity on loaded trips, or at departure from depots (EEA 2012).
- **High number of journeys:** All vans needs to run all the way from the suburbs to the centre of the city and back.
- **Significant stem mileage:** The part of the delivery trip occurring between depot departure and the first customer delivery in Central London is called stem mileage. The distance spent on this part of the trip is very long, more than 2/3rd of the total distance driven during the day.
- **Contribution to rush hour congestion:** Most vehicles need to drive during rush hours on the main axis towards central London. The cause is the business requirement to arrive at the first delivery point early in order to be able to distribute effectively and efficiently a high number of parcels during the day. Additionally, some parcel deliveries are required to take place within the time windows specified when the clients place their order. Normally the client can receive the goods all day. But for premium parcels deliveries, most carriers offer the option of a delivery before 09:00, 10:00 or 12:00. These are the reasons why the vans need to start from the suburban depots between 06:00 and 08:00, and arrive to Central London between 07:00 and 08:30. This morning trip is corresponding to the peak congestion time.

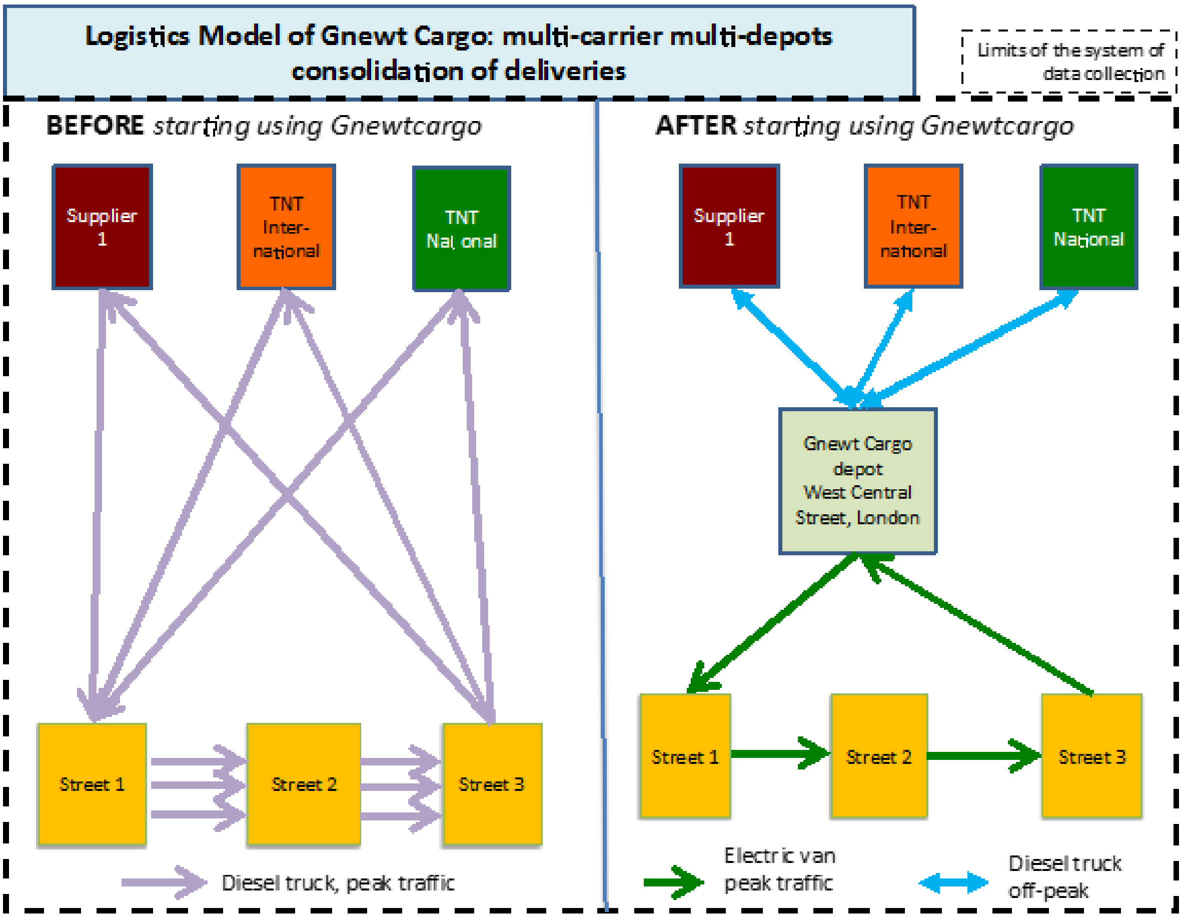

Figure 3: TNT logistics system before and after starting using Gnewt Cargo, Sept 2016.
Source: Gnewt Cargo 2016-2017

The “After” situation in Figure 3 (on the right-hand side) shows how this logistics model evolves when using the solution in place at Gnewt Cargo.

The benefits of the solution are not only relevant for businesses but also for the public sector:

- **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. These trucks are better loaded on the way towards the city centre, but needs to return back empty; for some clients such as TNT, trucks are not completely empty and they are filled on their way back with few parcels collected.
- **Less empty returns:** For the last mile trip of Gnewt Cargo, electric vans are starting full at departure from 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 (typically a distance between the last delivery point and the central London depot of less than one mile. In the before case, the return trip from Central London to Barking is about 12 miles long.
- **Reduced number of journeys:** the goods can now be delivered to central London on board of larger trucks coming from the TNT depots in the Midlands and Luton to the depot of Bermondsey where the Gnewt Cargo vehicles are loaded. It is possible to replace up to 7 vans with a single truck. In the case of another client of Gnewt Cargo, three to seven vans are replaced by one truck. In the case of TNT, the number of vans replaced by one truck is about 4.
- **Reduced mileage:** the trips reduction is leading to a corresponding reduction in total distance. This reduced mileage is best estimated in km per parcel, or km per delivery unit, because this indicator allows comparing different distribution systems and different businesses.
- **Off-peak trips:** The trips between the TNT depots and the depot of Gnewt Cargo are occurring at night and during the early morning hours. These off-peak trips are replacing almost entirely the journeys occurring at rush hours on the main roads towards Central London.

2.3 Implementation process

The decision to select this implementation action was taken in the London Living Lab, which include partners from Transport for London, Gnewt Cargo, TNT and University of Westminster, acting as decision making body of the CITYLAB project in London. The City of London has also been present in meetings and consultations when necessary – around four meetings per year for the duration of the action. The implementation action was started in accordance with a time plan set up in the Living Lab. The policy activities in the London Living Lab have been strongly influenced by the questions arising during the implementation efforts, which have focused around the limitation of further transfer of parcels flows and business growth in Gnewt Cargo due to the lack of affordable logistics depot space in central London.

The parcels delivery business of Gnewt Cargo focuses on the geographical area inside the London Congestion Charge Zone. The company is performing city centre distribution as carriers’ carrier with a centrally located consolidation centre, and a 100% electrically-powered van fleet. The key task is to increase the number of deliveries made on behalf of TNT.

There is one deviation from the initial Description of Action of the CITYLAB London implementation: the solution suggested by TNT of a mobile depot previously envisaged at the proposal stage cannot be implemented immediately. TNT’s experimentation with this mobile depot concept immediately prior to the commencement of the CITYLAB project proved not to be commercially viable. This issue, combined with the practical difficulties of obtaining suitable transhipment sites within central London, in which to locate the mobile depot each day, could not be resolved prior to the commencement of the London implementation. However, this mobile depot option has not been entirely dismissed at this stage, and resolution to these issues is still sought.

The main activities and steps of the London Implementation Action are summarised in Table 2 below.

Table 2: Main steps, activities and time plan of the Action.

Main steps and activities	Time
Data are collected at the West Central Street depot, and at all other depots where relevant business operations are occurring. Several vans, and their associated parcel operations are being observed at Gnewt Cargo (with these freight flows provided by TNT, as well as other retail clients. This data collection has taken place before and after the start of the growth of the TNT business delivered by Gnewt Cargo. The data allows quantification of the effects on Gnewt Cargo's internal vehicle operations and on the business case. This data is collected in a before-after approach, with the objective to demonstrate the profitability, barriers and success factors of this type of multi-carrier consolidation cooperation. Collection of data from initial situation (before data) took place during Sep-Dec 2015. Data collection during implementation takes place during the period from Aug 2016 – Apr 2017.	July 2015 – April 2017
(1) new TNT depot was found in Bermondsey. (2) shift of the starting date for the new delivery system from January to August 2016 (3) effective start of the new operations in August 2016	August 2016
These new operations were progressively increased in September and October 2016. Trial part (scenario) dealing with joining operations of domestic and international parcels distribution at TNT was tested in the months July to October 2016	July-October 2016
New growth scenario to be tested: Total of 10 routes reconfigured for Gnewt Cargo, with biggest electric vans	April 2017
A total of 3-4 scenarios of urban distribution were tested, with data collection and evaluation enabling successive evaluation steps to take place	December 2017

Even though the implementation is continuing and being further developed, data from London are available for a period from September 2015 to March 2017.

A Living Lab London meeting with Boroughs and companies addressed the topic of lack of available logistics depot space in January 2017 and multiple meetings took place in 2017 to explore this issue in further detail.

As of January 2018, Gnewt Cargo will move to another depot but the general problem remain unresolved.

2.4 Effects and consequences

2.4.1 Distance and fleet reduction: impact analysis

Table 3: TNT distance reduction, before-after comparison, September 2016.

BEFORE deliveries starting from Barking	**Number of vehicle trips per day**	**MPG**	**Monthly distance in km**	**Parcels delivered during month**	**Distance in km/ parcel**
Van TNT domestic	10		24,647	30,089	
Average		31			0.82
AFTER Gnewt Cargo operations					
Electric Van Gnewt	10	-	5,663	21,211	0.267
% reduction	**0**		**77**		**67**

Source: Gnewt Cargo, data from September 2016

The distance analysis is strongly influenced by the location of the depots and this result will probably change if another business type or another scenario is considered. In the past, the distance reduction achieved for different clients were between 20% and 85%, the current impact figures for 10 vehicles seem rather robust.

The distance travelled is reduced by 67%. This has an impact on traffic and on costs, and it is estimated that travel times are also reduced.

The number of vehicle in use is unchanged for the Gnewt Cargo business after the changes, due to the use of the electric vans directly starting from the TNT depot in Bermondsey.

The distance covered by trucks to deliver the parcels from the Midlands to Barking or to Bermondsey is not considered in this calculation, as these “trunking” truck trips were made before and after the trial started in a similar way. There might have been slight changes in total distance per parcel occurring on those trips, but the monitoring was not following this element of the supply chain.

2.4.2 CO_2 and air pollutant reduction: impact analysis

The before emissions for TNT diesel van distribution was recorded in September 2015. The average value of 195 grams of CO_2 per parcel for TNT is an average baseline value. The 2 million parcels a year of Gnewt Cargo would represent, with such an average, a total CO_2 emission of 440 tonnes per year, that can be potentially fully avoided. This example show how the potential future reduction might occur if the Gnewt Cargo logistics solution, or a similar system, would be further developed in London.

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. So, as of September 2016, the last mile operation under observation and for which the data collection occurred, was 100% electric.

Fuel use before was 0.07 litre per parcel, equalling 0.195 kilograms of CO_2 equivalent per parcel (kg CO_2/parcel), and this represents a value that is similar to other diesel vans in urban logistics. The lowest CO_2 emissions measured before as an average of one day, is 47 grams of CO_2e per parcel and the maximum is a daily round with an average of 2.38 kgCO_2 per parcel.

Table 4: CO2 reduction effect, before-after comparison, September 2016.

BEFORE deliveries starting from Barking	Number of vehicle trips per day	l/ 100km	Total litre/month	Litres/ parcel	$kgCO_2e$/ parcel
Van TNT domestic	10		2243		
Average		9		0.07	0.195
AFTER Gnewt Cargo operations					
Electric Van Gnewt	10	-	-		
Total	10				
Average			0	0	0
% reduction	**0**		**100**	**100**	**100**

Source: Gnewt Cargo, 2016

The total fuel use and CO_2 emission per parcel is reduced by 100% in the situation after, due to the 100% electric vehicle fleet in use from the start of the TNT depot.

The air pollutants emissions of PM10 and NOx decrease also by 100% for the same reason. (As reminder, only the tailpipe emissions are considered, as no data is available on any other air pollutant emissions from electric vehicles. It is likely that rubber contact with asphalt produces particulates emissions, but the amount could vary from 10 to 30% of tailpipe diesel emissions, and is unknown at this stage).

2.4.3 Energy reduction: effect analysis

The energy use expressed in grammes of oil equivalent (goe)/parcel takes into account the diesel energy of the diesel vans and compares it with the kWh energy of the electric vans. The value of 87% reduction in energy use per parcel is higher than the reduction in total distance driven (67%). The DEFRA conversion factors are used to convert litre diesel to goe and kWh to grammes of oil equivalent.

Table 5: Energy reduction for the TNT demonstration, September 2016

BEFORE deliveries starting from Barking	Number of vehicle trips per day	goe/ parcel
Van TNT domestic	10	
Average		63
AFTER Gnewt Cargo operations		
Electric Van Gnewt	10	8.4
% reduction	**0**	**87**

Source: Gnewt Cargo, 2016

2.4.4 Empty distance reduction: target analysis

The empty distance is much reduced as well (93%) due to the fact that electric vans are almost empty between the last drop or collection point and the return to depot, which was estimated as 1 km per van per day. In the situation ‘before’, the van trip back to the TNT depot in Barking is an almost empty return, except when the delivery trips can be combined with a collection trip, which is estimated to occur at one tenth of all trips. A van is considered “empty” when less than 5% of its capacity is used on the part of the round trip between the last stopping point and the depot. The empty distance in the “Before” case. in which vans make deliveries to central London customers from the TNT Barking depot, is estimated to be 16 km, and the empty trip is counted when starting from the last delivery point of the day, for the part of the journey going back to depot.

Table 6: Reduction in empty distance for the TNT demonstration, September 2016

BEFORE deliveries starting from Barking	**Number of vehicle trips per day**	**Monthly empty distance in km**
Van TNT domestic	10	2984
Average		
AFTER Gnewt Cargo operations		
Electric Van Gnewt	10	210
% reduction	**0**	**93**

Source: Gnewt Cargo, 2016

2.5 Challenges ahead

Economic growth and logistics performance growth for clean operators

Despite financial and ownership changes of both CITYLAB London industry partners TNT UK and Gnewt Cargo, which were due to wider economic reasons, the overall business growth picture remains positive at the end of the CITYLAB project, in Jan 2018. Gnewt Cargo was distributing about 20% more parcels in 2016 than in 2015, and 2017 seems to be another year with a strong growth tendency. Gnewt Cargo acquired new clients in retail and parcels delivery sectors and continued in 2017 its successful business. Gnewt received strong support from local authorities and multiple awards from UK industry organisations and networks.

However, not all challenges were successfully tackled, and this growth did not lead to a general increase in the sales of electric freight vehicles in UK.

The following barriers are currently strongly limiting the growth of electric vehicles in urban logistics.

1. The market for Battery Electric Vehicles in urban logistics remain very limited in 2015, at less than 0.1% of all commercial vehicle registrations in UK.

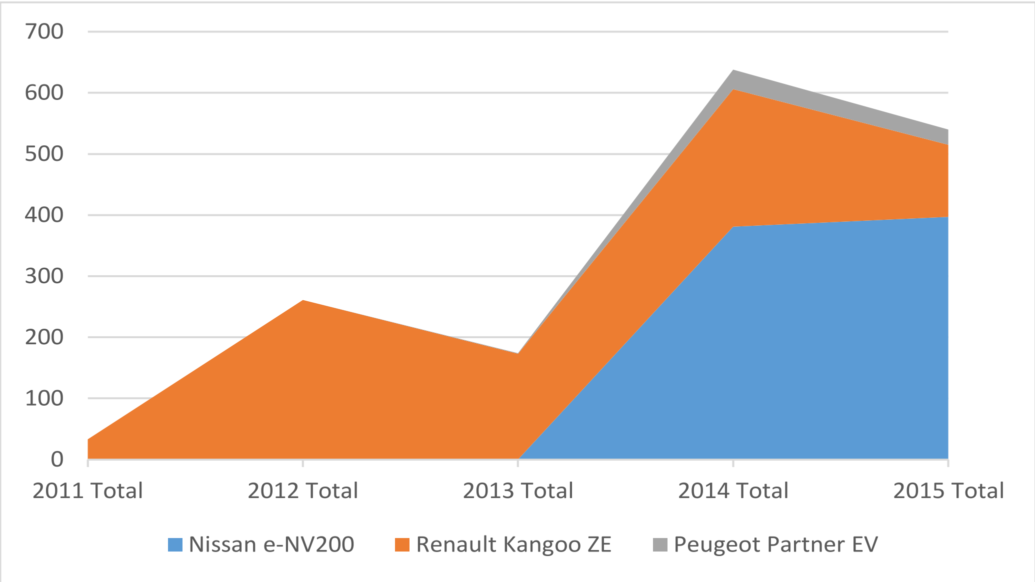

Figure 4: Growth in electric vehicle new registrations in UK, 2011 to 2015. *Source: EAFO European Alternative Fuel Observatory 2017*

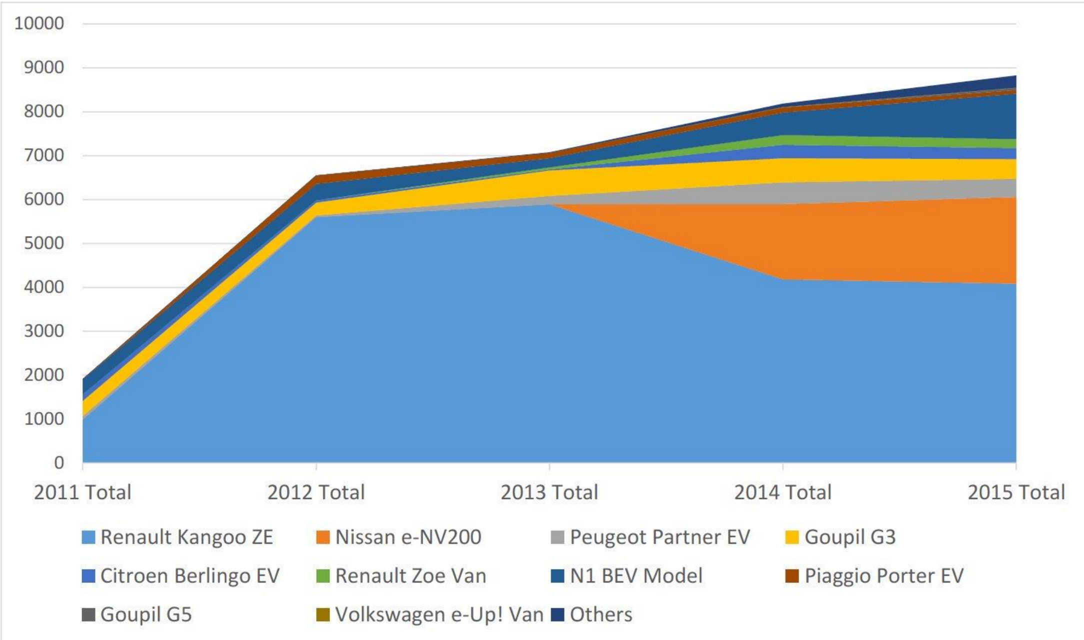

Figure 5: Growth in electric vehicle new registrations in Europe, 2011 to 2015. *Source: EAFO European Alternative Fuel Observatory 2017*

2. London electric charging infrastructure is improving, but in 2017 remains unsuitable for commercial use
3. On-boarding clients for multi-carrier consolidation has taken longer than anticipated.
4. Greatest barrier to growth may be the **lack of available space and the time consuming processes of identifying such locations within city centres for safe-guarded for environmentally friendly logistics last-mile solutions**. However, changing one depot location can result in an efficiency improvement. It will become an absolute necessity to provide cleand and efficient parcel movements in the future.

2.6 Lessons and generalisation of results

The London implementation, by monitoring operational and business growth, is contributing to a better understanding of the necessary conditions for successful operations concerning clean inner city distribution, consolidation and clean vehicle use. This will help facilitate future such growth in other locations and cities, and provide the potential for better informed management decisions. The business model involved in the London implementation has already demonstrated its viability. Further data collection and monitoring will continue to be performed on the costs situation in the London Implementation. The following barriers to growth of the London implementation have occurred so far:

- There are several challenges that need to be addressed and overcome in order to determine how best to grow and scale up this urban logistics solution
    - CITYLAB has started work on identifying further opportunities for scaling up
- The greatest operational difficulty encountered during the implementation is that none of the Gnewt Cargo depots in Central London are accessible by a large truck, so TNT was obliged to use smaller 7.5t urban trucks to deliver parcels to the Gnewt depot.

    - Ideally a new depot, more suitable for growth would be required
    - Help is being provided by TfL, London Boroughs, CRP and CLFQP through discussions with various stakeholders about logistics land acquisition issues
- Growth in operational scale implies a shift in business from one subcontractor to another
    - This may require contractual change within and between companies that work together
- Shared use of depots, vehicles and customer data
    - Depends on whether businesses will accept the idea that subcontractors could share depots, vehicles & data

Gnewt Cargo opened a new distribution centre in Oxford in Autumn 2016. The business model is therefore transferable and has the potential to be implemented and grow in other cities. A plan for replication and transfer in other European cities is in preparation with POLIS. Contacts are ongoing with Manchester and other cities.

In summary, scaling up for the different business cases has proven very relevant but difficult to implement.

- The business case, A1, where TNT deliveries in London were performed by Gnewt Cargo with no consolidation with other Gnewt Cargo volume. Altogether there were 15 routes with electric vans which was not profitable after four months. The reason for this was that it was difficult to find a large enough depot - the trial was therefore stopped.
- The business case, A2, where TNT deliveries in London were performed by Gnewt Cargo in consolidation with other Gnewt Cargo volumes in the same route/vehicle was profitable after seven months – proving its scale-up potential. In this alternative is was 20 routes with electric vans delivering from from multiple Gnewt Cargo depots.
- In the third business case, A3, the TNT deliveries in London were performed by Gnewt Cargo - consolidation with other Gnewt Cargo volume in the same route/vehicle. This alternative was also profitable and proved scale-up potential. There were 20 routes with electric vans delivering from an optimised, single Gnewt Cargo depot.

A key challenge, which had to be overcome, for the latter two alternatives was convincing the clients of Gnewt Cargo that it would be beneficial to complement the load of a TNT van with the load other clients.

Supporting measures and proposals for future supportive actions

Currently, the trial is performed with some public support, direct and indirectly beneficial for the business of parcels distribution in Central London. One of the main financial support is the exemption from the daily Central London Congestion Charge for 100% Battery Electric vehicle. Currently the amount is at £11.50 per vehicle per day. Another support is the UK government grant for the purchase of electric vans.

While the overall framework conditions are considered much improved in the last years, notably with the lower price and better quality of electric vehicles, there is room for further supportive actions that would benefit market growth of electric vans and cycles such as:

- Specific access rules for electric vehicles and cycles for certain urban areas such as pedestrian zones and other restricted areas (no Central London Congestion Charge Zone fees)
- Authorisation to use restricted parking and permit bays and for loading bays in central areas
- Consistency in rules for electric vehicle parking and stopping areas across different London Boroughs

- Help in finding logistics depots that are reasonably priced, but centrally located, as the current market rates are not suitable and the high cost endangers the viability of the business
- In the case of absence of any suitable depots, develop a land-use policy with dedicated areas reserved for sustainable logistics, and investments in new, suitable inner city depots
- Having a regular contact with local businesses and helping to coordinate the activities around new sustainable freight and new solutions for different clients, big and small
- Help develop and test different types of suitable technology with research funding

Regulatory measures would be important as they would provide even more competitive advantage that helps to offset the higher costs of running a Central consolidation centre, and using electric vehicles. Such measures could include:

- The continued exemption from road user taxes and Congestion Charges
- The allowance of access via EV over Diesel in certain areas of Central London
- The tariff for green electricity should be equivalent to standard electricity
- The exemption from certain types of parking fines for electric vehicles
- The clearance from the national and local traffic authorities and obtaining their allowances for to run on the road for electric vehicles
- To run on all or certain types of roads
- To access (or not) certain types of zones such as pedestrian area
- To access (or not) cycle lanes
- To circulate in the traffic at (or below) a certain speed limit

3 Amsterdam: Floating depot and city centre micro-hubs

3.1 Problem and aim

The Amsterdam implementation aimed to improve last mile logistics in the dense city centre by making better use of available infrastructure. In recent years, the recorded congestion level in Amsterdam remains at around 22-27% of additional travel time In the morning and evening peak times this can reach up to 65% of additional travel time. TomTom estimates that this results, on average, in 26 minutes extra travel time per day and 101 hours extra travel time per year per driver, which, in monetary values, brings a lot of additional extra costs to the delivery companies.

3.2 Description of the solution

During the project, several concepts were studied and one was actually implemented. The initial idea for the first cycle implementation was the following: the parcels are navigated into the city by a vessel (the floating depot) with a mechanism to lift the goods onto the quays. From the quays parcels are transported by clean vehicles to the final destination. After some issues (described in section 3.3), PostNL decided to use conventional vans for these parcels.

In the second scenario, 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 items would be the main goal. The floating depot would have made it possible to use ZE vehicles, replacing (diesel) vans. Evaluation performed at the end of design phase have illustrated that there is not yet a sustainable business model for this scenario.

The third scenario/solution was actually trialed and will be implemented to other cities as well due to its success. 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 on will be purchased when the implementation will be transferred to other cities. These 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. These micro hubs (for example abandoned stores or existing PostNL hubs) are shared with activities like daily mail.

With this concept, PostNL implemented two main improvements.

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

3.3 Implementation process

This implementation followed the Living Lab approach: based on a shared vision of making the city centre of Amsterdam more sustainable and reducing congestion, PostNL has cooperated with the local authorities (via the Amsterdam Smart City) and researchers (TNO, Amsterdam university of applied science HvA and the Vrije Universiteit Amsterdam) to improve the last mile logistics in the city centre using existing infrastructure facilities: in a first phase focusing on the floating depot as a main driver for the concept and in the second cycle on the usage of the e-freight bikes together with shared micro-hubs in the city centre.

The first phase of the Amsterdam implementation action was exclusively focused on the floating depot. The initial idea for the first cycle implementation was the following: the parcels are navigated into the city by a vessel (floating depot) with a mechanism to lift the goods onto the quays. From the quays parcels are transported by clean vehicles to the final destination. Analysis performed during the planning phase has revealed the following barriers to the implementation:

1) It is a challenge to combine the vision of a small company, a large boatbuilding company (Veka) and PostNL,
2) There is a lack of local government support;
3) The distance from the distribution centre to the city-centre is too long for light electric vehicles and it is too expensive to reload for transportation to an inner-city floating depot.

As a result of these barriers the implementation idea was adjusted in the beginning of 2016. The targeted segment to transport with floating depot was moved from parcels to the delivery of fresh goods to dedicated hotels, restaurants and bars in 'de Pijp' area close to the Amsterdam city centre. Analysis performed for the case of the fresh products deliverable, indicated that it was not viable for the following reasons:

1) The time to cover the distance (and speed) to the inner city location would take too much time.
2) A delivery barge requires 2 operators on the boat which cost €135 per hour.
3) The barge had the same loading capacity of a regular truck, but its final cost was much higher (almost twice as high).
4) It was hard to find lead customers who wanted to use to boat service of PostNL from the start.

Overall, it was decided that it was not cost-effective to bring the goods into the city by boat. Based on these evaluations, performed during 2016, at the end of 2016 PostNL decided to look at the other possibilities of using existing infrastructure within the Amsterdam inner-city area.

The second phase of implementations has started with the transformed idea of using disused stores and locations shared with other logistics service providers as micro-hubs for the deliveries with e-bikes. The micro-hubs are located in the city centre of Amsterdam. As price per square metre is very high in Amsterdam city centre, it was decided for the shared use of the micro-hubs. Initial ambition was to replace the vans by 50 to 60 e-freight bikes that will handle around 2000 stops. Post NL needed approximately 7 micro-hub locations in Amsterdam.

The implementation of e-freight bikes was successfully launched in 2017. PostNL noted several lessons learned such as the need for a dedicated navigation tools and securing the bicycles.

The main steps and activities are summarised in Table 7 below.

Table 7. Main steps, activities and time plan of the PostNL implementation.

Main step and activity	When
Implementation design floating depot parcels	October 2015
Redesign of implementation to floating depot for food	May 2016
Stakeholder meeting VU	May 2016
Implementation preparations	Until September 2016

Main step and activity	When
Redesign of implementation to micro-hubs	November 2016
Start of implementation micro-hubs	Q1 2017
Collection of data from initial situation (before data)	Q1 2017
Data collection during implementation period	Q2-Q4 2017
Analysis and validation of collected data	Q4 2017 – Q1 2018

3.4 Effects and consequences

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 deliver 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. The use of vans and electric freight bicycles is combined. About 1300 orders are still handled by vans while the remaining 2200 orders are handled by bikes from the micro-hubs that are supplied by truck.

The most interesting statistic is that bikes are able to be more productive than vans. In terms of orders per hour The speed is fairly the same but bikes do not require limited parking spots. The bike routes are also shorter due to the use of bicycle infrastructure. This saves about 2 kilometer per trip. The hourly rates are lower because lease-prices for bikes are less then for vans. Including the additional costs for the micro-hub delivery by truck it is estimated that the implementation saves approximately 1k Euro per day and 220 kg of CO_2.

Due to time savings during the trip caused by cycling infrastructure and lack of parking issues, bicycles can handle 5% more orders during a trip which saves about 5 trips per day. Over 90 trips per day are now being done by bike which is over 60% of the total. Drivers are satisfied with the additional exercise due to the cycling and experience less stress because congestion and parking issues no longer is affecting them. Also positive reaction from the public are experienced; tourists making pictured and enthusiasm from clients.

3.5 Challenges ahead

There are several challenges ahead, especially when extending to other cities. 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.

3.6 Lessons and generalisation of results

The first lesson was that floating depots do not easily create a valid business case. The development of a complete new technical functionality takes long before it is ready to be used in operations. Another lesson is that using the floating device for delivering food products doubled the costs compared to conventional daily practice. This mainly had to do with the higher operational costs as a result of a longer time needed to make the deliveries and the fact that the capacity of the barge/floating depot was not higher than conventional trucks.

Cooperation between industry, research and local authorities resulted in better understanding of each other's issues, as well as how to utilise each other's strengths. These relations contributed in developing and evaluating the concept. Especially the fact that it was clear to everyone involved why something did not succeed has been helpful when together looking for feasible solutions in a new cycle.

The results of the implementation are very successful and beneficial for both PostNL and the environment. Currently the implementation is being scaled up to other cities in the Netherlands. According to estimations the benefits will become smaller for cities, smaller than Amsterdam, but the overall results remain beneficial.

4 Brussels: Increasing load factors by utilising spare van capacity

4.1 Problem and aim

In recent years Brussels has been one of the most congested cities in Europe. The average time loss compared to free flow traffic is 38% (TomTom, 2016). Consequently, this leads to all kinds of negative effects such as air pollution, time loss, high economic losses for companies, and so on (MDS Transmodal, 2012). Vans and trucks account for one fourth of transport-related CO2 emissions and one third of NOx emissions in the Brussels Capital Region (Lebeau & Macharis, 2014). Despite efforts by the authorities to curb the negative impact, both transport and service-driven companies might be worse off. The extended pedestrian zone leads to increased complexity of delivering in the city centre (Verlinde, Kin, Strale & Macharis, 2016). The Road charging scheme further influences the costs of last mile deliveries (CITYLAB, 2016a). One of the contributors to congestion are the many delivery vehicles that are driving around with a low vehicle fill rate. For diverse reasons, it is not easy to maximize the vehicle fill rates of these vehicles. The focus of this implementation is on two different types of inefficiently organized last mile deliveries. On the one hand, there is a considerable amount of small, independent retailers (around 900 in Brussels). Field research indicates that the majority of these stores in Brussels are supplied by the owners themselves who visit a wholesaler/retailer on own account. Exact numbers are not available for Brussels, but a study in the city of Nijmegen, the Netherlands, indicates that the vehicle fill rate of own account vehicles is less than 25% (Buck Consultants International, 2005). It is estimated that these stores are supplied between three and ten times per week (Dablanc, 2011). Surveys by Procter & Gamble (P&G) within CITYLAB indicate that more than 50% of the storeowners visit the wholesaler at least twice per week. Price, followed by promotions and proximity are the main considerations for choosing a particular wholesaler. Supply is characterized by small quantities, delivered irregularly but frequently. Moreover, such stores often lack a storage room. When a product is not on the shelf, it is out of stock, which leads to continuous inventory replenishment (Blanco & Fransoo, 2013; Kin, Verlinde & Macharis, 2017; Kin, Spoor, Verlinde, Macharis & Van Woensel, 2017; Magalhães, 2010). This leads to an unnecessary pressure on the road network. Another type of inefficiently loaded vehicles, on the other hand, are those of service-driven companies (e.g., cleaning services). These trips are difficult to capture but form a significant part of traffic (Cherrett et al., 2012). Those companies have daily delivery and/or service trips and often need to design-in spare capacity in both their vehicles and the delivery network. Since they are service-driven, these companies need to execute specific delivery tours regardless of being fully loaded. Such companies mostly use vans (Allen et al., 2017).

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 transport capacity considered will be from different service-driven companies already providing a service in Brussels (owners of spare capacity). For these companies, the purpose is to test whether transporting additional goods is financially and operationally feasible. Delivering the stores in this way also shows whether it is more convenient for the storeowners, so trips to wholesalers can be avoided. For Procter & Gamble (P&G), the owner of the implementation, it is an opportunity to re-establish contact with the storeowner, with the aim to increase the visibility of their products, more frequent replenishment and/or higher sales, and to contribute to more sustainable logistics set-ups.

4.2 Description of the solution

The main concept is 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 is thus to reduce or eliminate inefficient storeowner pick-ups, and substitute these by utilizing the spare van capacity of service-driven companies, whereby load factors of these vehicles are increased. The concept is visualised in Figure 6. The vans considered will be from different service providers. The consumer goods will initially only include P&G products. In a later phase, P&G may also look into including other food/non-food products that are relevant for small stores located in city.

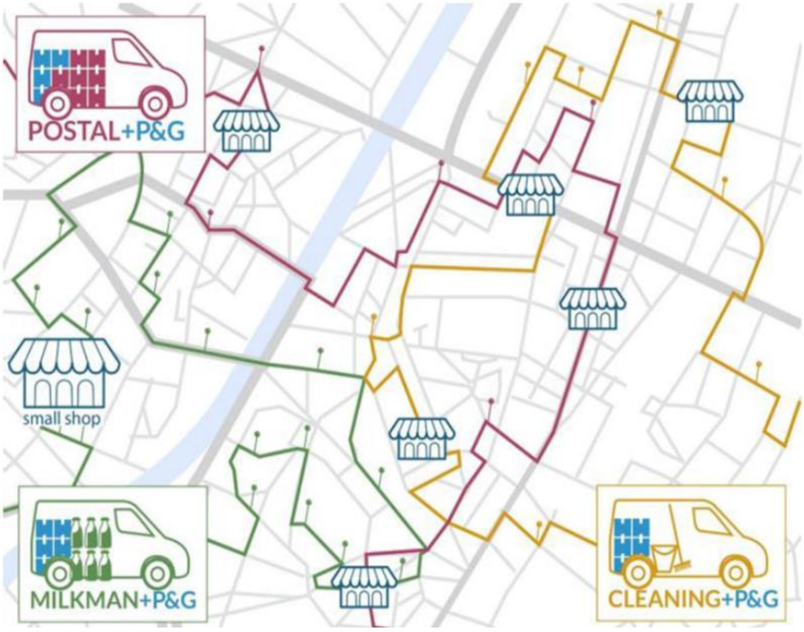

Figure 6. Concept of Procter & Gamble implementation.

The final set-up slightly deviated from the initially planned set-up (elaborated in Deliverable 3.2; CITYLAB, 2016a). This main difference is the involvement of a distributor to manage, store and sell the products (deviations described in the next section). The figure below shows the current set-up with the three flows of the supply chain: physical, financial and information (Mentzer et al., 2001).

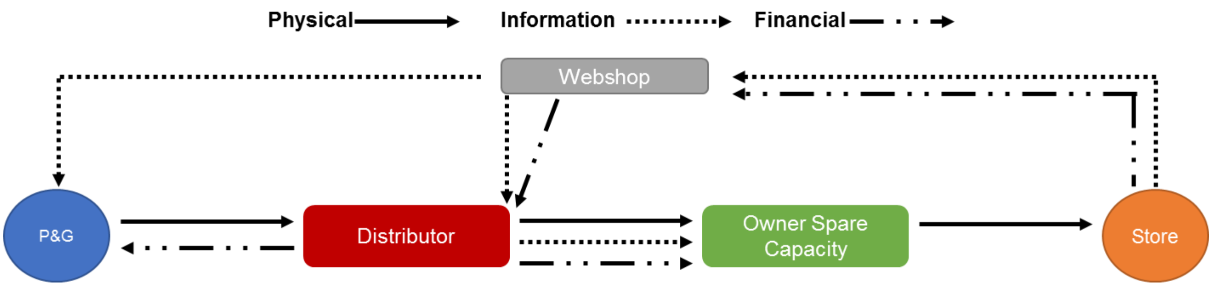

Figure 7. Set-up of the Living Lab implementation in Brussels.

A dedicated assortment of products is offered in the webshop. These products are sold and delivered by P&G to the distributor, after which these are stored. The stores can order the products on the webshop, followed by an online payment. The payment is transferred to the distributor. Order information is available to the distributor and P&G. Hereafter, the distributor informs the owner of spare capacity and delivers the products to the distribution centre of the company. The owner of spare capacity adds the additional delivery to its routing. At the end of the period, the owner of spare capacity charges the distributor in case of additional kilometres.

The aim was to test different set-ups of supplying the targeted 20-30 stores in the Brussels area, meaning that different owners of spare capacity are involved. In practice this means that supply towards the involved stores is taken care of by one service-driven company for a couple of months after which another company takes over. This allows testing different ways of supplying as well as adjusting the supply if necessary. Different forms of spare capacity are available. For instance, Febelco – a distributor of pharmaceutical products– has a dense network and uses vans to deliver to their customers (pharmacies) up to three times per day. This was planned to be followed by Parcify, which is a crowdsource concept. In this case, products are delivered to pick-up points throughout the city after which the very last mile is done by bike or on foot. Another possibility considered was to add the pick-up point to the routing of Febelco. The additional benefit with Parcify is that also nightshops can be delivered after 6pm. Hereafter, bpost or another company was going to take care of the supply. Meanwhile two types of upscaling are explored. First, the living lab implementation will reveal whether involving other manufacturers of consumer goods is viable. Second, upscaling by P&G at other locations is actively promoted. This is relevant because in other countries – particularly in Asia, Africa and Latin America – independent retail is mostly dominant. Although stores are mostly supplied by distributors, deliveries are fragmented with consequent negative effects (Blanco & Fransoo, 2013; Kin et al., 2017; Kin, Spoor et al., 2017).

As of March 2017, a sales representative (CPM/Kreasales) has been introducing the concept to the stores and helping them to place their first order. The storeowners are explained how to order the products online. Febelco subsequently delivers the goods (figure below). When a storeowner places his order, the distributor notifies Febelco that a delivery is coming. The information includes the delivery address, opening hours and the number of cases. The products are transported from the distribution centre of the distributor to the one of Febelco, located in close proximity to Brussels. Febelco adds the store to one of its routes in the Brussels Capital Region; the store is added as a regular stop and the software calculates the optimal routing, including this additional stop. Few stores were willing to order online during the implementation. After several deliveries by Febelco, it was therefore decided not to continue with the other service-driven companies that committed themselves (see Section 4.3).

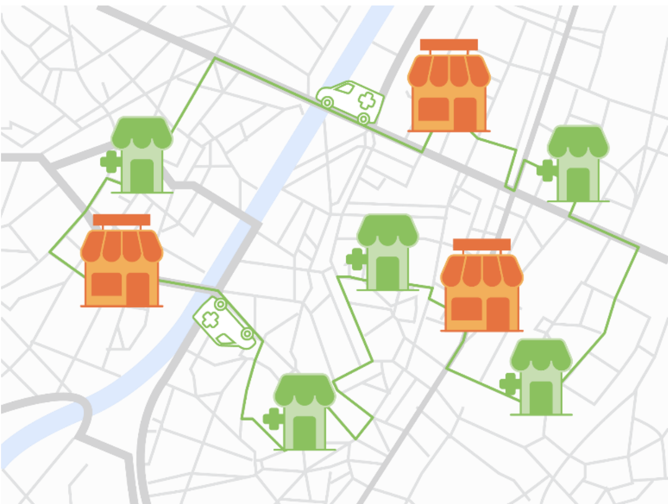

Figure 8. Concept of implementation with Febelco

4.3 Implementation process

The main stakeholders involved are P&G, the owners of spare transportation capacity and the storeowners. No supportive policies by the public sector are involved. Atrium – the Chamber of Commerce of the Brussels-Capital Region – provided an overview of all potential stores in the area. The current implementation deviated from the initial one where it was planned to use the existing 'company shop' platform of P&G, where the storeowners could place their order. The company shop allows P&G employees to order products online and have them delivered at their workplace. However, it was found that this is not possible due to national legislation and administrative reasons within P&G. The legal entity under which the company shop operates is not allowed to set-up a separate business entity to sell products. This necessitated the involvement of external companies:

- A distributor had to be contracted to manage, store and sell the products (Fastlane)
- A company to develop the webshop (ERGS), including a payment module (Ingenico) had to be selected and hired
- Product assortment had to be aligned internally (with the commercial department) and price setting had to be defined by the distributor (based on current pricing in stores)
- Another company that has knowledge of the retail channel had to be hired to go to the stores with a sales representative (CPM/Kreasales).

The change in planning led to a delay of several months in the operational start-up of the project. First, internally within P&G different departments had to be aligned again, particularly the commercial, tax and legal ones. New legal and supply chain set-ups had to be considered, checked for feasibility and aligned. Due to the new set-up, new distribution partners and webshop partners had to be tendered and selected which were not foreseen in the original plan. For the success of the project, selecting the right product assortment and prices is vital. As P&G has in Belgium no direct access and relationship with this channel anymore, it took time to decide the correct product portfolio suitable for this channel. The new set-up required thus considerable extra costs for which approval had to be internally aligned.

Altogether, the planning phase includes involving owners of spare capacity, selection of the product assortment, setting the prices, developing a webshop and involving the stores. Adapting the set-up shows that the Living Lab methodology is applied. The actual execution is set-up in such a way, that the Living Lab methodology is inherently part of it (i.e., involving different companies and allowing to change different parameters).

The products are now purchased by Fastlane and delivered from the P&G DC to the DC of Fastlane. From Fastlane the products go to the DC of the service company with spare capacity, being Febelco. Although it is not expected, time or vehicle capacity constraints might avoid that products are delivered to the stores on the agreed days. Therefore, a 3PL is considered as a back-up option.

In March/April 2017, a sales representative (CPM/Kreasales) visited the stores. During this visit, the concept and website were introduced, and products and prices were shown. If the storeowners were interested to join, the webshop is explained and the first order is placed. Earlier store visits indicated that storeowners are not interested when the prices are not yet set and the webshop is not ready. Following the order placement, products are delivered by Febelco. The supply between P&G and the different owners of spare capacity has been agreed and developed during the planning phase. The supply chain in the implementation is fixed but allows some modifications as described. Products are bought from P&G, and stored and sold by a distributor (Fastlane). Storeowners can order P&G products from a small, but tailored assortment with competitive prices. An invitation to create an online account and order products is done during the visits of the sales representative. During the ordering process, they have to pay online. The order is transferred to Fastlane, who subsequently picks and sends the products to the owner of spare capacity, who takes care of the last mile through his own supply network. Data on orders, sales, delivery addresses, kilometres driven etc. are shared with P&G and the VUB.

In total, five deliveries were conducted by Febelco in April-June 2017. The prices offered by P&G were competitive to the prices at the wholesaler. Nonetheless, few storeowners ordered online. Several storeowners indicated that they do not see the problem of having to go to a wholesaler on own account. At the wholesaler they acquire the products immediately at the time of purchase, which is not the case with online ordering and payment prior to delivery. Consequently it was decided to conduct similar store visits in the city of Antwerp. The main purpose was to collect data to gauge their willingness to participate and to let them place an order. The order would subsequently be delivered by Parcify. However, no orders were placed and the storeowners gave similar reasons for not participating as the ones in Brussels. The five storeowners who ordered online in Brussels, did not place a second order independently (i.e., without the sales representative being there). Based hereupon, P&G decided to terminate the implementation. The storeowners who ordered online, indicated that the prices were low and they liked the solution. However, they did not order a second time because they were not used to it. The impact of online orders on a larger scale and the logistical impact for Febelco has been simulated in different upscaling scenarios (CITYLAB, 2017c). Table 8 summarises the main steps and activities.

Table 8. Main steps and activities Brussels implementation

Main step and activity	When
Preparations: Define new supply chain set-ups, list and contact companies with spare transportation capacity, map small independent retailers in Brussels, store checks regarding product assortment and pricing, first communication and involvement small independent retailers	June 2015 – April 2016
Confirmation Febelco and Parcify to participate	Q2 2016
Internal alignment departments P&G final supply chain set-up, including selection product assortment	June 2015 – Q3 2017
Aligning supply chain set-ups with distributor and owners of spare capacity	Q4 2016 – Q1 2017
Develop webshop	December 2016
Contact storeowners for involvement and place first order (CPM/Kreasales), including (ex-ante) data collection	March/April 2017
Deliveries by Febelco	March – June 2017
Updating dashboards	March – September 2017
Store visits in Antwerp, including attempt to place first order and (ex-ante) data collection (similar results as in Brussels)	Q3 2017
Collection data for the ex-post behavioural analysis	Q3 2017
Evaluate supply chain set-up with P&G and Febelco	Q3 2017
Explore potential upscaling and transferability in this channel (P&G)	Q3/4 2017
Model upscaling scenarios	Q3/4 2017
Local workshop Brussels	Q1 2018

4.4 Effects and consequences

The first effects and consequences are the lessons learned during the planning of the implementation. This particularly relates to the feasibility for the manufacturer (P&G), the involvement of the owners of spare capacity and the motivations of the storeowners to be involved. First of all, a webshop is developed and operational with a product assortment and prices. Several service-driven companies expressed their interest to be involved. A new supply chain set-up to reach the stores in the Belgian context is established. Stores in both Brussels (58) and Antwerp (27) have been approached, which revealed their ordering behaviour and reasons for (not) participating. The use of a sales representative is important to inform and support the storeowners in ordering the first time. Multiple stores have created accounts on the webshop. Five of the stores actually placed an order that has been delivered by Febelco. Table 9 below shows the impact indicators of the deliveries by Febelco compared to business-as-usual (BAU) situation where the storeowners would have picked-up the same shipment at the nearest wholesaler with their own vehicle.

Table 9. Results first 3 deliveries

Impact indicator	Business as usual	Alternative (Febelco)
Air quality (gram) SO_2 NO_2 PM2.5	 0,024 16,15 1,634	 0 0 0
CO_2 (gram)	3895	0
Freight movements	5	5
Freight kilometres	19	0
Fuel consumption (litres)	2,07	0
Replenishment frequency (# SKUs/supply)	14	14
Lead time (days)	0	4

The emissions and fuel consumption are based on the type of vehicle used as elaborated in the STREAM report (Otten et al., 2017). In BAU, the kilometres concern a retour trip from the store to the nearest wholesaler. The kilometres in the implementation are calculated as follows: in the routing of Febelco all stops are indicated, instead of going from pharmacy A to B, a store is added between the two. The kilometres from A to B direct and via the store are calculated. The difference between the two are the extra kilometres driven. For the current deliveries by Febelco, there are no additional kilometres since the five stores were located exactly on-route between the pharmacies. Consequently there are no emissions. All indicators are constantly updated on the dashboards (CITYLAB, 2016b).

4.5 Challenges ahead

The challenges ahead relate to the potential upscaling and transferability of the solution to other locations. Three challenges can be identified in this regard. The first, and most crucial one is the involvement of storeowners. The biggest challenge relates to the willingness to participate. It turned out to be difficult to get the stores involved; i.e., to have them ordering products online. Several storeowners simply do not want to pay for the products prior to delivery. When they go to the wholesaler on own account, they acquire them immediately after the purchase (no lead time). Moreover, going to the wholesaler with their own vehicle is not considered to be a cost. Some others were not able to do so due to a lack of an online bank account or personal digital assistant (PDA) such as a tablet or smartphone. Others prefer to pay in cash. Those who ordered online, did not order a second time. As indicated in the ex-post survey, 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. For researchers, it is complicated to take the time of the storeowners to collect data. This was the case in Brussels and Antwerp during the ex-ante data collection. Another challenge was counting the actual stock keeping units (SKU's) before and after the implementation. This is time-consuming and highly depends on the moment of the counts.

Second, the supply chain set-up is important. This starts with finding appropriate service-driven companies. Finding companies that were willing to participate and could deliver a decent service level was one of the difficulties. Febelco adopted the solution quite easily, but this might change depending on the company, or network of companies. Logistically the solution worked; i.e., no additional vehicle kilometres. For Febelco – as well as any other company – the main challenge is to secure the core business and service towards main customers. The owners of spare capacity receive a compensation for the deliveries. How the compensation is calculated depends on the company involved. With Febelco it is agreed to charge additional kilometres. This is charged to the distributor at the end of the delivery period. Research must furthermore show whether the logistics of handling small volumes is financially viable. In the European context, labour costs are relatively high and orders mostly include large volumes (pallets). Handling, picking and transporting on SKU level might therefore be relatively expensive. Commercially, modern retailers/wholesalers buy big volumes and are able to drive the prices down.

The third challenge is to investigate the feasibility – legally and commercially – of offering products of more manufacturers on such a platform (i.e., horizontal collaboration). This is prerequisite to increase load factors and eliminate storeowner pick-ups at the wholesaler.

4.6 Lessons and generalisation of results

The lessons learned from this implementation are important for potential future upscaling and replication. Moreover, the transferability to other contexts (e.g., other European countries or emerging market economies where this retail channel is dominant), is an interesting avenue to explore. Altogether the lessons relate to the three main stakeholders involved in the solution: the owners of spare transportation capacity, the owners of independent retail outlets and the manufacturers.

1. Owners of spare transportation capacity (service-driven companies)

Based on the implementation, technical feasibility of adopting the solution by a service-driven company seems feasible. P&G and the company agreed on the type and format of data to be shared. The company added the additional stops in its regular routing. At the small scale, the solution was also operationally feasible. However, no conclusions can be drawn on the economic feasibility. Lessons on involving owners of spare transportation capacity can be summarized as follows:

- Finding service-driven companies with spare capacity is not an easy task as they do not offer themselves as such. Contacting the right person within the company is an additional challenge. The company has to be dedicated and willing to participate in an implementation outside its core business. The focus of most consulted companies is not on long-term innovation, even though this project might generate additional revenues in the future. Some are therefore hesitant to join. The decision time to join depends on the strategy and the core business of the company (easiness to fit additional deliveries in their routing).

- The companies that were interested but did eventually not participate, had the following reasons: interesting, but currently no fit; dedicated persons changed positions; potential conflict with operational/commercial requirements (e.g., deliveries to stores might impact service towards customers); interested but insufficient vehicles and/or the network is not dense enough; interested but the company does not fit in the philosophy of the project (i.e., not a service-driven company but a regular parcel provider).
- The companies that committed themselves had the following characteristics and reasons: potential additional revenues in the future (the fee should be sufficient to avoid additional costs for the service-driven company, but it must be lower than using a regular logistics service provider); green image of the company; anticipation on future legislation in urban freight transport (e.g., minimum load factor); drive and enthusiasm to innovate.
- A core characteristic of the company should be a dense network (high number of stops). Otherwise, supplying stores either leads to additional vehicle kilometres (making detours to serve the stores) or long lead times (only serving stores when these are on-route towards regular customers). The latter is important for the manufacturer as it can be expected that long lead times affect the satisfaction of the storeowners (i.e., high level deliveries). An additional condition to minimize the impact of store deliveries could be the use of clean vehicles (EURO norm or zero emission).
- Based on simulations (CITYLAB Deliverable 5.4, 2017; Kin, Ambra, Verlinde & Macharis, n.d.), the main recommendation is to use a network of service-driven companies that can pick-up products from a centrally located DC such as an urban consolidation centre. In this way additional vehicle kilometres and lead time can be limited to a minimum. The service-driven companies can be organized in an online pool, where they can subscribe to pick-up and conduct a delivery.

2. Small, independent retailers

The storeowners mostly adopt 'cherrypicking' when supplying their store, meaning that they try to find the lowest price and go after all promotions in different stores. Most care neither about the brand, nor alternative (innovative) ways of being supplied. Some storeowners do not replenish products when these are out-of-stock but not in promotion at the wholesaler. The implementation had to show whether the pricing and extra delivery service on the webshop can be competitive with this or not. The price was competitive with other suppliers, but this is important to take into account in other locations.

Inviting the stores to participate reveals that the adoption willingness depends on the price of the products, and the willingness and ability to pay and order online. The ability is determined by the availability of a of PDA and online bank account. Most storeowners use cash today. Instead of paying by bank transfer, some preferred to pay cash to the driver of the service-driven company delivering the products. It was decided to be undesirable to let the driver handle cash because it would lead to an additional burden for the service-driven company. Willingness depends on their current behaviour. In most cases, they go to the wholesaler on own account, whereas others are supplied by a distributor. This is found to be convenient and a change in this takes time. Moreover, pick-ups on own account are not considered to be a cost. Finally, lead time is important. When going to the wholesaler, products are acquired immediately and with a distributor, deliveries often take place shortly after the sales whereas payment can be done in cash or on credit. The latter seems to be a matter of trust.

An interesting avenue to explore is to make a distinction between the three flows of the supply chain: physical (goods), financial and information. Depending on the location and the characteristics of the storeowners (e.g., internet penetration) these could potentially be adapted. For instance, if a storeowner is happy with the delivery by a service-driven company, but does not want to order online, sending a sales person – if financially feasible – might be a good adaptation. The same relates to the payment, which can be done online, on credit or cash. In this way, modifications in the ordering and payment behaviour might allow using the spare transportation capacity of service-driven companies on a larger scale.

3. Manufacturer (shipper)

From the perspective of a manufacturer, the solution is a way to (re-)establish direct contact with the storeowner and make sure the products are on the shelf. Compared to the volumes that are usually shipped, the volumes were small and internally this caused an administrative burden. Therefore, it was decided to outsource this to a distributor. This is in line with most shipments from a manufacturer; large shipments to wholesalers, modern retailers and distributors. In case of supplying small, independent retailers, supply takes generally place indirectly through wholesalers or distributors. The implementation, nevertheless, led to important learnings which are also shared within P&G globally. This is important because in a lot of locations the number of fragmented deliveries to such stores is a lot higher.

In addition to the lessons listed above, the final question relates to the impact of fragmented deliveries to small, independent retailers for society and how this can be tackled by utilizing spare transportation capacity of service-driven companies. Assumed that the spare transportation capacity can be utilized, it is first of all important to offer a wider product assortment. This means that products of other manufacturers have to be included as well to eliminate inefficient storeowner pick-ups. This requires collaboration between (non-competitive) manufacturers (i.e., horizontal collaboration).

5 Southampton: Joint procurement and consolidation

5.1 Problem and aim

A fundamental policy objective of the City of Southampton is to improve air quality. Data gathered for the World Health Organisation (2016) indicated that PM_{10} levels in air in Southampton just exceeded the stated safety limit of 20 µg/m³ and NO_2 levels measured alongside ten of the city's busiest roads were also just above the required standard annual mean of 40 µg/m³ (Southampton City Council, 2016). In the national air quality plan for nitrogen dioxide, published in December 2015, the UK Government (2015) stated that they will require Southampton, Birmingham, Derby, Leeds and Nottingham to implement Clean Air Zones. This was followed by publication and consultation, in October 2016, on a draft framework for Clean Air Zones, covering older buses, coaches, taxis and lorries, with the results of the consultation expected to be published soon (DEFRA/DfT, 2016).

Southampton City Council (SCC) has been considering a range of complementary measures to tackle the causes of pollution, including those relating to transport and to freight transport, in particular. Within the CITYLAB project, the aims of the Southampton implementation actions, to support the policy objective, are to both 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 perceived issue is that LMOs are generating too much freight transport through their purchasing of goods and services, exacerbated by, arguably, overly flexible procurement practice (e.g. highly decentralised systems with many different buyers and suppliers and too frequent ordering) and with little consideration of the resulting environmental impact.

From the project outset, the main focus in CITYLAB was on the role large municipal organisations could play in reducing vehicle impacts by investigating the scope for consolidating incoming freight. SCC's approach centred around promoting the use of the 'Southampton Sustainable Distribution Centre' (SSDC) operated in conjunction with Meachers Global Logistics (MGL), and lying outside the proposed Clean Air Zone. For the first part of the CITYLAB project, case studies with the Universities' halls of residence, Southampton General Hospital and the Isle of Wight Hospital Trust were undertaken to quantify the case for consolidation. The planning of the Clean Air Zone (yet to be introduced) has also led to an additional case study being conceived through the Southampton living lab to address the scope to replace some of SCCs in-house vehicle fleet (n=700) over to purely electric operation which would significantly impact on pollutant emissions.

5.2 Description of the solution

In recognition of the fact that there is no one 'solution' to the problem of improving air quality, the Southampton living lab has considered complementary approaches which have been developed over the project life-time and in response to the needs expressed by the partners. The implementation action originally focused on the freight transport generated by LMOs in going about their day-to-day business. This included freight transport associated with vehicles delivering purchased goods or services, and in-house vehicles performing core functions (e.g. for movement of goods internally or within the community). 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 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.

While the concepts themselves are not necessarily innovative per se, the individual application areas are, having been identified as potential solutions to problems encountered by participants in the Southampton living lab:

1) Consolidation centres have traditionally focused on serving smaller, independent retailers to reduce the overall number of freight vehicle movements in urban areas, and the SSDC is already used by private companies (e.g. associated with general deliveries to the Isle of Wight (6-8 trailers per day) and for the cruise liner industry). Of interest is the wider application of the concept to LMOs and, in the case of Southampton, the freight generated by just under 9000 university students living in halls of residence. Also, the scope for reducing freight movements into hospitals, particularly in the area of pharmacy supplies, and the ways in which short-term off-site storage can aid ward-based infrastructure maintenance and refurbishment.

2) Small electric vehicles are now commonplace in both passenger and light freight activity but of interest here is to what extent they can be adopted in larger-scale municipal fleet operations serving local authorities.

The Living Lab approach has been instrumental in initially conceiving these concepts, undertaking evidence-based business cases to evaluate their potential benefits and promoting their wider adoption. Without such championing of the concepts and facilities it is likely that LMOs would remain unaware of the freight transport issues they cause and of the measures they can take to address them.

5.3 Implementation process

In Southampton, implementation actions have arisen through a series of (usually) face-to-face meetings between the CITYLAB partners and key personnel from the large municipal organisations that we are trying to influence to act differently. These meetings have been arranged by the CITYLAB partners, who have acted as the drivers of the living lab approach. The approach extends beyond the CITYLAB implementation actions with, for example, SCC consultation with the UK Freight Transport Association on proposals for a Clean Air Zone. In this respect, the CITYLAB implementation actions form a subset of the city's overall plan for air quality improvement. The living lab approach has been instrumental for:

- Identifying problems/challenges/issues from different stakeholder viewpoints
- Generating ideas and possible solutions to best mitigate those problems
- Agreeing and undertaking scoping studies to look at the feasibility of solutions
- Offering large organisations (both public and private) DSP support
- Implementing actions where scoping studies and research suggest benefits
- Developing a revised Memorandum of Understanding (currently being drafted) related to sustainable freight, intended to provide guidance and obtain support from the major freight generators in the city.

It should be noted that there are no official freight interest groups or bodies in Southampton. CITYLAB partner, MGL, have informal meetings with client companies to discuss freight issues. The Chamber of Commerce is a more formal body linking politicians, businesses and the City Council but has a much broader remit than freight transport.

SCC made a £70,000 subsidy available to support, or kick-start, one or more of the proposed implementation actions, although, in the end, only £15,000 of this was used £15k to cover site upgrades at the SSDC, as required by the audit undertaken as part of the Controlled Drugs License accreditation process. This was for additional camera and security requirements in order to hold pharmaceutical products on site. The investment enabled the SSDC to be suitable for future pharmacy demand.

The policy requirement to improve air quality through the introduction of a Clean Air Zone has been complementary to CITYLAB objectives and, in particular, has led to the consideration of the business case for electrification of some of SCC's in-house vehicle fleet. Research undertaken during CITYLAB has led to the procurement of a number of electric vehicles due to be received by SCC in February 2018.

During the project, various LMOs have been targeted for possible adoption of solutions, with some pilot surveys being undertaken but take-up has been dependent on decisions taken by external stakeholders (i.e. LMOs) and, to date, has been disappointingly low. The main activities and steps of the Southampton implementation action are summarised in Table 10, organised by the different institutions involved.

Table 10. Main steps, activities and time plan of the Action.

Main steps and activities	Time
Isle of Wight NHS Trust	
DSP undertaken for St. Mary's hospital	Apr 2015
Survey of goods coming into hospital depot	May 2016
Planned implementation of consolidation through SSDC	Oct 2016
Decision taken not to proceed due to changes in management at the hospital	March 2017
University Hospital Southampton NHS Foundation Trust	
DSP undertaken for Southampton General hospital	May 2015
Implementation of temporary storage and transportation of automated dispensing cabinets using the SSDC	Oct 2015 – ongoing
MGL application for controlled drugs licence to allow them to hold drugs on behalf of hospital pharmacy	March 2017
Survey of hospital pharmacy undertaken by Transport Systems Catapult (TSC) team under separate funding (at suggestion of CITYLAB team)	Oct 2017
Ongoing analysis of results and their implications on consolidation opportunities by TSC to be revealed at event being co-organised in London on 23rd Feb 2018 by TSC and CITYLAB, with final report expected March 2018. Hospital management awaiting above information before making decision how/if to proceed with consolidation.	Jan-Mar 2018
University of Southampton (UoS) and Southampton Solent University (SSU)	
Study of goods purchasing and resulting freight impact for the UoS	May 2015
Freight audit at four UoS halls of residence	Nov 2015
Draft proposal presented for a consolidated delivery service to SSU	July 2016
Decision taken not to proceed due to issues with managing 'same-day' delivery requests	Nov 2016
Southampton City Council (SCC)	
	Apr 2017

Review of work activity of in-house fleet of 700 vehicles with a view to electric vehicle use.	July 2017
Long-term electric vehicle procurement plan announced by SCC	Autumn 2017
Procurement process put in place which identified preferred supplier and first order of six electric vehicles placed; process delayed by supplier informing that the selected vehicle specification was no longer in production.	Jan 2018
Supplier announces new vehicle specification and SCC place new order for six vehicles. Delivery expected end of Jan 2018.	

Isle of Wight NHS Trust

A DSP was undertaken for St. Mary's Hospital, Newport, Isle of Wight, including a week-long (Mon-Fri) survey of their goods-in depot in April 2015, just before CITYLAB commenced and funded by SCC. Later meetings with the Finance Director and supply chain/procurement personnel (Mar/Apr 2016) led to another week-long survey of incoming deliveries at their depot, pharmacy and catering departments, for the 'business-as-usual' data collection, in May 2016, with results summarised in Table 11.

Table 11. Summary statistics for survey week (Mon-Fri)

		Depot	Pharmacy	Catering	Total
Number of vehicles	Delivery Collection Return Total[1]	88 42 1 125	77 1 1 78	8 12 7 17	173 55 9 220
Goods volume (m^3)	Delivered[2] Collected	72.5 146.9	27.7 -	36.6[3]	118.5[4] 165.2[4]
Number of packages	Delivered[2] Collected	996 1034	720 -	527[3]	1980[4] 1298[4]

[1] Some visits combined delivery, collection or return, hence Total <= D + C + R

[2] Excludes NHS Supply Chain overnight deliveries

[3] Deliveries, collections and returns were not distinguished here

[4] Total assumes that catering value is split 50/50 between deliveries and collections

Based on the substantial numbers of vehicles involved and the potential to reduce these substantially by consolidation at the SSDC, a phased implementation schedule was agreed in principle with MGL, due to start October 2016. However, the Trust subsequently took the decision that the implementation could not proceed due to financial pressures, other priorities, and the belief that the scheme would not be financially sustainable. Contributing factors to this decision included: (i) Lack of support from NHS Supply Chain and other major suppliers (i.e. unwillingness to change operations and/or reduce delivery charges associated with delivering to the SSDC rather than direct to the Isle of Wight); (ii) Trust commitment to reducing their current financial deficit; (iii) insufficient personnel availability (e.g. within the Procurement team).

University Hospital Southampton NHS Foundation Trust

A DSP was undertaken for the hospital, 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. Subsequent meetings with Directors of Procurement and Supply Chain led to a pilot scheme implementation of temporary storage and transportation of around 12 automated dispensing cabinets (Omnicell) using the SSDC (October 2015 - April 2016). After the successful pilot, a further roll-out to the whole hospital commenced in March 2017 with a completion target of Q4 2018. This roll-out includes a significant amount of warehousing space, office space and rework space along with inbound transport services. Parallel with this, planning is currently taking place for the hospital pharmacy to use the SSDC for consolidation of deliveries and for temporary storage during 2018; Meacher's have applied for a controlled drugs licence to enable this. Longer-term there are ongoing discussions about moving the Outpatients Pharmacy to the SSDC and for outsourcing the majority of their consumable goods through the SSDC.

Conclusion – good example of living lab approach (regular meetings between Meachers and hospital supply chain manager) leading to actual use of consolidation centre for storage of Omnicell cabinets and future planned use by pharmacy; however, it is unlikely that either application will provide data in time for CITYLAB evaluation purposes.

University of Southampton (UoS) and Southampton Solent University (SSU)

The research commenced with a study of goods purchasing and resulting freight impact for the UoS (McLeod et al, 2016). Dialogue between CITYLAB partners and university-based stakeholders identified student halls of residence as an area of concern that could be suitable for out-of-town consolidation. This led to a week-long freight audit at four UoS halls and a student online purchasing survey (486 respondents) in November 2015 (Cherrett et al, 2017).

Through the Living Lab, meetings with SSU Halls of Residence managers yielded goods receipting data that were used to form a draft proposal for a consolidated delivery service to SSU, including estimated costs of approximately £18 per student per year. Follow up discussions with SSU managers indicated that, at the present time, they were not prepared to go ahead with implementation due to concerns with same-day delivery provision via the SSDC and a lack of budget to fund such an initiative, despite SSC subsidy and potentially substantial time savings for university staff (Cherrett et al, 2017). Our dissemination activities have led to external interest from Manchester (UK), Dublin (Ireland) and Texas (USA), with similar surveys being used to estimate impacts of student e-commerce and with the University of Salford trialling consolidated deliveries to halls. **Conclusion:** Neither university will implement within the project timescale.

Southampton City Council (SCC)

After a review of the work activity of SCC's in-house fleet of 700 vehicles (undertaken by the University of Southampton on their behalf, in April 2017), SCC announced their long-term commitment to replacing their diesel and unleaded vehicle fleet with electric vehicles across all services, where practical. After a lengthy procurement process, delayed by the preferred vehicle specification going out of production, the first six vans are due to arrive at the end of January 2018, and are planned to be used by the parking enforcement team.

The review of vehicle work activity involved obtaining historic collection/delivery records and fitting GPS tracker units to samples of vehicles to quantify activity and establish benchmark performance criteria to compare against various electric vehicle options. Specific fleets considered were those working in parking, housing operations, animal welfare, courier services, libraries and waste management, all suitable for electric vehicle use as daily distances travelled were relatively low (e.g. significantly less than an electric van range of 60 miles). An assessment of charging infrastructure needs is also being undertaken and SCC's objective is to develop a solid business case for wider electric vehicle adoption, not only for themselves but for other businesses with vehicle fleets.

Once the electric vehicles arrive (scheduled for February 2018) it is planned to obtain operational data from them to assess the benefits.

5.4 Effects and consequences

Due to the lack of any significant take-up of consolidation, to date, by the LMOs, the effects and consequences reported here are based on measured 'before' data but **estimated '**after' data, based on stated assumptions about anticipated effects once implementation takes place.

Isle of Wight NHS Trust

Extrapolating the measured survey results for the 'business as usual' or 'before' case indicated that the combined delivery/collection vehicle visits made to the St. Mary's hospital depot, pharmacy or catering unit totalled around 11,440 per year, moving an estimated 170,500 items with a volume of around 14,750m^3. For the **estimated** after case, it was considered 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. A relatively small cost of consolidation of £4,252 per annum was estimated based on consolidation warehousing costs being partially offset by income being generated through increased space availability at the hospital due to reduced goods-in facilities being needed.

Total delivery costs would likely increase due to consolidation as the introduction of costs charged by MGL for the consolidation service may not be offset by any reduced delivery costs charged by 3PLs in delivering to the SSDC rather than to the Isle of Wight (involving a one-hour ferry crossing in each direction of travel). As existing delivery charges are integrated within product prices we could not estimate the price difference (i.e. increased cost) with any confidence. The Trust's initial attempts to negotiate reduced prices with suppliers have not been fruitful to date and this extra cost has acted as a significant barrier to implementation.

University of Southampton and Southampton Solent University halls of residence

Goods-in surveys at four University of Southampton halls with a total of 5,050 students took place over 6 days (9am to 5pm), immediately following the 2015 Black Friday sales event date (27/11/15). These surveys were restricted to deliveries of parcels and excluded deliveries of groceries and take-away food, which are perishable and thus would not be suitable for consolidation. A total of 3,504 parcels were delivered in 275 visits (average 12.7 parcels/visit) across the four halls and the biggest hall (1,900 students) received between 14 and 18 visits each day. Extrapolating these results to consider both universities in Southampton (14 halls with 8,886 students) and seasonal trends observed in annual goods receipting data obtained from Southampton Solent University, it was estimated that around 128,000 packages per year (= 14 per student per year) are delivered with an estimated total volume of 4,194m^3. The cost of providing a consolidated delivery service to both universities was estimated by MGL to be around or £160,000 or around £18 per student per year.

A significant benefit would be an estimated time savings of two hours per day for the hall receptionist in moving from having to deal with multiple couriers arriving throughout the day to a system having a single receipted and pre-sorted delivery from MGL. This time savings was estimated by a hall manager and derived from the daily time spent dealing with couriers (60 mins), logging parcels into the system (100 mins), liaising with students to handover items (30 mins) and retrieving items from neighbouring halls where a reception desk had been unattended when the courier arrived (20 mins). The usefulness of the time savings would depend on whether that time could be used effectively elsewhere or whether staffing hours could be reduced.

It was estimated that consolidation could have the potential to reduce the total number of delivery visits to halls 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). This was based on an assumption that urgent, timed deliveries would have to be excluded from consolidation as the student may have paid a premium to receive the item before a certain time and, from a legal perspective, it may not be feasible to restrict such requests.

A further benefit is anticipated associated with the amount of time required by couriers to deliver to the SSDC rather than to 14 halls of residence; however, it is difficult to estimate this with any confidence without detailed knowledge of their delivery volumes across the whole of the city and surrounding areas, so this estimate has not been made.

5.5 Challenges ahead

The key challenges that have been and are being experienced in realising tangible outcomes from the implementation actions are:

- i) 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.
- ii) The ability and willingness of local authorities to implement policy measures to positively drive forward sustainable logistics practice.
- iii) The current climate in local government where reduced funds from central government, coupled to the increasing financial burden from providing local services, combine to put additional pressures on a dwindling staff resource. The turnover of local authority officers is such that maintaining buy-in to proposed schemes and concepts which require long-term commitment is detrimental to realising longer-term sustainable freight policies.
- iv) Turnover of staff in industry means that commercial buy-in to such sustainable policies can also be difficult as evidenced by the IoW case study.

5.6 Lessons and generalisation of results

A number of lessons have been learned from the living lab process and the implementation actions:

1) A good understanding of all existing contractual commitments between the LMO and suppliers that might be affected by any proposed changes is needed
2) A robust contractual commitment is needed between the LMO and the operator of a consolidation centre to facilitate satisfactory progress on both sides
3) A highly flexible and non-prescriptive approach is required from the operator of a consolidation centre to suit individual customer needs
4) Managers in LMOs need to be convinced that the tangible benefits will outweigh the costs before any changes can take place
5) A dedicated consolidation centre may not be able to 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 readily adapt to changing volumes and initial slow take-up.

Although take-up to date has been rather slow, 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. Ultimately, decisions whether to implement changes or not will be taken outside the control of the CITYLAB project and the living lab. In the meantime, the living lab members will continue to communicate with the LMOs for support and further promotion of the concept. Once one LMO takes the initial leap, it is expected that others will follow. Dissemination of information to hospitals outside the Southampton area will occur through various NHS Trust networking groups.

6 Oslo: Common logistics functions for shopping centres

6.1 Problem and aim

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. The Oslo implementation, Økern shopping centre, is located in Hovinbyen - a part of Oslo were 27 000 new residences will be built and the Municipality of Oslo estimates that 100 000 inhabitants will live there in 2030 (Løken, 2015). The planned shopping centre is shown in Figure 10.

Figure 10. Illustration of the planned shopping centre.

Norway, is in Europe, among the countries with the highest concentration of retail trade located in shopping centres, representing around 31% of retail trade (Stugu, 2015). Despite large volumes being delivered to these multi-tenant facilities, the in-house deliveries to individual tenants are accomplished by the drivers of the delivery vehicles or the goods are collected by shop employees at the unloading ramp, as there is no service function for dealing with in-house distribution activities. When the drivers are delivering goods to the tenants the vehicles will occupy the unloading docks until delivery is completed. This can result in long dwell times and vehicle queuing in the freight receipt area, which contributes to inefficient use of space and delivery vehicles, increased use of fuel, as well as noise disturbance, traffic congestion, and driver stress levels (Browne et al., 2016).

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.

Very few Norwegian shopping centres have common logistics functions, and shopping centres are normally perceived as “difficult” locations to handle. Today facilitation of freight deliveries is considered late in the planning process of real estate developments, and has low priority. To improve the efficiency of freight deliveries, the Oslo implementation supports planning, e.g. regulatory, technical, design, organisation and financing challenges, when constructing shopping centre infrastructure for common logistics functions. One main innovation of the Oslo implementation is thus to engage stakeholders in the planning process of designing the common logistics functions in a way that fits the need of all stakeholders. CITYLAB provide insights to the importance of planning adapted to infrastructure needs, organisation and offer of logistic services needed to operate internal freight flows and deliveries in an efficient manner.

In recognising the complexity of common logistics solutions, the overall issues being addressed in the CITYLAB Oslo implementation are:

A. How to organise the planning process and design of the new shopping centre to make logistics more efficient and adapted to stakeholder needs? – see section 6.3
B. What are the perceived effects of implemented common logistic functions in ongoing tests and operations in other shopping centres? – see section 6.4
    - How should common logistics functions be financed? Costs and benefits are dispersed on several stakeholders?
C. What are the conditions for further uptake of common logistics functions in the Steen & Strøm group and other shopping centres?[1]

6.2 Description of the in house delivery solution

Steen & Strøm has for a long time planned to demolish and rebuild their shopping centre at Økern in Oslo combining shops and restaurants with offices, cinema, hotel, and a waterpark. In the commercial shopping centre (51 500 m2), it is planned for 155 tenants, generating significant freight flows. When the CITYLAB proposal was submitted, the expected opening of the shopping centre was planned to be end 2017/early 2018. Since then, the planning and construction of the centre has been delayed, however the main role of the project, acting as a Living Lab, contributing to the design of efficient in-house logistics services and common logistics functions, has been strengthened.

The implementation builds on experiences from FP7 project STRAIGHTSOL where Steen & Strøm, on a small scale, tested common logistics in an existing shopping centre in Oslo. In this pilot DB Schenker Norway registered that their drivers reduced delivery times by 4-14 minutes per pallet when delivering to a shopping centre with common logistic functions compared to delivering directly to the shop (Torekoven J A, 2016). The conclusions supported the need to go from a short-term pilot to permanent real-life implementations in shopping centres to further increase the delivery efficiency, in which CITYLAB contributes by optimising the offered services and logistics solutions by adapting infrastructure needed for the new in-house delivery solution. Rather than being a short-term pilot the logistics functions are developed to be permanently full-scale implemented in the new Økern shopping centre. The opening of the centre is expected to take place in 2022.

The basic concept of common logistics functions is that the in-house movements of freight from the freight reception area to individual tenants is decupled from the driver and vehicle. This is done by having a dedicated company responsible for receipt of all deliveries to the centre. This company has dedicated staff ensuring the in-house movement of goods, return logistics and waste. The company is also offering temporary storage for tenants. In Figure 11

[1] The upscaling issue will be dealt with in the transferability analysis in task 5.6 and WP 6.

we compare the delivery situations in the traditional setting with common logistics functions with a situation where the in-house delivery of goods is taken over by a dedicated service function and company. This will release time for both the vehicle and driver, and will in addition reduce the need for unloading docksdue to the reduced vehicle occupancy of unloading docks.

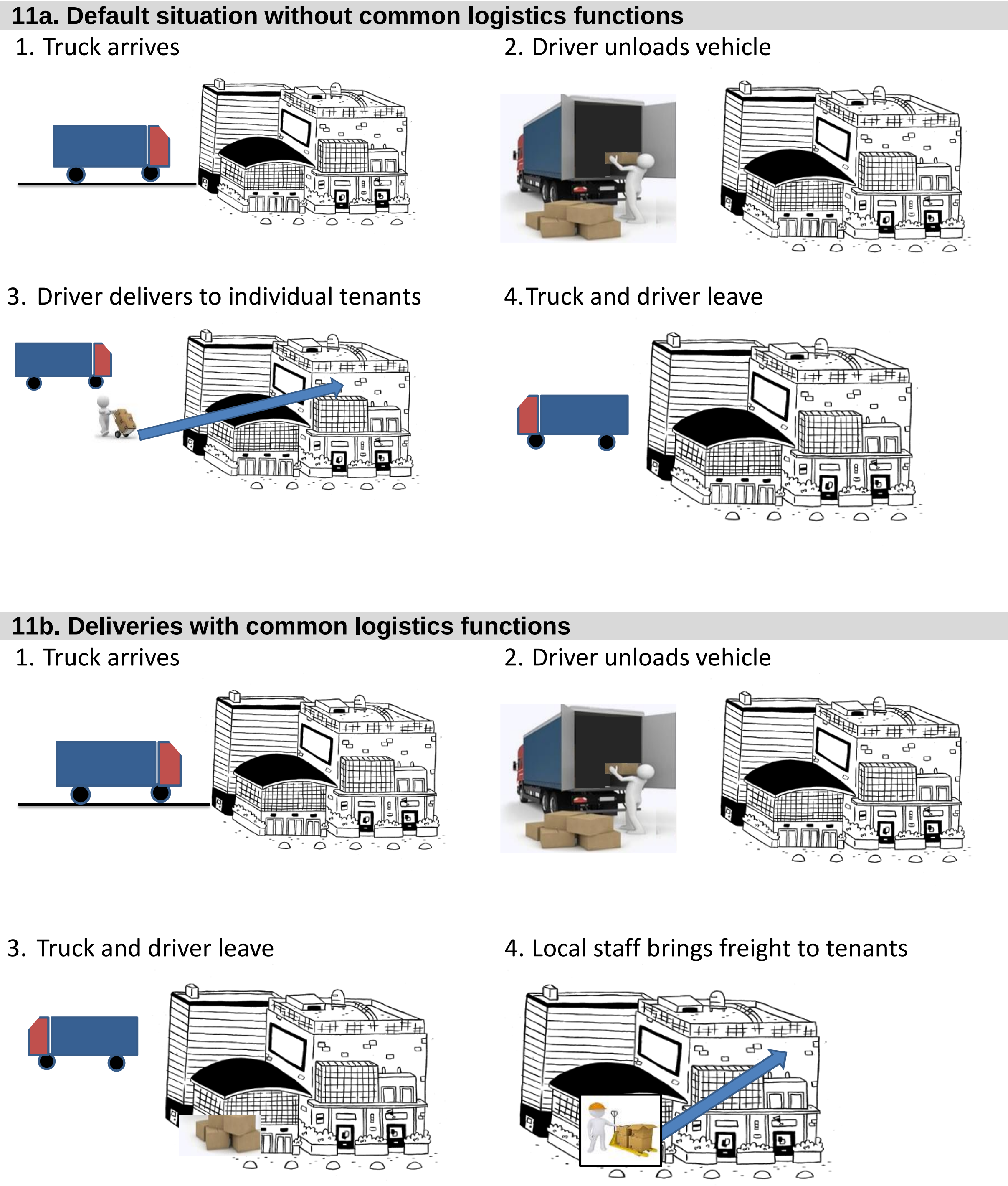

Figure 11. Illustration of common logistics functions.

In addition to improved efficient deliveries it is expected that common in-house services will contribute to more coordinated reverse logistics and waste management, as well as reduced damage on the buildings. Moreover, shorter dwell times facilitates replanning of routes and more efficient use of vehicles, and reduces the need for unloading docks significantly.. The concept of common logistic functions in the Oslo implementation will also assess the opportunities for providing additional services, such as pricing, unpacking, short time storage, reverse logistics, pick up points for e-commerce and waste collection, such services not fully available at shopping centres today.

6.3 Implementation process

This section report the planning experiences **(A) affecting the design and organisation of the Økern common logistics functions.** The most critical phase for ensuring the solution is the planning process, where the CITYLAB Oslo implementation actively contributes.

In the implementation, several iterations of planning, discussions and changing design of common logistics functions accomplished within the Living Lab planning. E.g., the shopping centre owner has, in cooperation with the largest shops (grocery stores) planned dedicated infrastructure for their deliveries. This means that common in-house logistic services are adapted to the rest of the shops in the shopping centre. The work done aims to secure the best possible design of the logistics functions, capturing the interest of all stakeholders concerned and ensuring that this function is built in such a way that it is fully functional and can accommodate the diversity of deliveries, goods and people present at the shopping centre. Specific activities are listed in Table 12.

Knowledge generated from dedicated CITYLAB on-site inspections at shopping centres with different solution for in-house logistics, CITYLAB workshops with stakeholders affected by common logistics functions, bilateral stakeholder interviews and surveys have contributed to the design, organisation and scope of the planned solution at Økern. Examples of solutions already being adapted by Steen & Strøm due to CITYLAB include an extension of planned storage capacity with 3000 m^2 close to the unloading bays, addressing concerns expressed by logistics service providers. Dedicated facilities for common logistic functions and planned infrastructure serving return logistics, e-commerce and waste management is planned for.. Other services discovered from CITYLAB learning is dedicated and individually adapted to-shop infrastructure and adapted design of goods receipt at the loading- and unloading bays to the trucks and vans serving the shopping centre.

This part of the work also utilises findings and experiences from the shopping centres inspected are used to assess effects. Conditions at the different shopping centres affects the setup and execution of the common logistics function. In addition, the various stakeholders have opposing interests and needs and thus perceive the added value differently.

The need to find solutions across multiple stakeholders makes this implementation appropriate for being supported by the CITYLAB's Living Lab approach. The CITYLAB implementation also contributes to the overall Living Lab environment in the City of Oslo and their aim of working closely with citizens, businesses, knowledge institutions, and other public authorities to develop and implement good climate solutions as emphasised in their Climate and Energy Strategy (Oslo kommune, 2016).

The drawings for the centre are now submitted to Oslo Municipality for approval. Although, the drawings are submitted it is still possible to adjust the solutions for internal logistics due to the flexibility of these areas. This means that there is a risk that priorities could be changed and that no common logistics functions will be established. If that should be the case, CITYLAB will identify and communicate the barriers or reasons that caused such an outcome. Agreement must also be reached with key stakeholders, some of which have a significant market power. CITYLAB contributes to identifying the needs of the stakeholders, and to evaluate how solutions that can be acceptable for all stakeholders.

Table 12. Completed and planned activities.

Activity	When
Site visits from Steen & Strøm and TOI to the shopping centres Emporia (Malmö, Sweden), Oslo City (Oslo, Norway) and Strømmen Storsenter (Oslo Area, Norway).	December 2015, May 2016, November 2016
Regular contact and meetings between the real-estate developer and TOI providing knowledge, contacts and information.	May 2015 - December 2016
Workshops with involvement of all relevant stakeholder groups - Steen & Strøm, the city of Oslo, logistics service providers, retail chains, ColliCare Instore and TOI discussed the plans for common logistics functions at Økern.	May 2016,
Data collection and in-depth analysis of solutions at Strømmen Storsenter (Oslo Area, Norway).	January -April 2017
Interviews of shippers and logistics service providers who are responsible for the deliveries to shopping centres.	January - April 2017
Data collection and in-depth analysis of solutions at Oslo City (Oslo, Norway)	January - April 2017
Data collection and in-depth analysis of solutions at Emporia (Malmö, Sweden)	April 2017
Monitor and evaluate a pilot with compulsory common logistics functions at Strømmen shopping centre starting April 2017.	April 2017 - >
Further assessment of the stakeholder cooperation process and the Living Lab way of working. Data for this analysis will be collected through participation in the process and in-depth interviews with the relevant stakeholders.	May 2015 – January 2018
Workshop with involvement of all relevant stakeholder groups at Emporia, Malmö.	June 2017
Collaboration with other municipalities to transfer the solution to other shopping centres in Norway	Q3 2017
Liaise with the NOVELOG project, who have conducted studies of the Nordstan shopping centre in Gothenburg.	Q3 2017
MAMCA workshop with stakeholders involved in Strømmen storsenter	Q3 2017
Interview with shops at Strømmen storsenter	Q3 2017
Interviews with in-house service provider at Strømmen, ColliCare	Q1 2018

6.4 Effects and consequences

This section reports the experienced transport, environmental and economic **effects (B) from other shopping centres.**

There is no traditional before-after comparison to describe the effects of the in-house logistic solution at Økern shopping centre itself. However, to increase the evidence beyond what was found in the STRAIGHTSOL project (STRAIGHTSOL, 2014), additional data are collected from shopping centres having some kind of solution comparable to what is planned in the new shopping centre at Økern. These centres are:

- **Strømmen** shopping centre in the outskirts of Oslo. This centre has a staffed goods receipt with voluntary use. Tenants have to pay to have goods delivered to them, otherwise they have to pick it up themselves. Therefore, most tenants have avoided the common logistics functions and rather had the goods delivered to them by the drivers. As of April 2017, the centre manager introduced a new regime trying to make the common logistics functions compulsory.

- **Oslo city,** centrally located in Oslo, owned by Steen & Strøm. This centre has a staffed goods receipt, but the tenants have to bring the goods from the receipt to their stores. Moreover, only the smallest trucks may enter the goods receipt area, as the dimensions of freight vehicles was not properly considered when the centre was designed.
- **Emporia** shopping centre in Malmö, Sweden, owned by Steen & Strøm. This centre has common logistics functions in operation, with a dedicated operator bringing deliveries to the individual tenants. The service is compulsory for most tenants[2] and mainly covered by the rent. Cost are registered for each delivery and invoiced as part of the tentants' rent.

The data collection from these centres forms most of the basis for the assessment of effects. A more specific before-after comparison is done for the solution being implemented at Strømmen shopping centre from April 2017. Data collection for this comparison is ongoing, and will be included in an updated version of the deliverable.

6.4.1 Operations and transport

Freight deliveries to shopping centres can be a time-consuming activity to the logistics service providers. It includes activities such as unloading of goods, sorting of goods at the freight receipt area, in -house distribution to one or several stores, return transportation of goods and/or waste. One of the main intentions of introducing common logistics functions is to save time used on these activities.

Table 13 presents observations that have been collected from **Strømmen shopping centre**, and shows the time used by truck drivers to deliver pallets from the vehicle to shops in the centre when no common logistics functions are used.

Table 13. Time spent on freight delivery activities without common logistics functions.

Number of pallets	Total time (minutes)	Number of stores
2	35	1
1	35	2
1	30	2
1	20	1
1	18	1
1	15	1
2	15	1
1	15	1
2	13	1

Table 13 shows that it takes up to 30 minutes for a driver to deliver one pallet when no common logistics functions are used. Time spent for drivers on in-house deliveries increases with the

[2] Two large grocery stores are exempted, and these have dedicated unloading docks and freight receipt.

number of pallets and/or stores, depending on the distance to the store from the unloading docks and how many trips to and from the freight receipt area that are necessary.

It was observed that logistics service providers delivering freight to multiple stores at the shopping centre can be parked at the freight receipt area for several hours while performing the in-house transportation. According to staff at different freight receipt areas this might lead to queuing and waiting for other carriers to enter, especially in peak periods. Representatives from the logistics service provider sector believe there is a potential for better utilisation of both driver and vehicle by delivering to a staffed freight reception area.

To show the difference with common logistics functions, the organisation of deliveries to **Emporia shopping centre** has been mapped. When the drivers arrive at the freight receipt area they are met with an information screen as shown in Figure 12 below. Vacant loading docks are displayed as green and the driver can plan where to park before entering the freight receipt area. The goods receipt area contains 20 loading docks in total. However, due to the efficiency of the common logistics functions, there is residual loading dock capacity. Some are reserved for grocery stores and permanent containers for waste handling. Only 6 loading docks are needed by drivers delivering to the common logistics function.

Figure 12. Information sign showing vacant loading docks.

From observations and conversations with drivers and common logistics function employees it can be concluded that it takes on average 2 minutes for the drivers to unload and deliver 1 pallet to the common logistics function buffer storage. It takes on average 15-16 minutes to deliver one pallet to one store depending on its location at the mall. Such a solution can therefore be said to generate a great amount of time savings for drivers, especially the ones delivering multiple pallets.

After registration and delivery of the goods to the in-house logistic service provider the driver's job is complete. The goods are placed in the goods receipt area as shown in Figure 13. Most of the goods are transported to the stores shortly after registration. The common logistics function prefers to have all the goods transported to the stores within 4pm. Stores have the possibility to agree upon a specific delivery time, but most stores want the goods delivered right away. A message is send to the store employees mobile phones when the goods have arrived and are ready to be transported to the store. Most of the goods are transported through hallways inside the mall out of sight to the shopping customers.

Figure 13. The freight receipt area at Emporia.

There are 12 employees at the freight receipt in which two handle waste, two are in charge of the registration and scanning of goods and the rest perform deliveries to the stores.

6.4.2 Energy use and emissions

The common logistics functions take place within the shopping centres, but the changes may still have some effects on energy use and emissions. Three dimensions are relevant:

1. For the logistics service providers who obtain the largest time savings, e.g. the ones with several pallets to deliver during one visit to a centre, the time savings are so substantial that they may be able to replan their routes and use a lower number of vehicles to serve the same number of clients within a day. It is however difficult to calculate the direct effects of it on the margin for just one centre.
2. A key concern in Oslo and many other cities is the air quality, in particular caused by high NO_x emissions in cold weather. Heavy vehicles contribute significantly to these emissions, and it is known that a high proportion of the emissions take place before the engines are warm. There has been limited documentation available on the exact measures, but in the most recent vehicle testing (Hagman, 2016), distinction is made between operations with cold and warm engine. For buses, the average NO_x emissions during the “Braunschweig cycle” were four times as high with cold start than with warm start of the engine. If logistics service providers are able to reduce the stoppage time by several hours (and assuming they turn the engine off while parked[3]), local emissions will be reduced, but it is very difficult to calculate the exact contribution.
3. Introducing common logistics functions is one step towards other measures reducing emissions, such as off hour deliveries and the possibility to consolidate shipments destined for the centre externally.

6.4.3 Costs, financing and liability

At the **Strømmen shopping centre** with 200 shops and HORECA activities a common logistics function is established, but shopping centre management face challenges in getting

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

stores on board with the solution. Strømmen shopping centre did not have a common logistics function in place prior to the opening of the shopping centre. Therefore, the contracts with the tenants do not demand mandatory use of the in-house logistics services. The costs seem to be a major obstacle for further up-take of the solution both for store employees and LSPs. For these reasons a trial period was initiated in April 2017 by the shopping centre management, offering the services for free for a time period of 6 months, until end of December. During this period all deliveries to the shopping centre was obliged to go through the common logistics functions and drivers were not allowed to deliver directly to the stores. The purpose of the trial was to have the stores experience the functionality and benefits of the solution in order to convince them of the added value creation.

During the trial period the expenses has been covered by the management of Strømmen shopping centre and not the users of the service. The operator of the common logistics function, ColliCare, pay rent on the areas covered by the freight receipt and buffer storage, but other than that the expenses are not shared among the different actors. This is however not seen as a permanent solution. Towards the end of the trial period, the shopping centre management decided upon a fixed monthly price that would cover all the main activities offered by the common logistics function such as receipt and registration of goods, short term storage, delivery to store and collection of waste. The price was equal to all the stores that chose to make use of the offer (NOK1000 per month equal to € 105 per month) regardless of size of the store and number of deliverie. It was anticipated that this price would cover the costs currently paid by the shopping centre management. Conversations with store employees during the trial period revealed an overall positive attitude towards the concept. Nevertheless, there was uncertainty among store employees about whether it was worth paying for this service.

It was at the same time concluded by the shopping centre mangement, after several conversations with many of the major LSPs, that it was not possible to obtain contributions from the LSPs delivering to the shopping centre. From earlier interviews with some of these actors we learned that there is a trade-off between the costs of having the drivers performing deliveries at the shopping centre and the potential revenue loss of not performing the last mile delivery to the customer themselves. However, one of the main reasons for the resistance to paying for this service is that the responsibility for the goods are transferred to a competitor. The company performing the in-house services is also a compiting distribution company. This rises an important liability issue and the question of who is responsible for the goods if it turns out the goods are damaged when delivered to a store. A representative from the common logistics function operator at Strømmen shopping centre acknowledge this to be an important matter to consider. Therefore, in cases of damaged goods the store employee is contacted and have to approve the damaged item before the driver can leave the freight receipt. This is a matter between the LSP and the final customer, and the common logistics function employees therefore do not register and take over responsibility for a damaged item without approval from end customer.

Learnings from the trial period and other shopping centres showed that in order to achieve the economies of scale associated with a great number of stores participating, there have to be stricter requirements from the shopping centre management. It was therefore decided that the ban of individual deliveries to the stores at the shopping centre were to continue also after the end of the trial period. Meaning that stores choosing not to use the service had to pick up their goods themselves at the freight receipt. An admission card was required to enter the center and use the lifts. Those who were allowed to deliver goods at the center were given permission to borrow an admission card, for instance suppliers of frozen goods.

A status update from a representative from the common logistics function at Strømmen shopping centre showed that the number of stores that by mid-January 2018 had dedicated themselves to the offered solution were 100 (out of 200 stores). Meaning that 100 stores have signed contracts agreeing to use the solution on a fixed basis and paying a fixed monthly price. The work of engaging more stores to the solution continues in cooperation with the shopping centre management. The trial project has shown to be an important and useful measure to increase the interest in the offer amongst the stores.

Table 14. Services handled by in-house service provider.

Services handled by in-house service provider	Increase in services handled 2016 2017
Number of items handled	+250 %
Number of pallets handled	+120 %
Number of employees per working day	+200 %
Number of deliveries from driver to buffer storage	+350 %
Number of delivery trips in the shoppincentre are 50-60 per day	

Emporia shopping centre use a common logistics function company spesialised in in-house logistics, which is not involved in the same industry as the LSPs. Shopping centre mangement at Emporia believe this to be an important factor explaining why they have not met the same resistance from the LSPs as Strømmen shopping centre. At Emporia all deliveries (except from the deliveries to two grocery stores) are done to the in-house logistics service provider (Logistikbolaget AB). Unlike Strømmen shopping centre this is not optional at Emporia and it has been part of the agreements with the stores from the beginning. Regardless of what is stated in the contract between the store and the LSPs it is not allowed for a driver to deliver directly to a store.

Interviews with representatives of Logistikbolaget in Emporia shopping centre emphasise that the main cost of the services connected to in-house logistics is personnel costs. Their business model build on a concept with fixed and variable costs. Meaning that, in addition to a fixed cost the stores pay a variable cost based on the time it takes to transport the goods from the common logistics function to the store. For all deliveries and waste management to and from a store; time spent will be registered. At the end of the month time spent will be summarized for each store in the shopping centre. The fixed costs are covering costs connected to services like: Rent of goods receipt, rent of buffer storage, scanners, pallet jacks, roll containers, registration devices used by the personnel.

Based on this business model and data gathered during interviews, surveys and registration, we have made estimations on average costs per delivery. The calculations are based on the following assumptions:

Fixed costs:

- Buffer storage of 400 m2
- 200 shops to be serviced
- One delivery per shop/day. Approximately 350 deliveries a year.
- 4 scanners
- 5 pallet jacks
- 5 roll containers

Variable costs:

- Wages for personnel, 4 man-years

Based on this assumption the average costs for in house deliveries is calculated to be € 5.15 (NOK 48.10) per delivery and € 1803.64 (NOK 16 828) per shop per year. More deliveries per year and the same number of staff will reduce the costs per delivery. If the service could be done by less personnel, the costs per delivery will also decrease.

Waste collection and waste management is also organised by the in-house logistics service provider. As an example Logistikbolaget AB also do the waste collection at Emporia. Every afternoon, employees from Logistikbolaget AB visit all shops to collect their waste. Logistikbolaget AB sort the waste into 23 different fragments. When the waste is collected it is the property of Logistikbolaget AB and can be sold in the market.

The cardboard and plastic is compressed before transported from the shopping centre. To serve the shopping centre there is a need for three compressing machines. After Logistikbolaget took over the waste handling and started using compressing machines the waste transport was reduced. Instead of 5.25 trips with 800 kg of waste, each transport consisted of 4 200 kg, a reduction in number of trips by 81 %.

Experiences from the two shopping centres show that to accomplish a full-scale solution it is important for all stakeholders to decide upon and agree on the financial and operational aspects in advance, and not after establishing a common logistics function. It is therefore advantageous for Økern shopping centre to have these matters discussed and agreed upon prior to the opening of the shopping centre.

6.4.4 Value creation

Experiences from the trial period at **Strømmen shopping centre** and conversations with store employees showed that the common logistics function service entailed great value creation potential to the stores. It was consensus amongst many stores that it was preferable to have the goods delivered to the store at an agreed time. This improved the control of deliveries and the opportunity to execute a more appropriate staffing, which in turn could be cost-saving to the store.

From conversations with LSPs delivering to the common logistics function during the trial period it was clear that they supported the concept, but not the financial proposition and the operator of the concept. However, the services also entailed value creation possibilities for the LSPs. Many of the stores previously demanded the goods to be delivered within specific slot-times or time windows during the day, which put a strain on the driver in planning a cost efficient route. More flexibility and an increased time window for deliveries increased the possibility to improve the utilization of the vehicles. In addition, time saved by delivering directly to the common logistics function freed up time for the driver and vehicle to perform additional deliveries elsewhere, which according to representatives from LSP companies generates a higher income on the car.

For Strømmen shopping centre there is a potential effect on inventory of having fewer drivers and store employees performing the in-house transportation of goods. The management regularly experienced wear and tear on the building and especially the elevators. From conversations with the shopping centre management conducted at the end of the trial period it was stated that the elevator maintenance employee at the shopping centre had experienced fewer collisions of the elevators than prior to the trial period. It was however difficult to anticipate the exact cost savings. In addition, a common logistics function solely performing the in-house logistics helps increase the overview of the deliveries and reduces the number of drivers performing freight delivery alongside the shopping customers. Due to noise friendly equipment used by the common logistics function this contributes to improve the overall shopping experience. Table 14 below illustrates some of the most important value creating effects the solution might have on the affected actors.

Table 15. Value creation possibilities for the actors involved.

The stores	The Logistics service providers	The Strømmen shopping centre
Increased control of the goods and the timing of deliveries and waste collection	Increased time window for deliveries	Saved costs on wear and tear of inventory
More cost efficient staffing	Reduced costs per delivery	Satisfied shopping customers
Freed time to provide better service to customers	More efficient route planning and income on the vehicle	Lower noise level

6.4.5 Society – stakeholder perception

As a part of the assessment of the situation **before the trial period** with compulsory common logistic functions at **Strømmen shopping centre**, 17 stores not utilizing the solution were interviewed. Out of the 17 stores 7 had goods delivered to the store by the driver and 10 picked up the goods at the freight receipt area themselves. Store employees were asked what they perceived as the main barrier of applying the services of a common logistics function. The results are categorized and presented in Figure 14 below.

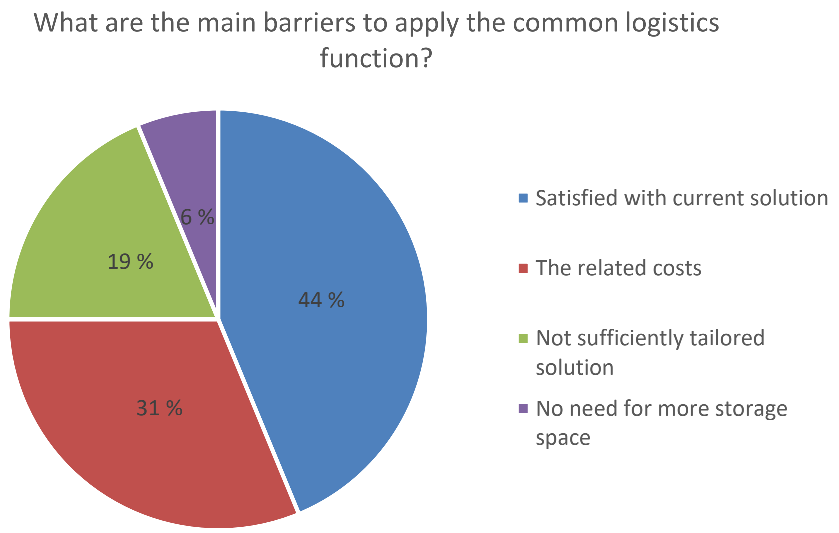

Figure 14. Store employees' perceptions of the main barriers of applying the common logistics function. N=17

Figure 14 shows that 44% of the respondents found the current solution of goods delivery to be satisfactory and saw no need for change. Many of these respondents received the goods at the store by the driver and was satisfied with the current situation. Further, 31% believed the costs to be a main barrier and some suggested that the costs should be lower than the related expenses of having additional staffing for goods handling. 19% mentioned different reasons the solution is not sufficiently tailored for the needs of the stores. These responses included among others a desire for extended opening hours at the freight receipt and perceptions that the knowledge and experience among the freight receipt employees where inadequate.

On the question of what benefits the store employees associate with a common logistics function the answers among the respondents varied. Several of the respondents specified that it was convenient to have the goods delivered at the store. Other inputs included in concise form:

- Assistance with goods delivery
- Beneficial around peak periods
- Additional buffer storage

- Collects waste
- Easier to plan a cost efficient staffing

More interviews and observations at Strømmen shopping centres were performed also **during and towards the end of the trial period**. When store employees where asked how satisfied they were with the common logistics function all replied that they were satisfied. See Figure 15. Most stores mentioned waste collection and handling as the most appreciated service.

Figure 15. Store employees' perceptions of how satisfied they are with the common logistics function. N=13

On the question of stores' intention to continue to make use of the offer after the trial period the answers were not clearly affirmative, despite positive feedback on the service provided. See Figure 16.

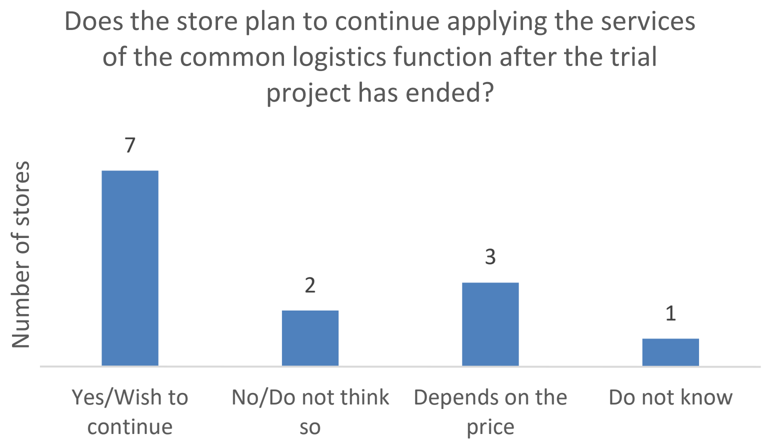

Figure 16. Store employees' perceptions of whether they were going to continue to use the services of the common logistics function. N=13

Interviews have also been done at **Emporia shopping centre**. We interviewed 9 store employees at Emporia to detect if the customers of the common logistics function where satisfied with the service provided. These stores received 2,07 pallets on average each week. The general perception among the stores was positive. 7 out of 9 responded that they were either very satisfied or satisfied with the service of the common logistics function (see Figure 17).

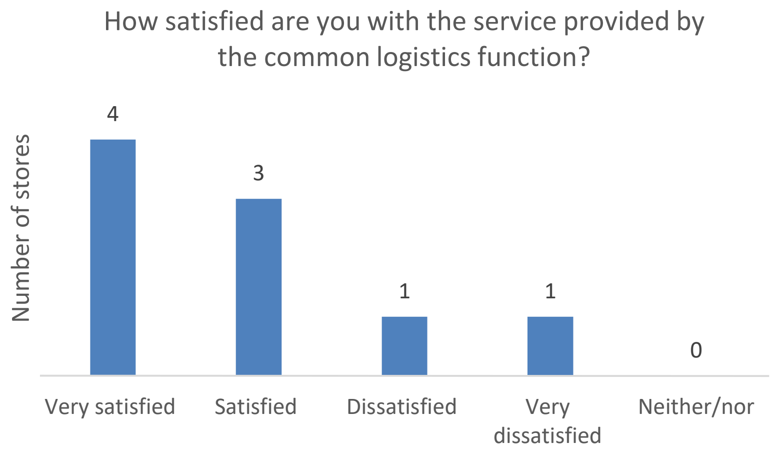

Figure 17. Store employees' perception of the services offered by the common logistics function. N=9.

On the question of what benefits the store employees associated with the services of the common logistics function the respondents were able to provide more than one answer each. The responses are categorized in Figure 18 below.

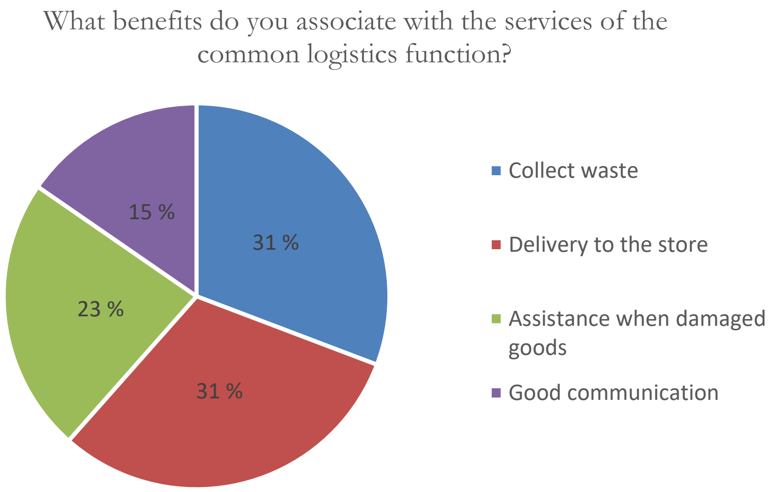

Figure 18. Store employees' perceptions of the benefits of applying the common logistics function. N=9.

The two most appreciated benefits among the store employees were that goods are delivered to the stores and that waste are collected from the stores (61% of the answers).

When the stores were asked to suggest ways in which the services of the common logistics function could be improved the responses were ambiguous and difficult to categorize. Some of the suggestions are listed below:

- Goods delivery earlier in the day
- Agreed delivery times
- Extended opening hours

- Greater capacity at the freight receipt in times of increased goods volumes
- Facilitate return logistics of goods

Several of the respondents expressed some dissatisfaction with late deliveries, but at the same time acknowledged that this could be challenging for the common logistics function due to uncertainty related to deliveries from the transport companies as well as the difficulty of satisfying the desires of all the stores simultaneously. According to some of the store employees an agreed delivery time would make it easier to plan how much staff is needed at all times which would be more cost efficient. All in all, the stores at Emporia seem satisfied with the services of the common logistics function and have accepted it as a common solution for the shopping center.

The drivers interviewed delivering at Emporia were also satisfied with the common logistic solution. One of the reasons was that they could deliver at Emporia from 07:00 in the morning. When delivering to shops in the city the drivers have to wait until 10:00 o'clock when the shops open. The drivers interviewed were positive because they saved time spent on delivery that could be used for extra transport commissions.

6.5 Challenges ahead

Stakeholder support

The implementation of common logistics functions is performed without direct public support. Support from shops and logistics service providers is, however, essential in order for the solution to be developed. The barriers of using a common logistics function varies across different stakeholders and shopping centres. This strengthen the importance of engaging stakeholders in the planning process of designing the common logistics functions. Challenges of further uptake of the solution can be explained by the low initial adoption willingness among stakeholders.

One of the main barriers of such a solution from the viewpoint of the logistics service providers is that the drivers lose the personal interactions with their customers. This critical point in providing good service is now in the hands of a different and potentially competing firm (depending on who operates the common logistics functions). However, for the implementation to be successful it has to be obligatory for all the transport companies delivering to the shopping centres. If all tenants are obliged to use the common logistics function it would not be perceived as poor service to not deliver goods directly to the store. Shopping centre managers and third-party service providers argue that many of the store employees do not know which company the drivers represent and thus that the marketing aspect is overrated.

The perception among the store employees is that the barriers of making use of the common logistics service are the related costs. In addition, many of the stores are satisfied with the service performed by the drivers and see no reason to change the current solution. Stores at different shopping centres worry that the staff at in-house logistics functions will not perform the tasks in the preferred manner and to acceptable prices. It is crucial for the staff at the common logistics function to deliver the same level of service and provide the same expertise as the drivers.

Financing and organisation

There are various suggestions as to how the common logistics functions should be organised or financed:

- The costs are included in the already existing shared costs between the tenants
- The tenants pay according to number of pallets/parcels/packages they receive

- The logistics service providers and the tenants split the costs

The experience based on observations and knowledge gathering through interviews is that in order for this solution to be implemented successfully from the start, the financing and organisation of the common logistics function have to be decided upon and included in the contracts of the tenants of the new Økern shopping centre prior to the opening of the shopping centre.

6.6 Lessons and generalisation of results

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.

Common logistics functions as a solution has for a while been known as an opportunity to improve efficiency, but such solutions are not widely used in the Scandinavian countries. One main reason for this is that the needs for efficient deliveries have not been given priority when new centres have been planned. In many cases, real estate developers do not care about deliveries, they are focused on maximising the potential revenues from their tenants. One main innovation of the Oslo implementation is thus the engagement of stakeholders in the planning process to design the common logistics functions in a way that fits the need of all stakeholders. For example, the outcome of a cooperative workshop was that the storage area was increased, hence the needs of logistics service providers and retailers were accounted for.

Steen & Strøm are continuously developing existing and new shopping centres across Scandinavia. The experiences from the common logistics functions in the Økern shopping centre will determine whether and how they will be integrating such solutions in the default planning of future centres. Finally, also other shopping centre managers in the Klépierre group, as well as the groups of Thon and Citycon may utilise the results from the project. Knowledge of design on logistics facilities in shopping centres established during the CITYLAB project will support a new standard for what services will be offered, need for infrastructure and how to organise logistics in new shopping centres, i.e. common solutions for in-house logistics, click and collect services, waste management and return logistics. When built, the Økern shopping centre will act as a state of the art solution for the selected logistic and service solutions

One additional perspective is that there is an increasing interest in generalisation of the results from shopping centres to city centre settings. One main difference between shopping centres and regular urban streets is that the shopping centres are private property where the shopping centre managers can impose solutions on their tenants. In city centres it may be more difficult to oblige individual tenants to common solutions. Despite this, there is an expressed interest from local authorities in solutions for how they may introduce common solutions even in city centres. In Sweden, the company Logistikbolaget AB, who are operating the common logistics functions in Emporia, have recently expanded service to other domains such as serving Arlanda airport in Stockholm, and they are also discussing how to service city centres. Another initiative is that around Emporia, considerable urban expansion is planned, and it is now considered whether the freight receipt at Emporia may also serve other clients in the close vicinity of the centre, thus acting as a consolidation centre for multiple freight receivers. Interestingly, this is close to what FP7 project STRAIGHTSOL considered for an urban consolidation centre in the city of L'Hospitalet de Llobregat in Spain (STRAIGHTSOL; 2014).

7 Rome: Integration of direct and reverse logistics

7.1 Problem and aim

The Rome implementation deals with “urban waste, returns and recycling” that is one of the four axes of intervention CITYLAB focuses on. It aims at improving and optimizing recyclable materials collection and reverse logistics. It pursues two specific joint objectives: (1) increase recycling; (2) reduce transport negative externalities.

Waste management is a major issue for the sustainability of urban areas (European Commission, 2010). Many countries are facing problems related to landfill capacity and emissions from combustion, leading to an increased attention and effort to reduce, reuse and recycle waste. This issue is linked to the circular economy concept that is an attractive and viable alternative that businesses have already started exploring today. The city of Rome, as well as other municipalities all around the world, views recycling as a viable alternative to rising cost of landfills. Recycling programmes are experiencing a substantial growth.

An efficient city logistics system should allow the collection of urban waste, based on reuse and recycling, while minimizing its impact on road congestion and polluting emissions. Increasing the amount of recycled materials might have strong logistic implications, negatively affecting the environment, if the collection process is not adequately organised. This objective could be reached by fostering the integration of forward and reverse logistics.

There are two main collection strategies adopted in Rome: (1) door-to-door collection; (2) ad-hoc collection points (“isole ecologiche”, ecological islands). The two systems are characterised by different: organisation, costs, amount of recycled materials and citizens’ effort.

In fact, the door-to-door system, applied to several types of recycled materials, implies: (i) a large number of trucks and fragmented collection taking place that might produce negative impacts on service efficiency; (ii) relatively high collection costs; (iii) higher probability of recycling success; (iv) low effort expected from the citizens participating.

Ad-hoc collection points, on the contrary, imply: (i) costly infrastructure interventions (the City Council has set an objective of having an ecological Island for each of the 15 Boroughs of the city); (ii) citizens’ dedicated trips to bring recycled materials to the collection point; (iii) greater effort, involvement and costs for the citizens that often translates into a low level of recycling and illegal disposal of noxious/hazardous materials.

Developing a well-balanced solution between all the requirements and constraints is needed but difficult to achieve. Thus, logistic organisation and transport management is critical to balance all the objectives jointly pursued.

From a private point of view, the major industrial partner involved in the Living Lab, keenly considers the implementation a good occasion to test a business opportunity related to the expansion of its core activities in a complementary, and potentially profitable, market where it could use existing capacity, operated at marginal cost, to perform reverse logistic activities.

This implementation contributes to the improvement of knowledge and understanding of the impacts increased waste recycling might have and how to mitigate them via an innovative service organisation. It also allows building a multi-actor community working together in the city context, to co-create innovative and effective solutions.

7.2 Description of the solution

The Living Lab implementation in Rome is an innovative system for integrating forward and reverse logistic flows in urban areas. 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 innovative idea characterising the implementation relates to the integration of an already existing frequent distribution system (e.g. mail delivery) with spare capacity on return trips, aimed at recycling urban waste.

Figure 17. The innovative idea behind the Rome implementation

The system proposed represents a hybrid waste collection strategy with respect to the two collection models presently used in Rome (see previous section). It intends to use large attractors as intermediate locations with dedicated recycling facilities, selecting specific waste categories and grouping their collection via appropriately organised and coordinated non-dedicated trips, making use of an IT alerting system. The main benefits expected relate to: (1) reduction of the effort agents have to perform when recycling (e.g. no specific trips would be required to visit recycling facilities); (2) reduction of number of trips collection firms need to perform to increase the amount of recycled materials; (3) minimization of illegal discharging of toxic/dangerous materials; (4) load factor optimization.

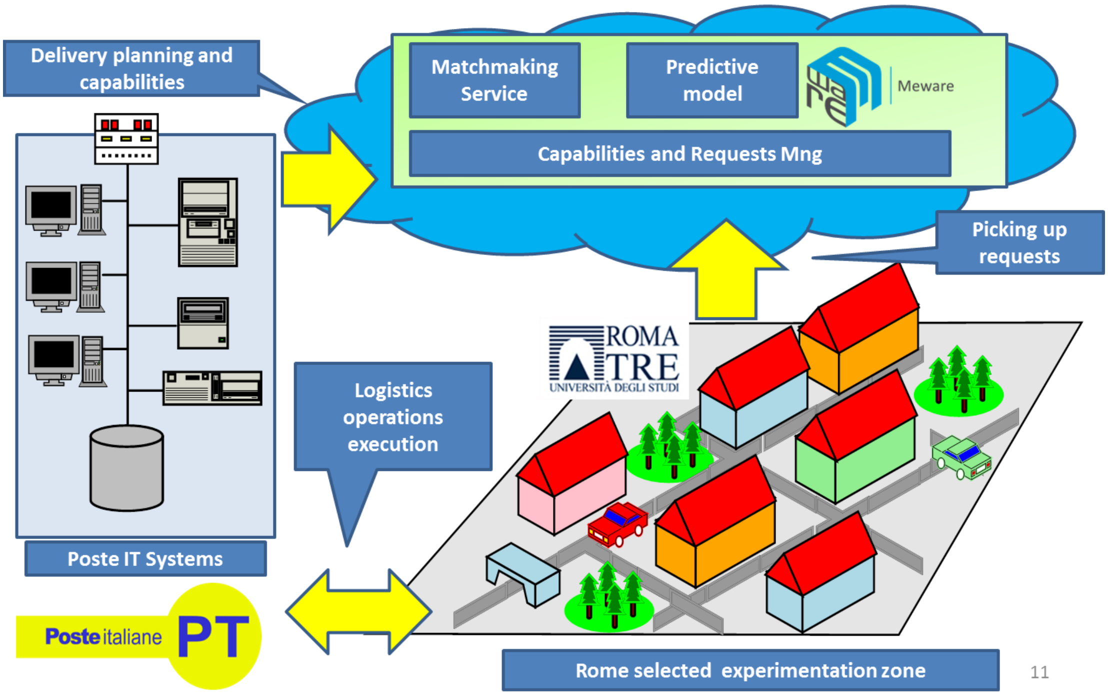

Figure 18. The operational scheme.

The solution proposed fosters the practical deployment of the EU circular economy strategy by providing an efficient city logistics system to collect recyclable/reusable urban waste thus minimising road congestion and polluting emissions while increasing freight vehicle load factors (European Commission, 2016).

7.3 Implementation process

The implementation in Rome deals with the integration of forward and reverse flows, which is an area where very little has been done until now. In order to reach the objective reported above, the Living Lab partners have decided to perform several Living Lab rounds starting from a small-scale implementation later to be up-scaled. In fact, in any completely new service the first experiments, also when run by private and innovative companies, are always performed on a small scale (see, for example Amazon[4]).

In the first Living Lab round (completed) the type of recycled material considered was limited to plastic caps and the area covered was minimised. The main focus and purpose, in fact, was to practically implement such an innovative solution in a real-life context so to investigate and discover all the possible organisational problems and also market opportunities to upscale it.

The second round (on-going) explored the opportunity to extend the implementation in terms of flows involved, sites and alternative recyclable/reusable waste by including the solution tested in the first round within the actual logistics process for urban waste management of the city of Rome according to the guidelines recently announced by the Mayor.

The implementation has followed a Living Lab approach getting all the actors involved from the outset so to account for everybody's constraints and interests. Under this respect it is important to recall, as an emblematic case, the lengthy discussion that has taken place among

[4] More information available at https://www.amazon.com/treasuretruck

participants with respect to the choice of the specific recycled materials to be considered for the real-case implementation.

The core CITYLAB partners are: Department of Transport in Rome (DTR), Poste Italiane (PIT), MeWare (MEW) and the University of Roma Tre (UR3).

Other stakeholders involved in the implementation are: Department of the Environment in Rome (DER), the company responsible for providing the concierge service at UR3 (CSU); UR3 Mobility Manager (UMM); UR3 students, teaching and administrative staff (STA).

DTR is both owner of the Living Lab, monitoring the Living Lab development process, and customer, benefitting from the environmental positive results derived by the new solution proposed, especially in a long-term period when the scale dimension of the implementation is expected to be enlarged.

UR3, while playing different roles, is the Living Lab facilitator helping the development of the implementation case throughout the process. It is responsible for stimulating the organisation of meetings and monitoring the activities performed. As a stakeholder, it supports the implementation process by providing research knowledge useful for both determining barriers/opportunities/pre-requisites and assessing impacts and transferability potential. As a user, it is involved in testing the real-life solution making available four university buildings. As a customer, it may obtain both financial benefits and an optimal return on image from the implementation.

The role of MEW in the Living Lab is the technology enabler that supports the logistics and research stakeholders in the exploitation of the identified business case.

The role of PIT in the Living Lab is the logistic operator. PIT is interested in implementing a new smart approach to urban logistics which provides functional integration between forward and reverse logistics and in acquiring information on new market opportunities.

DER is directly involved in the second round of the implementation to support identifying new opportunities with respect to well-focused recyclable/reusable materials and tackling potential conflicts/overlapping activities with the intention of developing a balanced mix of recycled materials/collection tailored to the Roman case.

CSU is involved in the alerting system by using a web-based interface to communicate with PIT whenever a box containing recycled materials is full.

UMM is involved in the Living Lab process from the planning of the system to the operational aspects linked to implementation, due to her previous involvement in the same recycling initiative promoted by the University of Roma Tre.

STA is the actor responsible for the success of the recycling initiative. In fact, they have been consulted in the planning phase via specific surveys to acquire relevant information needed to define the most appropriate recycling system to foster their participation.

The activities performed so far within the Living Lab implementation contributed to the development of collaborative working relationship linked to the overall freight city environment. In fact, clean waste recycling issues can be included in the next Urban General Traffic Plan as well as in the Sustainable Urban Mobility Plan whose activities are about to start. Under this point, it is worth mentioning that two out of four core CITYLAB partners (DTR and UR3) are formally involved in all the activities pertaining to the development of the Sustainable Urban Mobility Plan and will actively promote the inclusion of reverse logistics issues within the plan.

Moreover, the implementation contributes to the city environment where the recently passed Directives 2016-2021 for the future governance of the city of Rome has set waste collection and management as one of the most relevant issues to be tackled (Roma Capitale, 2016).

Achieved activities are summarised in Table 16 below.

Table 16. Main steps and activities performed in the Living Lab implementation in Rome.

Main step and activity	When
Choice of the: recycled materials to be transported, actors and specific department buildings of the University to be involved	January 2016
Analysis of the potential demand and the fundamental elements for increasing the likely amount of recycling	June 2016
System pre-dimensioning (boxes, vehicles, full box alerting system, routing/frequencies, warehousing issues, etc.), site inspections and deployment of the entire operational procedure for the new system	July 2016
Construction and deployment of structures (eco-totems) for collecting recycled materials, a web-based interface to support communication and overall system functioning, and warehouse management.	September 2016
Formal agreement with the concierge service firm	October 2016
Development of different types of advertising campaigns	November 2016
Real-case implementation	November 2016
Data collection	February 2017
Analysis and validation of collected data	April 2017
Start second round Living Lab implementation	April 2017
Analysis of the “Reuse Centres”	September 2017
Analysis of hazardous materials	January 2018

More in detail, the activities carried out followed the Living Lab methodology, articulated in the four phases: Plan, Implementation, Evaluation, Act.

7.3.1 Plan

- Choice of the: recycled materials to be transported, actors and specific department buildings of the University to be involved.
- Analysis of the potential demand and the fundamental elements for increasing the likely amount of recycling.
- System pre-dimensioning (boxes, vehicles, full box alerting system, routing/frequencies, warehousing issues, etc.), site inspections and deployment of the entire operational procedure for the new system.
- Construction and deployment of structures (eco-totems) for collecting recycled materials, a web-based interface to support communication and overall system functioning, and warehouse management.
- Formal agreement with the concierge service firm.
- Development of different types of advertising campaigns.

Several focus groups with citizens and shop owners have been performed to acquire valuable information on the problems faced by them regarding the waste disposal and to identify the most appropriate types of clean waste that could characterize the implementation (e.g. toner, plastic caps, exhausted batteries, medicines, etc.). Plastic caps were chosen.

The choice rests on the following considerations:

1) stringent regulatory/labour legislation constraints the type of materials the national postal operator can presently transport. PIT preferred to practically implement and test such an innovative solution in a real-life context, considering a compliant type of material. The aim is investigating and discovering all the possible organisational problems as well as potential market opportunities;

2) no clear and appropriate support could be secured from the beginning by the City of Rome. The main motivation being the temporary absence of political guidance (subsequently solved), while it was thought that an effective involvement useful for project upscaling would be reached afterwards (as indeed happened later);

3) plastic caps can be collected separately and are more profitable than generic plastic (in fact, they are composed by polyethylene, an easy to recycle and versatile-economic type of plastic). Plastic caps recycling initiatives have been spreading in local/national contexts in recent years demonstrating their capability to get people involved. Furthermore, the existing collection system at the University of Roma Tre, based on voluntary workers performing dedicated collection trips with diesel/gas propelled vehicles characterised by extremely low load factors, was neither sustainable nor efficient. Moreover, choosing university buildings as recycling facilities was considered suitable to test the correct functioning of large attractors collection points (e.g. hospitals, shopping malls, airports, etc.) that can be used in the up-scaling phase for developing the hybrid collection system the group has in mind.

An ex-ante behavioural analysis has been performed via stated choice experiments (e.g. Gatta and Marcucci, 2014) to identify barriers/opportunities and necessary, strategic/operational pre-requisites for the proposed solution to be accepted and supported. Results obtained from a sample of around 600 people show that offering an environmentally-friendly transport system and applying game dynamics in the initiative context have a significant and positive impact on the individuals' utility functions. Starting from those results, a scenario analysis allows estimating users' participation in the recycling initiative (CITYLAB, 2017b). The behavioural analysis performed was strategically useful to plan the proposed solution according to stakeholders' preferences so to increase their participation and foster sustainable behaviour. Moreover, the research team proposed an advanced user-centred gamification design approach, accounting for players' heterogeneous preferences, to appropriately conceive, deploy and manage gamification (Marcucci et al., 2016).

While the original project description foresaw the use of iso-modular boxes for transporting materials due to the participation of some of the CITYLAB members also to the Modulushca project (http://www.modulushca.eu/), in the first round of the Living Lab implementation, standard plastic boxes were used due to the problems that arose within Modulushca concerning the use of iso-modular boxes. In fact, the ISO approval has still to be obtained for the modular units developed in Modulushca and there is no available ISO-Modular standard to be used as a reference. However, this change has not had any major implication for deployment, and this type of boxes could be considered in future developments.

In the following, a detailed flowchart of the operational procedure is illustrated (Figure 19) together with a brief description of the main tasks associated with each actor involved (Figure 20).

For each building

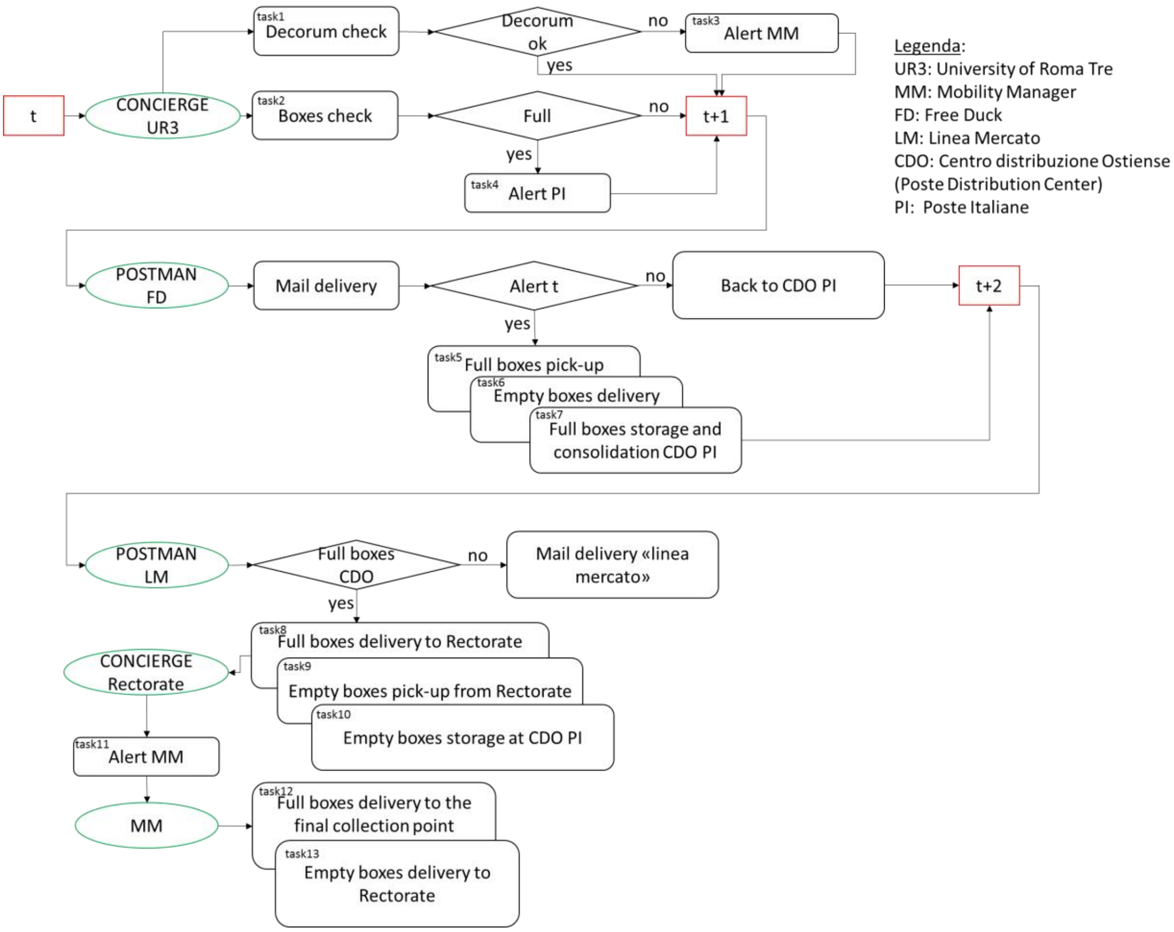

Figure 19. Detailed flowchart of the operational procedure.

Task	Name	Brief description	Actor involved	Time frame
1	Decorum check	Boxes will be placed near the concierge offices, in order to help them check the status of decorum near the boxes (e.g., caps on the floor, eco-totem moved, plastic bags full of caps on the floor)	CONCIERGE UR3	t
2	Boxes check	Boxes will be placed near the concierge offices, in order to help them check the status of filling of the boxes	CONCIERGE UR3	t
3	Alert MM	The Concierge informs the Mobility Manager if decorum status is altered. The alert consists of pushing a button in a web platform	CONCIERGE UR3	t
4	Alert PI	The Concierge informs Poste Italiane if one or more boxes are full. The alert consists of pushing a button in a web platform	CONCIERGE UR3	t
5	Full boxes pick-up	The Postman with electric “Free Duck” (FD) vehicle, during the mail delivery trip, picks up full boxes from the University building if an alert has been received the day before (time t)	POSTMAN FD	t+1
6	Empty boxes delivery	The Postman with electric “Free Duck” (FD) vehicle, during the mail delivery trip, delivers a number of empty boxes to the University building which is the same of the full boxes he/she is simultaneously picking up	POSTMAN FD	t+1
7	Full boxes storage and consolidation CDO PI	The Postman with electric “Free Duck” (FD) vehicle, at the end of his/her tour, deposit and consolidate full boxes at the Postal Distribution Centre	POSTMAN FD	t+1
8	Full boxes delivery to Rectorate	The Postman of “Linea Mercato” (LM) with natural gas “Ducato” vehicle delivers full boxes to Rectorate	POSTMAN LM	t+2
9	Empty boxes pick-up from Rectorate	The Postman of “Linea Mercato” (LM) with natural gas “Ducato” vehicle picks up a number of empty boxes from Rectorate which is the same of the full boxes he/she is simultaneously delivering	POSTMAN LM	t+2
10	Empty boxes storage at CDO PI	The Postman of “Linea Mercato” (LM) with natural gas “Ducato” vehicle delivers empty boxes from the Rectorate to the Postal Distribution Centre	POSTMAN LM	t+2
11	Alert MM	The Concierge of the Rectorate informs the Mobility Manager when the Postman LM arrives. The alert consists of pushing a button in a web platform	CONCIERGE Rectorate	t+2
12	Full boxes delivery to the final collection point	The Mobility Manager is in charge of delivering full boxes from the Rectorate to the final collection point	MM	t+2
13	Empty boxes delivery to Rectorate	The Mobility Manager is in charge of delivering a number of empty boxes to the Rectorate to the final collection point which is the same of the full boxes he/she has picked up	MM	

Figure 20. Task description and actors involved in the plastic caps collection process

An IT platform has been developed to enable communication and collaboration among the stakeholders involved in the implementation. Specifically, a web application, accessible through the Internet browser, has been created. The application allows users to authenticate and perform specific tasks related to their profile.

<table>
<tr><td colspan="4">Eco-totems at the buildings' hall</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="4">Postal Distribution Centre “Centro di Distribuzione Ostiense Poste Italiane”</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>Electric “Free Duck” vehicle for boxes pick-up</td><td>“Free Duck” capacity
(L_1 69 cm x L_2 39 cm x H 30 cm)</td><td colspan="2">Natural gas “Ducato” vehicle for boxes delivery</td></tr>
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Figure 21. Pictures of the main components of the plastic caps collection process

7.3.2 Implement

- Real-case implementation

The real-case implementation, foreseen in the first round of the Living Lab (lasted one month), is a small-scale implementation considering a specific material (i.e. plastic caps) and covering a relatively small area (around 1 km^2, involving four department buildings of the University of Roma Tre). The process is carried out according to the organisational characteristics previously described.

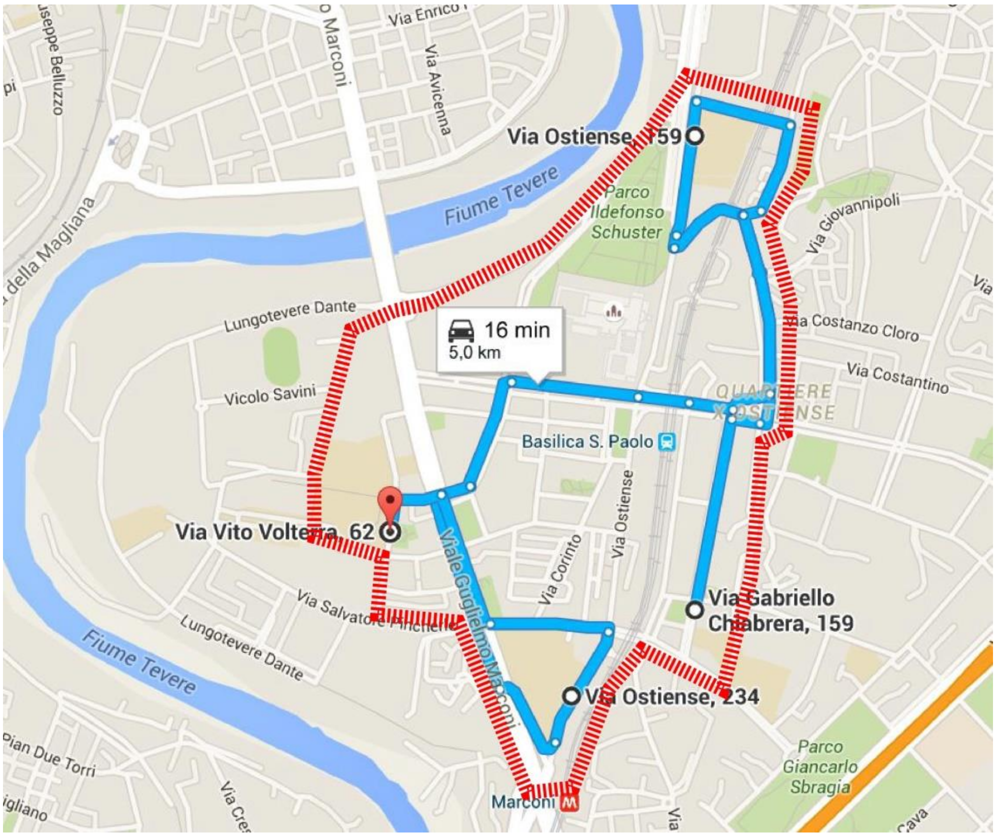

Figure 22. The geographical area covered

7.3.3 Evaluate

- Data collection
- Analysis and validation of collected data

The Living Lab implementation assessment is mainly based on its transport and environmental impacts. The main results are reported in section 7.4. Data collection and validation is based on the information gathered through the IT system that has been developed.

7.3.4 Act

- Start second round Living Lab implementation
- Analysis of the “Reuse Centres”
- Analysis of hazardous materials

As planned, the Living Lab partners have decided to keep the process open and start a second round with the aim of further extend the initially tested solution (e.g. other recycling materials, larger geographical scale). The Department of the Environment in Rome joined the Living Lab and the group started exploring the opportunity to extend the implementation according to the new action plan signed by the Rome Counsellor for Environment (31/03/2017) which aims at reducing the amount of urban waste produced.

A specific point foreseen in the plan refers to the creation, development and management of the so called “reuse factories” or centres for creative reuse, where consumed materials can be stocked, processed, transformed and sold. Presently, in Italy, all reuse centres are based on voluntary work and donations. However, there is a latent need to fully activate the reparation and reuse sector while also developing artisan and commercial activities, that might guarantee the self-management and the general self-sufficiency of reuse centres. This will help reducing the amount of waste and creating new jobs. The critical issue is linked to the dedicated trips that citizens would perform to deliver consumed materials to reuse centres. The solution proposed in the first Living Lab round could be up-scaled considering this new circular economy framework. In fact, since a consumed material can be classified as product if it is reused (and not as waste as in the case it has to be disposed or recycled), the strict legislation for waste management does not apply in this case. Therefore, no (hard-to-obtain) authorisations are required and the national postal operator should provide a small effort to meet the actual regulatory constraints. Moreover, the first reuse centre in Rome could be created at the University of Roma Tre benefitting from the previous real-case experience, while financial sustainability could be based on: (i) revenues derived by the materials sold in the market; (ii) financial subsidies from the local authority. Alternatively, the transport service could be provided using alternative and innovative solutions such as crowdshipping that foresees delivering goods via the crowd (e.g. Marcucci et al., 2017) also taking advantage of behavioural change levers (e.g. gamification). Any trip people perform to satisfy personal objectives can become a vector for shipping consumed materials using the usually available spare load capacity. This would allow avoiding dedicated trips.

The new action plan of the city of Rome aims at increasing the collection of recycled materials from the current 44% up to 70% by 2021. Hazardous materials represent a critical issue especially when they are illegally disposed. According to LEGAMBIENTE (2016) illegal landfills in Italy are about 3000, for a total of 15 million square meters to be cleaned up. Here, the materials most frequently found and, given their size, most appropriate for our implementation are: exhausted batteries and oils, pharmaceuticals and WEEE, which are all particularly dangerous for the environment. These types of materials do not fall into the same waste management system characterising standard recyclable materials (i.e. paper, plastic, glass or metal). There are various collection points in the city, whose location is not optimal (e.g. difficult to see or to reach). Alternatively, these materials can also be directly transported by citizens to ecological islands with a consequent increase in dedicated trips. The local Administration has started a pilot of the so-called “domus ecologiche”. In such places - fenced areas of about 25 square meters located in proximity of an aggregation of condominiums – citizens can discard standard recyclable materials after identifying themselves via a green card. This system provides economic incentives for particularly virtuous citizens. It could be possible to link the collection of the above mentioned hazardous materials with this system and using the innovative solution tested in the first round of the Living Lab to transport those materials to ecological islands. This upscaled system has a great potential since it may help both properly collecting more hazardous materials (due to a better positioning of collection points that become more visible and easier to reach) reducing illegal disposal and avoiding dedicated trips with significant CO_2 savings. Again, legislation issues apply if considering PIT as the logistic operator. In fact, only authorized companies can transport those types of materials. However, public subsidies (more likely to be provided due to the resulting positive environmental effects and the cost reduction of landfills remediation) may help making this new market profitable and lead the national postal operator taking the necessary legislative steps (fulfilling specific technical requirements). Therefore, focusing on these types of hazardous materials has been considered a possible challenge.

7.4 Effects and consequences

The real-case implementation in the first round of the Living Lab proved the service tested was technically feasible and environmentally sustainable. Two different and potentially contrasting objectives have been achieved: (1) increasing the amount of recycling performed; (2) reducing the amount of emissions due to the related transportation activities.

The evaluation is performed by using a hypothetical counterfactual hypothesis. After having acquired the info concerning the amount of plastic caps recycled in each site and determined the number of collection trips, one can compare the actual system developed with respect to the one previously adopted. In fact, since no dedicated trips are made in the actual system, the environmental impacts can be calculated taking into account both the vehicle type used in the previous system and the number of vehicle kilometres that would have been driven, according to the Business-as-Usual (BAU) scenario, to perform the actual collection. This procedure can be used to measure the different amounts of polluting emissions with respect to alternative realistic scenarios considering further extensions of the implementation.

Environmental and transport indicators are calculated per collection (≈ 2 Kg - plastic caps transported)[5]. More in detail, polluting emissions were abated by:

1) avoiding dedicated trips: 3.5 Km,
2) cutting:
    a) 2.75g of NO_2;
    b) 0.29g of PM2.5 and PM10;
    c) 677g of CO_2;
    d) 0.004g of SO_2

Additionally, more plastic caps have been collected. In fact, with the old system around 40 kg of caps were monthly collected (about 17000 caps), while during the implementation a total of 108 Kg (+170%) have been collected (about 43000 caps).

Now, supposing the solution is applied to the city of Rome exploiting other large attractors (e.g. hospitals, schools, shopping malls, etc.), the following environmental and transport indicators are estimated. Assuming the same tax of participation to the initiative and accounting for the population density, one obtains savings per month of:

a) 53.31 Kg of NO_2;
b) 5.60 Kg of PM2.5 and PM10;
c) 13,128 Kg of CO_2;
d) 0.08 Kg of SO_2

The implementation provoked a great participation, interest and curiosity that materialised in several clarification requests as well as suggestions to extend the initiative both geographically (e.g. students/academics/administrative employees asked for the collection to be implemented also in their departments) and with respect to the materials recycled (e.g. the Engineering Department at the University of Roma Tre, already recycles exhausted toner, batteries and paper).

The results obtained in the Living Lab implementation proved relevant and have been reported in scientific publications and presentations in International Conferences (Gatta et al., 2017a, 2017b, 2017c; Marcucci et al., 2016, 2017). The outcomes and the implementation deployed are extremely useful for future developments since they provide a real-case experience that can be used as an example for future extensions both geographically and with respect to the recycled materials. This, in turn, provides a greater incentive for other stakeholders to participate and strengthens the support provided by those already involved.

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[5] The following environmental and transport indicators relate to savings per month: --185 vehicle kilometers; -148.53g NO_2; -15.60g of PM2.5 and PM10; -36,576g of CO_2; -0.22g of SO_2.

PIT is now aware of the environmental (see the indicators above), financial[6] and organisational (see section 7.3) implications linked to the new service provided and its Strategic Marketing Unit is actively investigating the extension of the service to other clean waste materials and exploring possible alleys to secure financial subsidies from local authorities.

The local administration is now capable of illustrating to citizens the implications deriving from a new and environmentally-friendly transportation system that could be applied to specific urban waste collection.

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. Results will be available once the second round of the Living Lab will reach the implementation phase. Preliminary estimations, linked to the deployment of the system tested in the first round of the Living Lab to specific hazardous materials collected at "domus ecologiche" (see Section 7.3.4), reveals that 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, 2017c).

7.5 Challenges ahead

The Living Lab partners have decided to keep the process open with the aim of upscaling the solution to be more relevant for the city of Rome (i.e. more effective in terms of environmental benefits), and for the industrial partner (i.e. more profitable). Several key points characterising the environmental policy action plan in Rome could potentially benefit from the adoption of the integrated forward-reverse flows solution in the Living Lab implementation. For instance: (i) improve separate collection systems; (ii) implement recycling in schools and public buildings; (iii) develop a recycling plan for small WEEE; (iv) design a new system for recovering highly polluting vegetable oils locating containers in public areas; (v) create new public collection centres for domestic metals production.

On-going activities, to be performed within the second round of the Living Lab implementation, are to:

1) identify the most appropriate recycling scheme where transferring the first round experience;

2) estimate the volumes and economic value potentially derivable from the subset of materials logistic operators, such as PIT, can realistically handle;

3) define the specific regulatory/administrative changes needed to allow logistic/postal operators to perform recycling activities;

4) compare the costs and benefits PIT is likely to face as well as the costs the local waste collection company incurs when performing similar operations;

5) investigate the possibility/determine the actions to hive off specific collection/recycling services produced by the local waste collection company;

6) define appropriate bidding mechanisms to assign contracts and define optimal incentive structures to produce potentially non-financially viable services;

7) define the operational procedures/activities;

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[6] Concerning the financial sustainability, we describe the detail calculations as follows. Operating cost (OC) = 1.50 €/Kg; Operating revenue (OR) = 0.20 €/Kg (plastic cap resale value); Operating profit = OR – OC = -1.30 €/Kg. This implies a 2.60€ deficit per collection. Including also the avoided social costs linked to climate change and air pollution (Ricardo-AEA, 2014), the deficit decreases to 2.40€ per collection.

8) deploy (innovative) strategies to stimulate active citizen engagement in new recycling initiatives with a particular focus on developing real counterfactual tests so to calculate gamification's potential in fostering behavioural change; 9) start a real-case implementation; 10) collect the data and calculate impacts on negative externalities for the City (measured by reduced congestion and pollution emitted), amount of increased recycled materials and financial viability of the solution proposed.

The following potential barriers have been identified:

- Regulatory/contractual constraints might limit the number of flows (volume) and alternative waste to be considered for recycling.
- The location for the recycling sites/facilities might be difficult
- There are potential conflicts/overlapping with other waste collection companies

The participation of DER in the second round of the Living Lab implementation in Rome will help finding workable solutions to overcome the main barriers reported above. Acknowledging, at least in principle, that regular waste collection companies are not necessarily the best equipped when it comes to recycling specific types of waste especially if this implies a customer tailored type of service, an open discussion, in the light of the newly and wider city objectives with respect to the desire of increasing the amount and type of materials recycled, will be beneficial both in terms of allocation of chores and resources to the most apt institution that can jointly pursue the objectives set.

The needed regulatory and institutional changes, as in any major change, necessarily rest on a strong and well rooted political will. Given the repeated assertions made in the major planning documents at the city level, it seems reasonable to foresee that the city administration will continue to provide all the necessary support to stimulate an organisational, institutional and functional change in the way waste is collected in Rome with increased recycling and reduced emissions as two joint guiding principles.

The Living Lab approach to solution co-creation can prove particularly valuable since the involvement of potentially antagonistic organisations with respect to the ideas proposed (e.g. labour unions) early in the project could steer the solutions to be investigated towards more feasible and pragmatic options for the extension to other materials. Moreover, a potentially fruitful option to investigate is the use of specific box types that could circumvent the limitations presently characterising the handling and transportation of recycled materials.

The location of recycling facilities represents a critical issue and should be dealt with keeping in mind the specific limitations pertaining to each type of material to be recycled (since different materials are characterised by different constraints) but, at the same time, there will also have to be an overall optimization both in terms of locations as well as combinations of materials to be recycled that shall determine the overall configuration of the collection points within the city. The active involvement of all the interested partners will provide a valuable contribution to find the best possible compromise solutions.

7.6 Lessons and generalisation of results

The main lessons learned are reported below.

- Dealing with waste management is a complex task and requires involving, at a public level, both the Transport and the Environmental Department. The challenge is to connect their visions and policy actions.
- The choice concerning the recycled material to be transported by the national postal operator is critical given regulatory/contractual constraints. This implies that only part of the already recycled materials could be considered when up-scaling the solution proposed unless actual constraints are re-negotiated, or other logistic operators are involved subject to less stringent labour constraints. A possible solution could be to

concentrate on consumed materials to be re-used. In that case, in fact, no specific legislations apply.

- The choice of the sites where to locate recycling facilities has to take into account contrasting issues (e.g. maximising the total amount of recycled materials, guaranteeing easiness of checking the filling status of disposal containers, high standards of cleanliness, and respect of safety rules). This implies that one has to consider the restrictions imposed by the various constraints each specific material has when choosing specific sites to locate the recycling facilities needed without costly infrastructure interventions (e.g. schools, hospitals, shopping malls, etc.).
- A field survey is beneficial to fine-tune the solution proposed according to users' preferences and to understand what users expect from a gamified experience so to increase their participation to the recycling initiative and foster sustainable behaviours. Since citizens' involvement in recycling is essential, this implies that an ex-ante stated preference survey (e.g. Gatta and Marcucci, 2016) is fundamental to identify the most preferred characteristics of the system (e.g. the maximum distance to collection site, type/dimension of collection facilities, type and level of effort required to citizens, etc.). Citizens' involvement might increase by deploying specific gamification techniques (Marcucci et al., 2016).
- Using three boxes of 14 Litres (L38/H19,0/W26,5 each) for collecting recycled materials was correctly dimensioned for a total of 4 recycling facilities located within a 1Km^2 area with a potential demand of approximately 8,000 users. This information acquired in the first round of the Living Lab is at the basis for system dimensioning when upscaling the solution proposed.
- Box dimensioning necessarily has to be jointly considered with vehicle type to be used for transportation, waste material considered, expected demand and peak/non-peak periods. This could impact the choice of the most appropriate logistic operator to perform the forward-reverse logistic activities.
- The alert system is problematic. Two main types can be used: automatic and non-automatic. The former implies costly technological infrastructures to be physically applied to the boxes with a high risk of damage and theft. The latter is less risky but implies either an active involvement of people already present in the collection point or the installation of CCTV cameras that might arise privacy concerns. Moreover, in this case, the boxes must be transparent so to allow an easy checking of the filling status. A joint evaluation of alternative technologies, costs and organisational impact have to be considered so to find a viable solution capable of guaranteeing a well-functioning system. This could be related to the choice of large attractors to be involved as recycling facilities. In fact, in some cases (e.g. schools) non-automatic alert systems can be applied while, in others (e.g. shopping malls), automatic systems are more appropriate.
- A cloud based application proved successful in sending pick-up requests, tracking the activities performed within the delivery processes and storing all the events taking place thus enabling further statistical analysis. This allowed achieving a greater understanding of service features the dedicated software should have. The first round of the Living Lab implementation has made available a basic software product with a potential for further development:
  - use of geo-localization to improve the alert system;
  - improving service features by optimizing the day-by-day mailman route, accounting for both the deliveries to be performed and pick-up requests, in order to minimize the distance covered and maximize load factors.

- In case of non-automatic alert systems, a formal agreement with people responsible for checking the filling status of the boxes is needed. Formally defining a collaboration protocol between those already present in the facility considered for deploying collection points and the company responsible for collecting/transporting recycled materials might be more or less difficult depending on the location chosen (e.g. simpler for schools and, probably, less so for shopping malls). It is a good idea considering a “social recognition” for participating in a green project/initiative via social media to stimulate collaboration while reducing possible financial requests to perform additional surveillance activities that might come from the institutions/people asked to participate in the alert system.
- Appropriately advertising the initiative is needed to engage potential users and increase recycling. It is appropriate to consider different communication channels depending on the main stakeholder categories, types, age range, gender, etc. that should be most involved in the initiative.
- Notwithstanding the type of waste considered in the first round of the Living Lab (i.e. plastic caps) has an economic value, the small-scale solution proposed is not enough to be financially sustainable. Higher market value materials should be considered unless public funds are used. Alternatively, one could focus on hazardous materials (i.e. exhausted batteries and oils, WEEE and pharmaceuticals) that represent a serious problem for municipalities in case of illegal disposal. In this case, public subsidies are more likely to be provided for such innovative solutions due to social/environmental cost reduction.

The overall outcomes and lessons can, in principle, be transferred to all cities interested in increasing the amount of recycling materials while minimizing the transport-related negative externalities. From a private point of view, any postal (or logistic) operator could be interested in undertaking such innovative solutions to increase their market potential.

The Living Lab implementation proved successful in building a coordinated and cooperative way of working to test and adjust new urban freight innovations. No formal active collaborations taking joint-action on improving urban freight sustainability are established in Rome. The Living Lab implementation represents the first attempt for setting up a good context to develop a close relationship between research, industry and local administration with respect to a focused issue. Starting from it, a Living Lab on a city level has also been established addressing additional problems related to the improvement of accessibility while reducing negative transport externalities. The following issues are currently undertaken: (i) loading areas management; (ii) demand management through off-hour deliveries. In both cases several meetings have already been held with the main identified stakeholders (including retailers’ associations, transport providers’ associations and citizens’ associations). We are currently in the planning phase of the Living Lab approach covering activities linked to the acquisition of preliminary information useful for developing the most effective solutions.

To sum up, the Living Lab implementation in Rome influences long-term policy-making in this sector providing knowledge needed to develop an operative intervention plan. The integration of forward and reverse logistics will most likely be included as a medium-long term objective within the Sustainable Urban Mobility Plan in Rome currently under discussion.

8 Paris: Logistics hotels

8.1 Problem and aim

The logistics real estate market has undergone fundamental changes since the 1990s, as soaring investment and management costs led to warehouse outsourcing by distribution and logistics companies to real estate developers-investors/managers. Between 1994 and 2007, 61% of warehouse areas in the Paris region were constructed by real estate developers instead of by the users of the warehouses (Raimbault, 2014).

On the one hand, since 1970s, as environmental problem and energy risk started to occupy public debate, new regulations have been issued in terms of environmental protection and energy saving which also affected the logistics sector. Goods flows have increased their visibility on the urban space, causing significant noise and atmospheric impacts, while contributing to space occupancy and congestion (Dablanc, 2007).

Logistics activities lost the favour of local authorities, which preferred housing or commercial real estate projects with higher tax revenue and better perception from residents. High land cost led to intensive competition of urban real estate projects. Logistics facilities, which require increasingly large surfaces, are typically heavy investments with low return rates compared with retail and office real estate.

Paris has a very high population density and land use. In the Paris region's inner area (within the A86 ring-road), one square metre logistics rent until recently could not reach much more than €100 per year, whereas office property allows for rents that range from triple to the eightfold (since then, market price for logistics rents in prime urban areas has gone up). Thus, the choice of warehouse location has tended to relocate towards far away suburban areas filling criteria of access to highway interchange, large available land parcel, affordable rent, and access to employees, instead of the proximity to receivers within the dense area. This has been termed "logistics sprawl" (CITYLAB, 2017a). Logistics sprawl is the spatial deconcentration of logistics facilities and distribution centres in metropolitan areas (Dablanc and Ross, 2012), and it has been a noticeable spatial pattern for the last decades in large cities around the world.

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.

Every day, around 893,000 deliveries are provided in the Paris region in which about 57% are made with vans. Vans and trucks are responsible for 16% of travelled distances in the French capital city. Moreover, 63% of freight flows are linked to Paris and/or to the very dense urban areas of IdF, which makes sense given the huge spatial concentration of economic activities in these areas. By contrast, logistics related trips (LRTs) originating or serving the interurban and the diffused urban areas are almost negligible, around 7.6% of total regional freight flows (CITYLAB, 2017a).

Table 17. Freight transport intensity in Paris region and Paris city

	Paris region (Ile-de-France)	Paris City
Flow of vans (veh./h)	22	65
Flow of trucks (veh./h)	19	47
Freight vkm by vans (M/day)	6,40	1,50

Freight vkm by trucks (M/day)	5,70	1,10
Share of freight of total driven kilometres (%)	7,80	15,80

Sources: CITYLAB, 2017a.

Around 155 million vehicle*kilometres (vkm) are travelled daily in IdF. The city of Paris concentrates 11% of motorized mobility whereas the fringes of the metropolitan region account for 30% of travelled distances, despite low population and jobs densities. In addition, LRTs make up around 8% of total driven kilometres. Urban freight in general, for the Paris region, brings the following environmental impact: the share of traffic-related CO2, NOx and PM10 due to urban freight is 2.5 times larger than the share of vans and trucks in the regional traffic. The contribution of urban freight to air pollution is larger in the city of Paris. Social costs of air pollution caused by road traffic in general amount to 0.9% of the regional GDP in 2012.

Table 18. Environmental impact of freight transport in Paris region and Paris city

Pollutant	Share of regional emissions due to road transport (2010)	2012 emission factors at 50 km/h (g/km)			2012 emission factors at 30 km/h (g/km)		
		Cars	*Vans*	*Trucks*	*Cars*	*Vans*	*Trucks*
CO_2	29%	166.22	212.99	733.67	201.13	276.67	933.02
CO	56%	1.31	0.37	1.30	1.11	0.58	1.80
NOx	55%	0.50	0.79	4.97	0.61	0.99	6.97
PM_{10}	25%	0.07	0.09	0.64	0.07	0.10	0.67
NMVOC	16%	0.11	0.07	0.10	0.13	0.09	0.18

Sources: CITYLAB, 2017a.

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 will provide 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.

8.2 Description of the solution

Logistics hotels are new ideas in Europe and North America (they exist in developed cities of Asia such as Tokyo, Seoul and Hong Kong). They are logistics facilities implemented in urban areas and having specific characteristics such as mixed uses and/or several stories. Some of them are multimodal. The “logistics hotel” is a key element of the City of Paris’ strategy to reintroduce logistics activity in the dense urban area. **The Chapelle project** is part of a broader urban renewal project of the City of Paris with many ambitious objectives: providing affordable urban housing with social diversity, renovating disaffected industrial or logistics sites and turning them into environmental friendly facilities; and reinventing well integrated mixed urban land uses.

As for **Beaugrenelle urban distribution space,** it s located in the 15th arrondissement of Paris. The Beaugrenelle Urban Distribution Space was transformed from an old parking (over ground multi-story) and has been in operation since 2013. It is configured as an urban distribution centre to serve final parcel distribution in the South-West Paris and immediate neighbour cities. It is composed of a road logistics terminal of 2 565 m² operating parcel and express transport with two parcel sorting areas, as well as one customer reception area (for private pick-ups) open from 9h-19h. Another area of 462 m² is dedicated to offices and sanitary/social infrastructure.

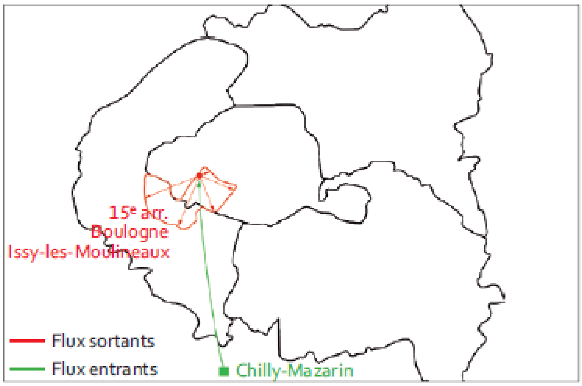
The 11 employees and 50 drivers of the sole operator of the terminal Chronopost (express parcel integrator) handles 6 500 parcels per day (distribution and collection) and 3 500 deliveries per day. Chronopost currently uses a fleet composed of 50 light goods vehicles (mostly owned by contractors) and intends to use cleaner delivery methods. It experimented with about 10 electric vans, but progressively reduced that number, as electric vans did not fit the needs (volume being one issue). It is hoped that Beaugrenelle increases the flexibility and quality of service, while reducing overall CO_2 emissions of Chronopost operations, thanks to the **consolidation potential** of an urban location (last kilometre trips are much reduced in terms of distance).

Geographical situation of Beaugrenelle

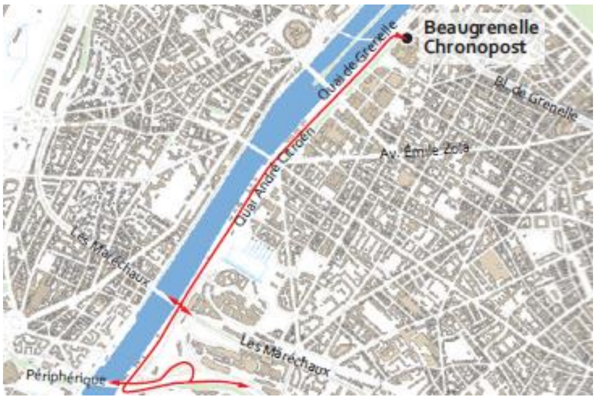
(Source: APUR, 2014)

Location

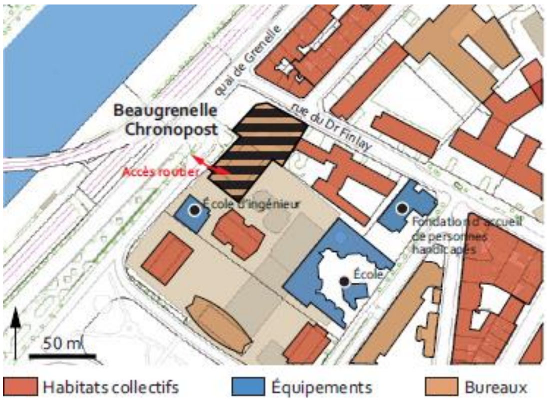
Catchment area



Road access



Ground occupation



Organization of the Beaugrenelle urban distribution space

(Source: Sogaris, 2014; Chronopost, 2014)

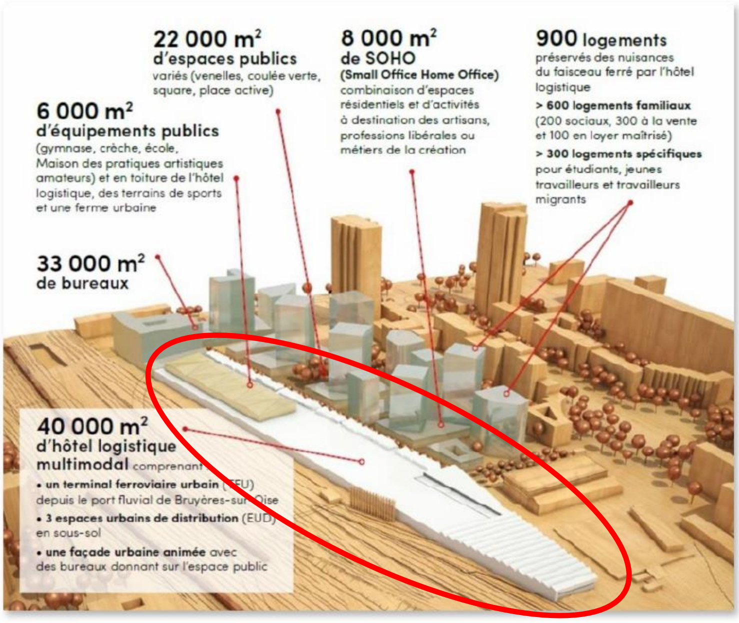
Beaugrenelle logistics hotel concept

Outside look on the top (visitors' entrance for consumers' parcel pick-ups)

Inside look of parcel operation

Chapelle International logistics hotel is located in the 18th arrondissement of Paris and has just been finished (January 2018) in terms of construction. The logistics hotel is a part of a bigger urban renewal project within the 'North-East Paris Urban Renewal Large Project' (Grand Projet de Renouvellement Urbain de Paris Nord Est) launched in 2002. The Chapelle International urban renewal project covers 6 hectares and is composed of two parts: the first part is an urban logistics facility of several levels (underground and overground), and the second part is a mix block with residential areas, offices, 'SOHO' (small offices home offices), urban public facilities and shops.

Chapelle International urban renewal project



Vue d'ensemble de la programmation générale du site de Chapelle. Source : Espaces Ferroviaires.

The new logistics hotel is located in 61 rue de la Chapelle. The 2.4 hectare land is connected by Paris North rail network, road networks (Rue de la Chapelle, Boulevard Ney, Boulevard périphérique, national road 1, and A1 highway) and public transport (Tram T3, Metro M12, Buses). The dimension of the logistics hotel occupies 24 203 m² grand surface (42 000 m² total floor surface), 390 metres long, 27 metres large and 7 metres height (above ground, with a total height of XX). The building has two functional levels – a ground level of 18 826 m² and an underground level of 17 758 m² - and a green zone on the roof.

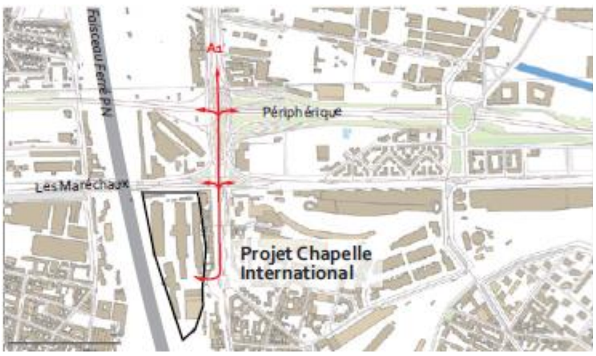
The Chapelle logistics hotel will accommodate rail freight operations as well as road operations. It is planned to become an urban distribution centre that will delivery to Paris city mostly. It is due to be inaugurated in April 2018. It is considered as an architectural innovation combining a rail-road terminal and consolidation centre before final deliveries thanks to the mixed used of facilities. The ambition is also to substitute diesel vans by electric vans for final deliveries.

Geographical situation of Chapelle logistics hotel

(Source: APUR, 2014)

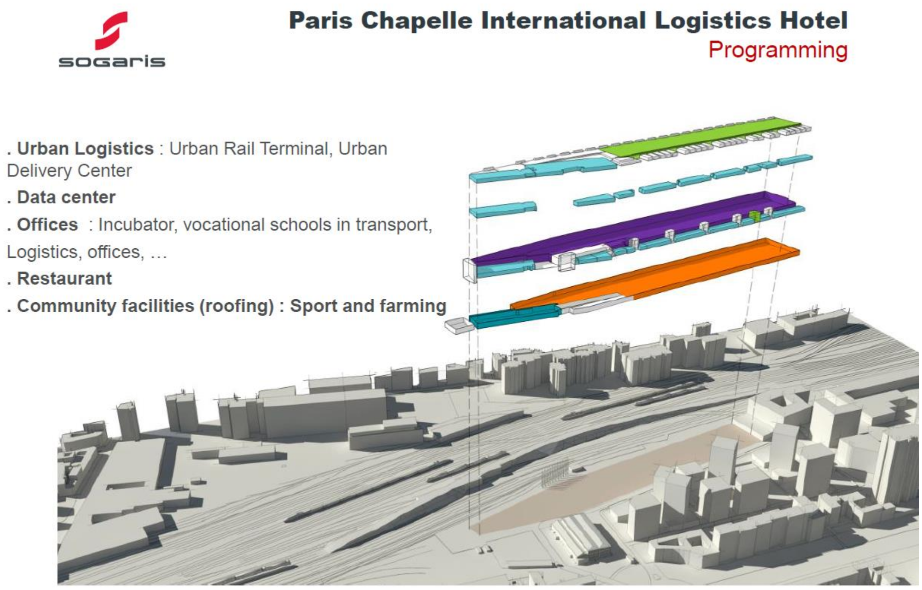
Location

Road connection



Chapelle International logistics hotel concept

(Source: Sogaris)



The innovative ideas behind the assessment of the two Paris logistics hotels are:

- Reduce negative impacts of deliveries - especially emissions (CO2, PM, NOx), noise and congestion - through consolidation and switch to cleaner modes of transport at points of entrance to dense urban area.
- Provide efficient, modern logistics facilities to businesses operating in the dense area of the Paris region.
- Provide rail access to one part of the building and promote urban rail freight.
- Reduce total vehicle kilometres by promoting (intermodal) urban terminals permitting consolidation and reduced mileage for last miles.
- Increase mixed activities – logistics activities, leisure, sport facilities, office spaces, urban farm – in specific areas of Paris.
- Test new architecture, planning and urbanism concepts for the integration of logistics facilities in dense urban areas: form, acoustic, energy efficiency, integration of pedestrian flows.

8.3 Implementation process

Urban planning has witnessed a change of paradigm in favour of sustainable development and urban renovation since the 1990s. At the French national level, in terms of urban land use, the Law on City (loi d'orientation de la ville) of 1991 and the Law on Solidarity and Urban Renewal (SRU, loi relative à la solidarité et au renouvellement urbains) of 2000 paved the way for reclassifying urban industrial lands for logistics activities in dense urban areas. In terms of urban transport planning, in 1982, the Law on Interior Transport (Loi d'orientation des transports intérieurs) resulted in the adoption of Urban Transport Plans (PDUs, plans de déplacements urbains). The specific modality of PDUs has been set up by the Law on Air and Rational Use of Energy (loi sur l'aire tl'utilisation rationnelle de l'énergie) of 1996, which introduced clear mandates to design strategies related to logistics buildings and freight mobility.

At the city level, in 2006, Paris issued a zoning ordinance (PLU, plan local d'urbanisme), which marked the start of a new wave of urban projects integrating logistics. The Paris zoning plan of 2016 has reinforced this policy.

At the same time, in 2006, the first Charter of Good Practices for Goods Transport and Deliveries in Paris (Charte de bonnes pratiques des transports et des livraisons de marchandises dans Paris) was signed. Although non-abiding on a strictly legal sense, the Charter put together different stakeholders: professional trade unions (freight and retail trade groups, chamber of commerce), agencies (rail infrastructure manager, port of Paris), large companies such as logistics and parcel delivery firms or major shippers (UPS, Geodis, Carrefour). It provided a written framework of the engagements of stakeholders to respect urban transport.

In 2013, the Charter has been renewed and become the "Charter for Sustainable Logistics" (Charte en faveur d'une logistique urbaine durable) with more than 80 stakeholders. It relies on greater involvement on the part of the signatories who undertake to develop or support projects that will assist the implementation of sustainable logistics.

The emphasis on environmental protection has also been reinforced. In 2015, the City of Paris introduced a low emission zone, which for vans and trucks is based on the Charter's objectives. This measure has a direct impact on express and parcel transport companies, especially for urban contractors (very small freight and delivery companies) which depend mainly on old vans and for which punctuality is key.

It is under this context that the Paris Living Lab has been initiated and developed. Among the 16 "Projects" presenting the concrete initiatives for the logistics sector of the 2013 Charter for Sustainable Logistics, the **Chapelle International logistics hotel** is the second project and the development of logistics spaces in conceded parking and in social housing blocks, which paved way for the development of **Beaugrenelle urban logistics space,** is the fifth project.

The Living Lab approach has made the realisation of the concept of Logistics Hotels possible. The Living Lab gathered different stakeholders – public authorities (the City of Paris and the Paris Region), urban logistics real estate developer (SOGARIS, a logistics real estate investor and manager whose capital is mainly controlled by the city of Paris) and logistics operators (Chronopost for Beaugrenelle terminal, XPO Logistics and Eurorail for Chapelle logistics hotel). The concept has been developed together by the stakeholders. The solutions have then been converted into a favourable regulatory and economic environment through discussions within the Living Lab. Both logistics hotels are assessed within the CITYLAB Living Lab, and replication possibilities are imagined there.

The Paris implementation studies two logistics hotels serving the dense area of the Paris region.

For **Beaugrenelle**, there have been regular site visits and discussions with different stakeholders. The CITYLAB team has participated in an assessment effort (finalized in January 2017). The main data have been collected by a consultant (IFSTTAR is part of the steering committee of this study).

It reveals that the initial plan was to create a mixed fleet with electric vehicles. After the first assessment, the company recently decided to rely less on electric vehicles and switch to natural gas vehicles due to the high costs and technical complexity related to the deployment of electric fleet. An important reduction in emissions (CO2, PM and NOx) has been achieved despite the reduction in the number of electric vehicles, thanks to the consolidation effect of an urban location.

Mooville, the electric delivery vehicle of Chronopost

Source: Chronopost, 2016

In **Chapelle**, construction work has been going according to the schedule and the building is now achieved. Tests are carried out (especially for the rail service) and inauguration is planned for April 2018.

Table 19. Main steps, activities and time plan of the Action.

Main steps and activities	Time
Initial data collection of Chronopost operation in Beaugrenelle	September 2015
Regular steering committee monitoring meetings of Beaugrenelle and Chapelle	September 2015 – Q4 2017
First study on logistics sprawl and urban logistics	November 2015 – February 2016
Regulars site visits from IFSTTAR to Chapelle	June 2016 – December 2017
Second study on logistics sprawl and environmental impact of urban logistics. Study on environmental impact of urban freight transport and service trip added.	November 2016 – January 2018

First ex-ante study on the Chapelle Living Lab process	November 2016 – March 2017
Assessment of clean fleet deployment of Beaugrenelle and consolidation effect Data collection of Beaugrenelle operation	January 2017
Data collection for Chapelle ex-ante behavioural analysis	February 2017 - April 2017
Chapelle ex-ante behavioural report	April-June 2017
Second assessment on clean vehicle fleet deployment of Beaugrenelle	Q1 2018

8.4 Effects and consequences

For **Beaugrenelle**, there have been regular site visits. Assessment efforts have been achieved. The main data have been collected by a consultant (IFSTTAR is part of the steering committee of this study). They have been made available in January 2017. The assessment study of Beaugrenelle has been completed while still using electric vehicles and a second assessment, if data is available, it will be completed to identify the changes in fleet composition. The assessment study, released in January 2017, shows an important decrease in freight vehicle kms 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.

In **Chapelle**, construction work went according to schedule and the official opening of the building will be effective in April 2018. What is assessed in the Chapelle case is NOT volume or operational achievement, but regulatory, technical and economic challenges when constructing logistics buildings in cities. In CITYLAB, the assessment of construction challenges has been done according to plan (Spring-Summer 2016). It has been translated in English and updated.

8.5 Challenges ahead

Economic/financial indicators are an important part of assessing the success or failure of a logistics hotel, as well as making it susceptible to reproduction, therefore it will be important to provide some sort of economic evaluation. However, the availability of data can be challenging.

For **Beaugrenelle**, it has not been permitted to publish economic data and results (while environmental data were fully available).

For **Chapelle**, as the site is not yet operational, the actual economic and technical sustainability is uncertain. We can only base on the *ex-ante* evaluation to assess the potential outcome and risks.

8.6 Lessons and generalisation of results

Urban land use is highly regulated and under a general trend of public policies aiming at reducing emission and promoting clean transport methods, there is little possibility to build logistics facilities with lorries transiting in and out, and frequent truck and van movements in a very dense, although mix-used, area of Paris. Progress in these types of complex projects involving multiple stakeholders depended largely on a regulatory and administrative framework, increasing the risks and uncertainty on the viability of the project.

The assessment of **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.

This is the first time an assessment has been made of the main regulatory, technical and economic challenges when building a major logistics terminal in an urban area. This report (a direct CITYLAB outcome) has been presented within the Paris Living Lab. Lessons can be transferred to other French and European cities.

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 Chapelle assessment study has demonstrated that discussions between stakeholders (within the Paris Living Lab) could help mitigate obstacles and go ahead with construction, dodging obstacles step by step. Energy and willingness from main stakeholders was key to mitigating barriers. In both cases, the Living Lab approach which emphasizes the cooperative process proves to be a constructive method to implement an innovative project as it allows partners to adjust the concept according to the real situations and needs of stakeholders and thus to reduce the long terms risks.

Recommendations will be provided for cities, operators and real estate investors interested in logistics hotels, as part of medium to long term urban planning. Partly following the CITYLAB report, the Paris zoning ordinance of 2016 (Plan local d'urbanisme) has incorporated lessons from Chapelle and Beaugrenelle implementations, and opened more land to future logistics hotels (the projects are Paris Bercy Charenton in Paris, and Vitry/Les Ardoines near Paris). One regulatory reform (a technical amendment to the interpretation of national the building code) has been adopted at the national administration level, easing the construction of logistics buildings in dense urban areas (arreté of April 11, 2017).

9 Closing remarks

This deliverable summarises the experiences from the seven implementations of the CITYLAB project. The information provided should give an understanding of the progress of the implementations, and summarises expected and experienced effects of the measures. The summaries will be used for subsequent evaluation activities of the project, looking at sustainability and profitability of the solutions as well as the potential upscaling and transfer of solutions to new contexts, cities and companies. Along with the summaries, data collection is done by the use of indicators developed in Deliverable 5.2 (CITYLAB, 2016). The indicator framework is generic, but the operationalisation of the indicators varies between implementations. Not all indicators are relevant for each implementation.

Overall, the CITYLAB implementations cover many different segments and types of freight flows. However, the main experience from each CITYLAB implementation is summarised in Table 20. Since these are real-life implementations there have been delays in the development process, however, this has provided opportunities to gather information on how to avoid this useful to others implementing similar solutions.

Table 20. Summarised main experiences from the CITYLAB implementations.

Implementation	Contributions and impact	Main experiences
Growth of consolidation and electric vehicle use (London)	A viable and transferable business model with identified barriers for growth and a potential to be implemented in other cities.	The business model is viable, but there have been 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.
Floating depot and city centre micro-hubs (Amsterdam)	Micro-hubs combined with clean vehicles is a successful concept, and PostNL would like to extend the concept to other cities and the remainder of Amsterdam.	Floating depots do not easily create a valid business case due to technical functionality of the depot and a cost increase compared to conventional daily practice. Cooperation between industry, research and local authorities result in better understanding of each other's point of view. There seems to be a strong business case for the implemented solution with micro-hubs and clean vehicles.
Increasing load factors by utilising spare van capacity (Brussels)	Development of a new online sales channel and proof-of-concept of new delivery solution utilising spare van capacity. Identified opportunities for transferability to other contexts such as emerging market economies where this retail channel is dominant.	Finding service-driven companies with spare capacity and a dense network willing to participate was feasible. The main recommendation is to use a network of service-driven companies that can pick-up products from a centrally located distribution centre. The new solution requires a change in purchasing behaviour, which is a significant step. Among storeowners the adoption willingness depends on the price of the products, and the willingness and ability to pay and order online. For a manufacturer, the solution is a way to (re-)establish direct contact with the storeowner and make sure the products are available.
Joint procurement and consolidation (Southampton)	Documentation of possible extensions of the financially viable Sustainable Distribution Centre in Southampton. Promoting and undertaking 'delivery and servicing plans' (DSPs) across a range of business and municipal organisations across Southampton to enable them to	A good understanding of all existing contractual commitments between the large municipal organisations (LMO) and suppliers that might be affected by any proposed changes is needed. It is also important to have a robust contractual commitment between the LMO and the operator of a consolidation centre. Managers in LMOs need to be convinced that the tangible benefits will

Implementation	Contributions and impact	Main experiences
	review and rationalise their procurement processes and mitigate the negative impacts of freight and service vehicle movements. A review of the activitity of the municiaplitiy's in-house of fleet of 700 vehicles led to a long-term commitment to replace conventional vehicles with electric ones.	outweigh the costs before any changes can take place. A dedicated consolidation centre may not be able to 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 readily adapt to changing volumes and initial slow take-up. Also, a highly flexible and non-prescriptive approach is required from the operator of a consolidation centre to suit individual customer needs
Common logistics functions for shopping centres (Oslo)	Documentation of experiences from several centres exploring common logistics functions. Improved dialogue between shopping centre managers, the logistics industry and retailers, allowing the shopping centre manager to capture customer needs and adapt the design of the Økern shopping centre to allow for common logistics functions.	It is important to include real-estate owners in last mile logistics since they define the infrastructure used for deliveries. Concerning common logistics functions, it is key to engage stakeholders in the planning process and to design the common logistics functions so that it fits the needs of all stakeholders e.g. size storage area and new technical solutions for freight deliveries. The challenge with this solution is the division of costs and benefits between stakeholders. It is possible to incorporate costs for the solution into the rent when new shopping centres are established with common logistics functions in place from the beginning Improved management of waste is also one means of funding common logistics functions.
Integration of direct and reverse logistics (Rome)	Proof-of-concept combining direct and reverse flows. Integration of forward and reverse logistics might be included as a medium-long term objective within the Sustainable Urban Mobility Plan in Rome.	Waste management requires involving both the Transport and the Environmental Department. It is key to consider the type of material, transport operator, collection site and collection boxes and to develop an application-based alert system for when to collect the materials. Combining research, industry and cities to work with this issue proved successful innovation and collaboration mechanisms.
Logistic hotels (Paris)	Documentation of effects from one logistics hotel in operation and process experiences from establishing a second one. The Paris zoning ordinance of 2016 (Plan local d'urbanisme) has incorporated lessons from Chapelle and Beaugrenelle implementations, and opened more land to future logistics hotels.	The issues that may impact the operation of the mixed function facilities are the regulatory and technical complexity, the economic viability of the business model and the engagement of stakeholders. It is also clear that a strong political voluntary and coordination is essential to the implementation of such innovation.

A common element is the need for stakeholder collaboration as the solutions and measures are not just in the hands of one stakeholder. In many cases, the support or intervention of local authorities is needed. For instance, in London, the collaboration with Transport for London has been vital for the industry partners. The operations with electric vehicles also benefit from exempt from congestion charge. In Amsterdam, PostNL benefits from collaboration with the local authorities for facilitation of micro-hubs. On the other hand, in Brussels and Oslo, the role of authorities is more limited, but the need for private-private collaboration is even stronger.

It has also been crucial to make small adjustments to the business models as the implementation has developed over time (London, Amsterdam, Oslo, Brussels, Southampton). Minor adjustments can make a large difference e.g. the price of the common logistics function already included in the rent compared to having to implement the costs afterwards. This reflects the willingness of organisations to make operational changes to logistics practices in favour of sustainability when the outcome, although positive, will inherently impact (potentially negatively) on customer/client experience.

A clear political will and the support of local government has played an important role in securing funding and building partnerships in the project. Public sector involvement, often across municipal agencies, is key in several of the implementations (Paris, Rome, Southampton, London). E.g. in Rome waste management required involving both the Transport and the Environmental Department. The challenge of being dependent on the public sector is their ability to connect their visions to policy actions. Strong political voluntary effort and coordination is essential to the implementation of urban freight innovations. The ability and willingness of local authorities to implement policy measures to positively drive forward sustainable logistics practice has been crucial in some of the implementations.

Pilot and field surveys/studies to gain accept and interest of end-users is beneficial to fine-tune the implementation according to users' preferences, i.e. to understand their expectations to increase their participation. This was done in Rome, Brussels, Southampton and Oslo. In Brussels, a sales representative visited the stores to explain the concept, website, products and prices.

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Annex: Fact sheets for each implementation

GROWTH OF CONSOLIDATION AND ELECTRIC VEHICLE USE - LONDON

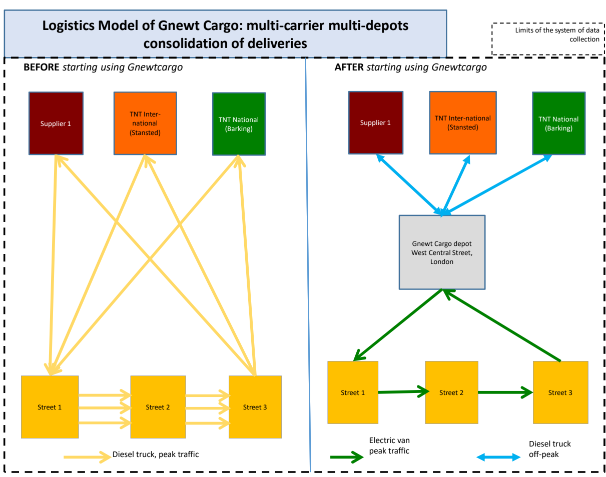
PROBLEM AND AIM

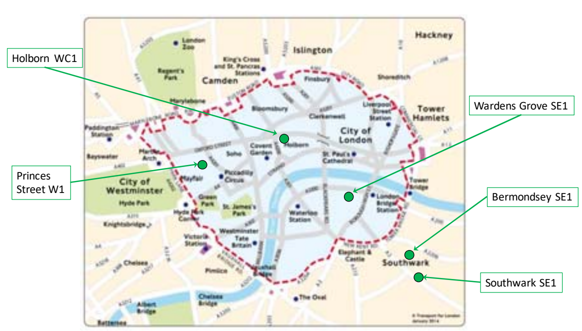
1. little or no growth in most inner city consolidation centres and electric freight vehicles (EV),
2. the conditions for future growth are not well understood
3. there is a need to gain better understanding of business models for clean deliveries with electric vehicles and tricycles.

Objectives of the London Living Lab implementation are

- to test different business models with a parcels delivery provider (TNT UK) and a carriers' carrier (Gnewt Cargo) in central London,
- to evaluate the benefits of the solutions and scenarios for public and private sector
- as a legacy, to know how to scale up different business models

DESCRIPTION OF THE SOLUTION





IMPLEMENTATION PROCESS

2 years of implementations of different business models and scenarios

RESULTS TO DATE

- Distance and fleet reduction in km/parcel: 67%
- CO_2 and air pollutant reduction in gCO_2e/parcel: 100% reduction on exhaust
- Energy reduction in goe/parcel: 87%
- Empty distance reduction in monthly empty distance: 93%
- No fleet reduction, no reduction in number of staff

Distance, parcels and fleet data

BEFORE deliveries starting from Barking	Number of vehicle trips per day	Monthly distance in km	Parcels delivered during month	Distance in km/ parcel
Van TNT domestic	10	24,647	30,089	
Average				0.82
AFTER Gnewt Cargo operations				
Electric Van Gnewt	10	5,663	21,211	0.267
% reduction	0	77		67

CHALLENGES

- Lack of affordable space in city centre
- 1.5 year search for suitable logistics space in city centre did not lead to results yet
- Lack of bigger 3.5t electric van with at least 15 m^3 volume and 1.4 t load weight capacity
- Shared use of depots, vehicles and customer data
- Growth in operational scale implies a shift in business contracts from one subcontractor to another

OPPORTUNITIES

- Specific access rules for electric vehicles and cycles for certain urban areas such as pedestrian zones and other restricted areas (no Central London Congestion Charge fees)
- Authorisation to use restricted parking and permit bays and for loading bays in central areas
- Consistency in rules for electric vehicle parking and stopping areas across different London Boroughs
- Help in finding logistics depots that are reasonably priced, but centrally located
- In the case of absence of any suitable depots, develop a land-use policy with dedicated areas reserved for sustainable logistics, and investments in new, suitable inner city depots
- Having a regular contact with local businesses and helping to coordinate the activities around new sustainable freight and new solutions for different clients, big and small
- Help develop and test different types of suitable technology with research funding

CONTACTS

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Transport for London https://tfl.gov.uk/info-for/deliveries-in-london/
Gnewt Cargo www.gnewtcargo.co.uk

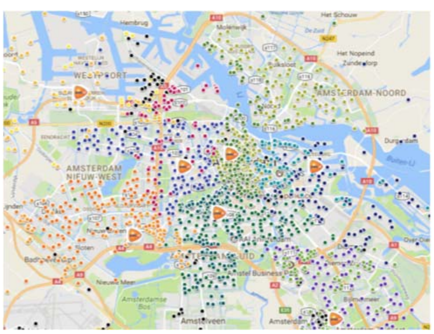
CITY CENTRE MICRO-HUBS - AMSTERDAM

PROBLEM AND AIM

- The Amsterdam implementation action aims to improve last mile logistics making better use of available infrastructure
- Trying to reduce and avoid the congestion, making deliveries in a sustainable way

DESCRIPTION OF THE SOLUTION

- 8 micro-hubs within Amsterdam
- Zero emission electric vehicles: 60 e-freight bikes
- Efficiency increase due to less parking and shorter routes
- Less emission and lower costs



IMPLEMENTATION PROCESS

- After some initial attempts to focus on transport on the canals with a floating depot, a shift was made to distributions via micro-hubs with e-freight bikes
- Started with one micro-hub, later concept was rolled out over the inner city

RESULTS TO DATE

- Now 6 micro-hubs within Amsterdam
- Zero emission electric vehicles: 45 e-freight bikes
- Several types of e-freight bikes tested

CHALLENGES

- Dedicated bicycle planning software required
- Difficult to find a sufficient amount of freight bike drivers

OPPORTUNITIES

- Extending operations: delivering packages, local delivery and evening delivery
- Upscaling planned to all other big cities in the Netherlands
- Use of the canals on the longer term

CONTACTS

postnl

TNO innovation for life

INCREASING VEHICLE FILL RATES BY UTILIZING SPARE VAN CAPACITY - BRUSSELS

PROBLEM AND AIM

Vehicles with a low vehicle fill rate (VFR) are an important contributor to congestion, particularly vans.

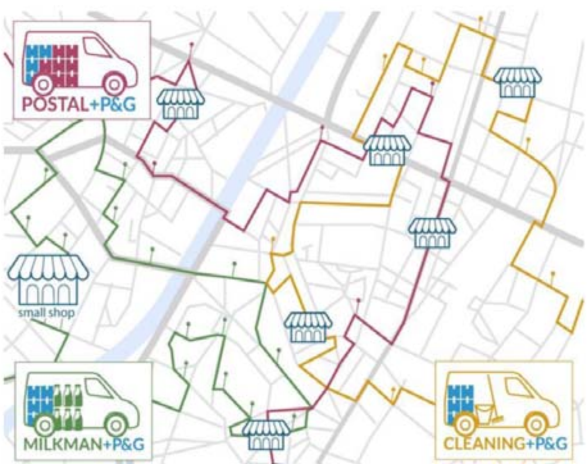
The CITYLAB implementation in Brussels focuses on two types of freight transport with suboptimal VFRs:

1. Independent store owners mostly replenish their stores at a high frequency by visiting a wholesaler/retailer with their own vehicles.
2. Service-driven companies (e.g., plumber, cleaning services). have daily delivery/service trips, regardless of being fully loaded.

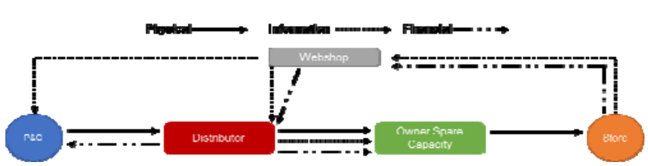
DESCRIPTION OF THE SOLUTION

The scope of the initiative is to supply fast moving consumer goods (FMCG) from Procter & Gamble (P&G) to small, independent retailers, or nanostores.

Field research indicates that most nanostores in Brussels are supplied by the owners themselves who visit a wholesaler or modern retailer. The aim of the implementation was to test whether individual trips from storeowners to wholesalers or retailers can be avoided and whether VFRs can be increased by unlocking spare transportation capacity in vehicles of service-driven companies.



A dedicated assortment of P&G products was offered in a web shop, operated by an external distributor. Nanostore owners could order P&G products in the web shop and pay online. Following the payment, the distributor informed Febelco that they would have to carry out a delivery and delivered the products to the distribution centre (DC) of Febelco. Febelco is a distributor of pharmaceutical products. Their customers (pharmacies) are delivered one to three times per day on demand. When they received delivery information, Febelco added the additional delivery to its routing.



IMPLEMENTATION PROCESS

- The solution does not require support from authorities
- Alignment between several P&G departments was needed
- Delay because the company web shop for employees could not be used for online sales to nanostores
- Involvement of several external partners is required:
  - A distributor to manage, store and sell the P&G products
  - A web shop developer
  - A sales company with knowledge of the nanostore retail channel in Brussels. Their sales representative visited stores to introduce the solution and place the first order
- Important steps in the implementation process
  - development of the new supply chain set-up
  - involving owners of spare transportation capacity
  - selection of the product assortment and setting prices
  - developing a web shop
  - involving nanostores

RESULTS TO DATE

Only 5 stores placed an online order.

Surveys among shop owners in Brussels (58) and Antwerp (27) revealed that their behaviour regarding product purchasing and acquirement (delivery and/or pick-up) is key:

- Reluctance to pay for products prior to delivery
- Going to the wholesaler with their own vehicle is not considered as a cost
- Some store owners do not have an online bank account or a device from which an online order can be made
- Some store owners prefer to pay in cash
- Going to the wholesaler or retailer is a habit

The 5 orders were delivered by Febelco. In Business as usual, trips to get supplied with P&G products were done by shop owners themselves. In the CITYLAB solution, deliveries were done by Febelco. It appeared that Febelco did not have to drive additional kilometres to deliver the goods to the stores, they could fit them in their planned high stop density tours.

CHALLENGES

- Engaging shop owners by:
  - Changing their perception that supermarket promotions are always cheaper
  - Changing their perception that supplying themselves does not involve a cost
  - Convincing them to start ordering and paying online, and upfront to avoid costly and inefficient own account trips
- Offering a wider product assortment to avoid wholesaler pick-ups

OPPORTUNITIES

- Offering a product range from more than one manufacturer
- The implementation proved that it is operationally feasible to use spare transportation capacity in vehicles of service-driven companies operating in an urban context

CONTACTS

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JOINT PROCUREMENT, CONSOLIDATION AND ELECTRIC VEHICLES – SOUTHAMPTON

PROBLEM AND AIM

Improve air quality in city centre and along main access roads.

DESCRIPTION OF THE SOLUTION

Complementary solution approach comprising:

1. Delivery and Servicing Plans (DSPs) for businesses and organisations to review and rationalise procurement practices and resulting freight impact
2. Consolidation of incoming deliveries to large municipal organisations (LMOs, e.g. hospitals, universities, council) at the Sustainable Distribution Centre (SDC), operated by Meachers Global Logistics (pictured below)
3. Use of electric vehicles by Southampton City Council (SCC)

IMPLEMENTATION PROCESS

The Citylab partners have driven the process through:

- Consultation with procurement personnel at major freight generators (e.g. General Hospital, Solent University, Associated British Ports) to discuss issues and solutions
- Offering and undertaking DSPs as an incentive to participate
- Drafting of an informal memorandum of understanding
- Undertaking scoping studies to estimate benefits and costs of using SDC (e.g. for university halls of residence and for hospitals in Southampton and Isle of Wight) and for SCC's use of electric vehicles
- Uptake of solutions where considered beneficial:
  - Southampton General Hospital use of SDC
  - SCC phased introduction of EVs into in-house vehicle fleet

RESULTS TO DATE

Scoping study for consolidation to university halls of residence indicated savings of around 2 hours per day for hall reception staff and a 35% reduction in delivery visits. Concerns about cost (£18/student) and reduced service levels (delivery delays) were barriers to implementation.

DSP audit of Southampton General Hospital indicated 900 delivery vehicles per week (71% vans, 18% lorries); small-scale use of SDC to date, with more use planned, but no results.

DSP audit of St. Mary's hospital, Newport, Isle of Wight, led to detailed implementation planning for use of SDC but plans were eventually shelved after appointment of a new supply chain manager.

SCC have stated their intention to introduce EVs on a wide scale aiming for at least a 20% EV fleet by 2020. To date, 6 EVs have been purchased.

CHALLENGES

The main challenges are organisational and financial:

1. Persuading organisations to make logistical changes in favour of sustainability when the outcome may negatively impact the customer/client experience (e.g. slower delivery)
2. Competing priorities and limited funding streams within LMOs – resources for logistics-related issues are scarce
3. Staff turnover within LMOs can result in a lack of continuity in planning (as seen at Isle of Wight Hospital Trust).

OPPORTUNITIES

Although take-up to date has been rather slow and disappointing, 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. Ultimately, decisions whether to implement changes or not will be taken outside the control of the Citylab project and the living lab. In the meantime, the living lab members will continue to communicate with the LMOs to support and further promote the logistics solutions. Once one LMO takes the initial leap, it is expected that others will follow. Dissemination of information to hospitals outside the Southampton area will occur through various NHS Trust networking groups.

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COMMON LOGISTICS FUNCTIONS FOR SHOPPING CENTRES - OSLO

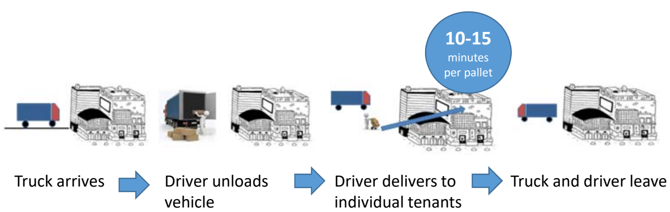
PROBLEM AND AIM

Improve the conditions for efficient deliveries, return logistics and waste management to shopping centres and reduce the impact of freight movements. The Oslo implementation, the Økern shopping centre, will develop common logistics functions to be permanently full-scale implemented.

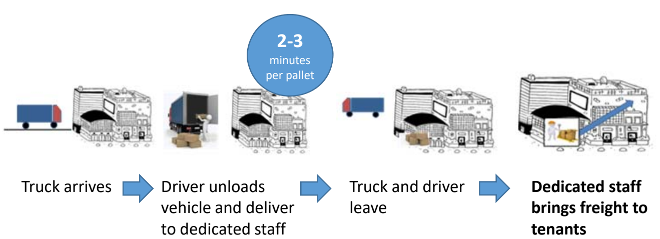
DESCRIPTION OF THE SOLUTION

The in-house movements of freight from the freight reception area to individual tenants is performed by a dedicated staff from the common logistics function and is thus decupled from the driver and vehicle. The company offers receipt of deliveries, temporary storage space and in-house movements of goods and waste.

- The situation **without** common logistics function



- The situation **with** common logistics function



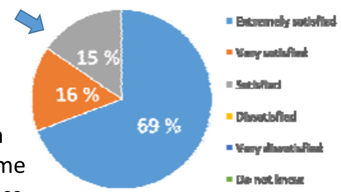
IMPLEMENTATION PROCESS

The most critical phase for ensuring the solution was the planning process, where the CITYLAB Oslo implementation actively contributed. Knowledge generated from dedicated CITYLAB on-site inspections at other shopping centres, CITYLAB workshops with stakeholders affected by common logistics functions, bilateral stakeholder interviews and surveys have contributed to the design, organisation and scope of the planned solution at Økern shopping centre.

RESULTS TO DATE

- Reduced dwell times for delivery vehicles in the freight receipt area. An observed time reduction of **10 to 15** minutes per pallet delivered for the drivers using the solution.
- Improved in-house logisitics and fewer individual transports inside the shopping centres.

- Better waste handling and increased degree of waste sorting
- Satisfied store employees. **69%** extremely satisfied with the common logisitcs solution during a trial project at one of the shopping centres investigated



CHALLENGES

The main challenge of the Oslo implementation case was to gain stakeholder support and overcome the low initial adaption willingness. Support from shops and logistics service providers is essential in order for the solution to be successfully implemented. Agreement on the organization and financing of the common logistics function solution proved to be the most difficult challenge to overcome, especially since costs and benefits are dispersed on several stakeholders.

OPPORTUNITIES

Very few Norwegian shopping centres have common logistics functions. The CITYLAB project will communicate the logistics solution and if Økern shopping centre manage to establish a well working offer, further uptake of common logistics functions in the Steen & Strøm group and in other establishments is expected.

The common logistics function is also an applicable solution for consolidation of freight deliveries to areas in city centres where consolidated last mile deliveries is a more sustainable solution for the city as a whole.

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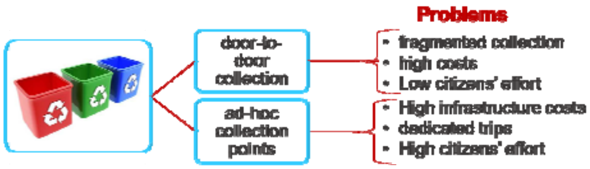
Steen & Strøm AS
Pål Samuelsen pal.samuelsen@steenstrom.com

INTEGRATING DIRECT AND REVERSE LOGISTICS - ROME

PROBLEM AND AIM

The urban waste collection system is fragmented, expensive and inefficient.



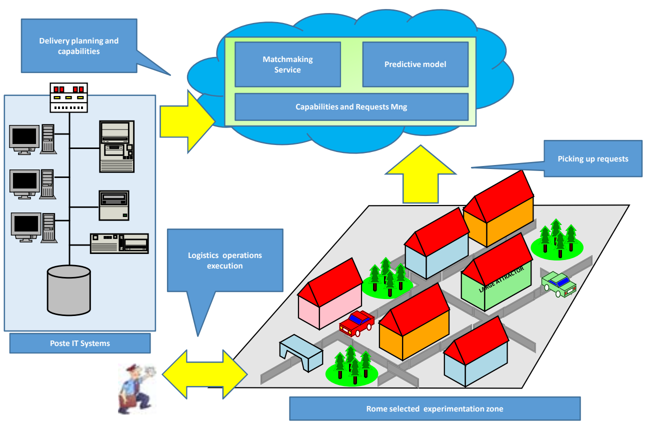
Objectives

- Increase recycling

- Reduce transport's negative externalities

DESCRIPTION OF THE SOLUTION

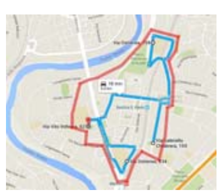
- Urban waste management's efficiency can be increased by **integrating direct and reverse logistics flows.** In particular, the main idea is to involve the national postal operator, already delivering mail/parcels all around the city, in the pick-up, via electric vehicles, of **recyclable materials** 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**.



IMPLEMENTATION PROCESS

- The core partners have decided to perform several **Living Lab rounds** starting from a small-scale implementation later to be up-scaled.

- In the **first round** (completed) the type of recycled material considered was limited to plastic caps and the area covered was minimised (~1Km^2) involving University buildings as large attractors, in order to practically implement the solution in a real-life context and discover organisational problems as well as market opportunities.



- The **second round** (on-going) explored the opportunity to extend the implementation in terms of flows involved, sites and alternative recyclable/reusable waste by including the solution tested in the first round within the actual logistics process for urban waste management of the city of Rome according to the guidelines recently announced by the Mayor.

RESULTS TO DATE

- *First round of the Living Lab*

- +153%

- \- 40Kg of CO_2 → **- 13,200Kg of CO_2**
  (monthly) (estimated monthly in Rome)

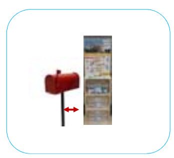
- *Second round of the Living Lab*

Preliminary estimations, linked to the deployment of the system tested in the first round of the Living Lab to specific **hazardous materials** (exhausted batteries and oils, pharmaceuticals and WEEE) collected at "*domus ecologiche*" (fenced areas of about 25 square meters located in proximity of an aggregation of condominiums), reveals that a total of 17,236 Kg of CO2 can be annually saved if considering the involvement of 25% of the condominiums in Rome.

CHALLENGES

- increase **financial** revenues

- **regulatory**/contractual constraints



- **Locating** recycling facilities

OPPORTUNITIES

- Several key points characterising the **environmental policy action plan** in Rome could potentially benefit from the adoption of the integrated forward-reverse flows solution in the Living Lab implementation. For instance: (i) improve separate collection systems; (ii) implement recycling in schools and public buildings; (iii) develop a recycling plan for small WEEE; (iv) design a new system for recovering highly polluting vegetable oils locating containers in public areas; (v) create new public collection centres for domestic metals production. Focusing on hazardous materials represents an opportunity to reduce illegal discharging of toxic/dangerous waste

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LOGISTICS HOTELS - PARIS

PROBLEM AND AIM

Paris has a very high population density and land use. Logistics rents average €100-150 per sq m per year (whereas office property is triple to the eightfold) while suburban rents are around 50-70. Thus, the choice of warehouse location tends to relocate towards far away suburban areas (“**logistics sprawl**”).

The implementation aims to address the negative consequences of “logistics sprawl” by reintroducing logistics terminals in dense urban areas. Warehouse location has a direct impact on truck-kilometres in the urban region.

DESCRIPTION OF THE SOLUTION

The main concept of the Paris implementation is to develop and assess a model for logistic facilities called “**logistics hotels**”. Logistics hotels are a key element of the City of Paris’ strategy to reintroduce logistics activity in dense areas.

The implementation considers two logistics hotels in Paris, developed by the city’s logistics real estate company SOGARIS. **Beaugrenelle** is already functioning, and CITYLAB focuses on the effect of its operation. For **Chapelle** logistics hotel, being built with rail access and opening in April 2018, the implementation is not assessing volume or operational achievements, but regulatory, technical and economic challenges when constructing logistics buildings in cities.

Chapelle is a **mixed-use operation** (sport facilities, offices, data center, urban farm). Both Chapelle and Beaugrenelle are **mutli-story buildings**.

IMPLEMENTATION PROCESS

For Beaugrenelle, there have been regular site visits and an assessment study has been conducted. Chronopost is the sole operator of this urban delivery centre. Before Beaugrenelle, Chronopost was running a regular service from a suburban cross dock terminal located 10 km from Paris. The urban location of the depot made **consolidated shipments** possible all the way to Beaugrenelle (with Chronopost trucks), then contractors take over. 11 employees and 50 drivers (incl. subcontractors) of Chronopost handle 6 500 parcels and 3 500 deliveries per day. Current Chronopost/subcontractors fleet is composed of 28 Euro 6 diesel vans and 2 electric vehicles.

Organisation of the Beaugrenelle urban distribution space
Source: Sogaris and Chronopost

In Chapelle International, the construction work is now finished. There are on-going tests of train operations. The logistics hotel will be operational from April 2018 with a slight delay from previsions. Works have been finished in Nov-Dec 2017 as planned. The CITYLAB team has followed the planning and construction process. This is the first time an assessment is made of the regulatory, technical and economic challenges when building a major logistics terminal in an urban area.

Rail terminal Chapelle nearly finished

West façade of building

Mixed-use operation, construction site on Chapelle 01/2018

RESULTS TO DATE

The assessment study of Beaugrenelle showed that compared to the distribution without consolidation, it contributed to the following **emissions reductions**: 50.4% CO_2; 52.4% PM; 47.8% SO_2; 34.3% CO and 34.7% HO; as well as a veh.km savings of 52%. In 2016, it contributed to the 8% reduction of noise with the deployment of electric vans.

The Chapelle assessment study has demonstrated that discussions between stakeholders (within the Paris Living Lab) could help mitigate obstacles to go ahead with construction. **Coordination, energy and willingness** from main stakeholders was key to mitigating barriers. **Rail** (which was required at the time of the building permit) has added substantial investment costs.

CHALLENGES

The Chapelle logistics hotel, being the largest of its kind in Europe, demonstrates the obstacles facing these types of urban projects. It is clear that a strong **political coordination** is essential to the implementation of such innovation.

The rigidity of rail transport represents one constraint. The train paths (slots) are fixed and must be booked well in advance. This does not match the high frequency and flexibility that urban last mile deliveries require. Rail services, especially in France, are costly.

OPPORTUNITIES

The Paris zoning ordinance (Plan local d'urbanisme 2016) has incorporated lessons from Chapelle and Beaugrenelle implementations, and has opened more urban land to future logistics, potentially multi-uses. The City of Paris has launched new tenders for similar projects. Sogaris is competing for example for a new logistics hotel in the Bercy area (southeast Paris). Decision will be made in Spring 2018. There is also a lot of interest from other cities to learn from Paris. In the Greater Paris, several projects are being decided or implemented (e.g. in Vitry/Ardoines, where Sogaris has won a bid in Oct 2017).

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