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Sustainability analysis of the CITYLAB solutions

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CITYLAB consortium by Living Lab			
Living lab	**Municipal partner(s)**	**Industry partner(s)**	**Research partner(s)**
Brussels	Brussels Mobility	Procter & Gamble Services	Vrije Universiteit Brussel
London	Transport for London	TNT Gnewt Cargo	University of Westminster University of Gothenburg
Oslo	Oslo kommune	Steen & Strøm	TOI
Paris	Mairie de Paris		IFSTTAR DLR
Randstat	Gemeente Rotterdam	PostNL	TNO
Rome	Roma Capitale	Poste Italiane MeWare SRL	Università degli studi Roma Tre
Southampton	Southampton City Council	Meachers Global Logistics	University of Southampton
Networking and outreach partner			
POLIS			

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Executive summary

The objective of the CITYLAB project is to develop knowledge and solutions that result in roll-out, upscaling and further uptake of cost effective strategies, measures and tools for emission free city logistics. CITYLAB includes a set of Living Laboratories where promising logistic concepts are implemented related to emissions free city logistics. Deliverable 5.4 is the fourth deliverable within the evaluation work package. The objective of this deliverable is to assess the possible impact when the CITYLAB implementations are scaled up. The main challenge that has to be overcome is the difference in type, availability and detail of data from different CITYLAB implementations.

This assessment of the impacts of upscaling is done by integrating all stakeholders' opinions in the evaluation process and taking into account the costs and benefits for society as well as the financial viability for industry partners. At first, business as usual situation is compared to what happened in the implementation. For this, CITYLAB Deliverable 3.2 and CITYLAB Deliverable 5.3 are largely used, describing the objectives, operation and effects of implementations. The effects from implementations present the baseline for upscaling. Research partners, involved in the CITYLAB implementations proposed viable upscaling scenarios. Based upon the data available, and the impact and effect of the CITYLAB implementations, the effects after upscaling are estimated. For each implementation, two scenarios were identified and further developed. This is an exception for Brussels, where eight alternative scenarios were simulated and analysed. CITYLAB upscaling scenarios are:

- Amsterdam: shared logistics micro-hubs implementation:
  - Upscaling scenario A: All deliveries conducted by electric bikes
  - Upscaling scenario B: CITYLAB solution applied to another city
- Brussels: unlocking free capacity of service-driven companies to cost-efficiently supply consumer goods to nanostores implementation:
  - Eight upscaling scenarios with various level of replenishments ordered online
- London: clean delivery via inner city depot implementation:
  - Upscaling scenario A: The volumes through Gnewt will increase by at least 20% per year in the next 5 years
  - Upscaling scenario B: When more companies start using electric vehicle for the last mile
- Rome: integration of recycling logistics into existing flows implementation:
  - Upscaling scenario A: implementation is applied to the whole Rome territory
  - Upscaling scenario B: implementation applied to different recycling materials
- Oslo: common logistics functions in shopping malls implementation:
  - Upscaling scenario A: implementation is applied to all biggest shopping centres in Oslo and Akershus
  - Upscaling scenario B: implementation is applied to all big and medium shopping centres in Oslo and Akershus
- Paris: implementations addressing negative "logistics sprawl":
  - Upscaling scenario A: Chapelle logistics hotel is running four trains a day
  - Upscaling scenario B: Increase the number of Beaugrenelle type of solutions in Paris
- Southampton: implementations reducing emissions from the large municipal organisations:

- o Upscaling scenario A: All residence halls of Southampton Solent University and Southampton university are using consolidation centre for the combined deliveries
- o Upscaling scenario B: all municipality fleet is turned to electric vehicles.

CITYLAB implementations are in different operational stages: some are only in a planning process, some are currently being developed and tested, others are already existing and for them ex-post evaluation was carried out in the framework of the project. That is why, the amount and quality of data differs a lot per implementation and therefore the final step in this research is done by using several different evaluation tools. For example, business model canvas is used in order to assess they key effects from implementations and upscaling scenarios. Dashboards are used as efficient data collection tool, necessary for the quantification of scenarios. For the upscaling of Brussels case, general model SYMBIT was used. The multi-actor multi-criteria analysis (MAMCA) workshops focus on the evaluation of CITYLAB solution on the objectives of each of the stakeholders involved and use this as input for a MAMCA. This method provides insight into the extent to which the CITYLAB implementations contribute to the criteria of the stakeholders.

Active involvement of the end users and integration of their opinion into the implementations is one of the key features of the living lab approach. That is why, next to the identification of the economic and societal benefits from the upscaling, a more detailed look into stakeholder opinions and the changes of this opinion depending on different alternative scenarios of implementation are studied. The conclusions from the MAMCA workshops differ a lot per implementation. For example, involved stakeholders support implementations in Amsterdam and Rome in their current form. In London the solution with the changed depot location of preferred by all stakeholders. The Paris solution also got the most stakeholder support, while Oslo and Brussels show mixed results across stakeholders.

1 Introduction

1.1 Background and overview of CITYLAB

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.

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

Work already carried out in CITYLAB has evaluated the expected economic, social and environmental outcomes of the initiatives in the seven CITYLAB implementations. The results of this analysis are provided in Table 2 and reflect expected improvements in operational efficiency, traffic safety, air quality, and carbon dioxide (CO_2) emissions across the seven implementations. Table 2 reflects the wide coverage of the expected positive efficiency, traffic and environmental impacts of the CITYLAB implementations, beyond that of CO_2 emissions reduction (CITYLAB, 2016).

Table 2. Analysis of Living Lab implementations and their expected positive economic, social and environmental impacts.

Logistics impacts	London	Amsterdam	Brussels	Southampton	Oslo	Rome	Paris
Reduction in vehicle kilometres	✓✓	✓✓	✓✓*	✓✓	✓	✓✓	✓✓
Reduction in CO_2 emissions	✓✓	✓✓	✓✓	✓✓	✓	✓✓	✓✓
Improvement in air quality	✓✓	✓✓	✓✓	✓✓	✓	✓✓	✓✓
Reduction in logistics-associated noise and disturbance	✓	✓	✓	✓	✓	✓	✓
Reduction in total time spent by vehicles on roads (driving/ loading / unloading)	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓
Retiming of logistics operations (i.e. out of peak period)	✓	✓		✓	✓		✓
Alleviation of logistics sprawl**	✓✓	✓✓		✓✓			✓✓
Promotion of alternatively-fuelled / clean delivery vehicles	✓✓	✓✓				✓	✓✓
Reduction in time spent by receivers on goods reception and internal logistics	✓✓	✓✓	✓✓	✓✓	✓✓		✓✓

✓✓ - expected outcome ✓ - possible outcome * - also expected to reduce car trips by shop owners
** - In the sense of reducing the need for road-based stem mileage.

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

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

Relating to the first role, the CITYLAB implementations are initiated from engaged private industry partners who believe their implementation is financially and environmentally sustainable. The CITYLAB implementations receive no funding for equipment purchase (i.e. capital expenditure) or subsidy of operating costs. CITYLAB funds the implementations by 1) supporting labour efforts from the research team studying the ongoing processes in their hometown implementation, collecting quantitative and qualitative data concerning the solutions, impacts and disseminating lessons learned, and 2) partially supporting the industrial partner in setting up these implementations.

Secondly, the implementations act as gate-keepers in building partnerships needed for developing city logistics living labs. Several ex post EU and global level evaluations have shown that multi-stakeholder deployment is the key challenge in the city logistics innovation process. In CITYLAB, we use Living Labs, which is new in city logistics, as an implementation approach to foster innovation deployment. The concept of Living Labs, compared to conventional demonstrations, creates an experimentation environment in which stakeholders such as citizens, governments, industry and research, together aim at achieving a shared long-term goal. Using an iterative cyclical approach of planning, implementing, evaluating and acting (CITYLAB, 2015), the ambition is to reduce conflicting stakes from different backgrounds and to speed up real-life developments and deployment of innovations. In this environment stakeholders can co-design, explore, experience and refine new policies, regulations and logistics actions. This implies a process in which implementations are tried out, supported by dynamic prediction and evaluation tools, where the environment is adapted to make it work, and where barriers are directly dealt with to have a maximum impact. City logistics living labs require continuous cooperation between research, industry and authorities. Since the seven CITYLAB cities have different experience levels of cooperation between these three types of actors, CITYLAB aims at using good examples from advanced cities to transfer knowledge to the others e.g. from the charter in Paris to clean air cooperation in Southampton. Additionally, the CITYLAB implementations provide a groundwork for continued cooperation after the project life-time.

Finally, the seven CITYLAB implementations provide detailed insight and understanding to how the selected initiatives achieve their objectives and how they should be prepared, organised and **supported to achieve these objectives**. That is why CITYLAB does not stop when the initiatives have been implemented. The outcome of the local implementations will be used for a **transferability analysis**, transferability workshops in the seven CITYLAB cities and a transferability trajectory with 7 non-CITYLAB cities. CITYLAB also has 18 **follower cities** who expressed interest in following one or more CITYLAB implementation. In combination with the dissemination activities, CITYLAB aims to facilitate roll-out and/or upscaling of the successful CITYLAB initiatives.

CITYLAB project consists of several interrelated work packages:

- Knowledge Development and Data Management – WP2 (to collate, refine and further develop existing knowledge as well as create new knowledge and analyse key trends currently influencing urban freight transport in a Data Observatory)
- Living Laboratories – WP3 (to establish Living Labs in the CITYLAB cities as a co-creation of the (local) CITYLAB research partner, city partner and industry partner including the development of a methodology that enables cities to set up a Living Lab as a way to improve the local urban freight sustainability issues, support Living Lab processes in the seven Living Labs set up in CITYLAB)
- Implementations – WP4 (supporting the seven implementation actions initiated by the industry partners and collecting data as basis for evaluation of the concepts and processes)
- Evaluation – WP5 (to thoroughly analyse how well the seven CITYLAB implementations perform in a specific context and analyse whether the successful ones could also be transferred to other cities)
- Living Lab Interaction and Transfer – WP6 (to promote the replication and uptake of CITYLAB implementations in the other CITYLAB Living Labs and in cities beyond CITYLAB)
- Dissemination and Exploitation – WP7 (to operate an effective dissemination and exploitation plan to establish and maintain various communication channels with relevant bodies, and to develop a series of targeted outreach activities and mediums for communicating the project to different stakeholder groups).

1.2 Scope of the deliverable

Deliverable 5.4 is the fourth output deliverable in WP5 – Evaluation. Deliverable 5.1 presented an evaluation framework and the necessary indicators. In deliverable 5.2 dashboards were developed to evaluate these indicators. Deliverable 5.3 followed up with an assessment of the actual process and impact of the seven CITYLAB implementations. Deliverable 5.4 follows up with a qualitative and quantitative impact assessment of large scale implementations by taking into account (1) the costs and benefits for society, (2) the financial viability for industry partners and (3) integrating all stakeholders' opinions in the evaluation process. For the upscaling purposes, Deliverable 5.4 uses different evaluation tools and data support, which are described in methodology.

1.3 Deliverable structure

Chapter 1 is an introduction to the Deliverable 5.4. In chapter 2 methodology and approach are explained, as well as evaluation tools applied for the large scale urban innovations. Chapters 3 to 9 focus on the upscaling of each CITYLAB implementation. For each implementation we first look into the business as usual situation compared to the CITYLAB implementation, assessing the impact from the implementation itself. As a next step CITYLAB solutions are evaluated on the objectives of each of the stakeholders involved and use this as input for a multi-actor multi-criteria analysis (MAMCA). Next, possible upscaling scenarios are suggested and their impacts on society and financial viability are discussed. Chapter 10 outlines the main conclusions from this deliverable.

2 Methodology

The key objective of this document is to evaluate the effects of large-scale implementation of the CITYLAB solutions. It looks into: benefits and costs to society, financial viability of solutions and integration of all stakeholders' opinion in the process. This deliverable largely builds up on the assessments of all CITYLAB implementations, performed in deliverable 5.3, developing the upscaling scenarios and further assessing the impact of the implementations once scaled up.

2.1 Impact assessment and upscaling

The common factors across the CITYLAB implementations are stakeholder involvement, sustainability, cost effectiveness and city logistics. At the same time there are a lot of differences between the CITYLAB implementations, which creates complexity in defining a common upscaling methodology. First, CITYLAB implementations are at different stages of implementation: some are only being planned and preliminary analysis are carried out; other are currently being trialled, as well as there are those that already function and evaluation is performed. Second, even though each implementation includes research, industry and city partners, which is a key feature of CITYLAB approach, the roles and involvement of partners differs a lot from implementation to implementation. That have a direct impact on the quality of data and access of information regarding implementation effects. Third, some implementations have more strict data policy where confidential financial and operational information cannot be opened. Finally, the nature of CITYLAB implementations differs a lot between the cities and some have more straightforward impact assessment indicators whether for the others more qualitative approach should be applied. Altogether these factors have a major impact on data and on the quality of data available per implementation for the estimation of the costs and benefits for society and financial viability for the industry partners.

This is the reason while flexible impact assessment and upscaling approach is necessary. That is also the reason why the results of upscaling should be taken with caution and more regarded as initial approach for the estimation of potential upscaling benefits and its impacts on different stakeholders.

In order to deal with these challenges, the differences in type, availability and details in the data must be overcome. Therefore the ability to express the effect of upscaling in a qualitative and quantitative way, differs for each implementations. This methodology deals with this challenge by using several research methods that ensure, all available data is combined. Therefore the result of each step for each implementation has a different level of detail in its outcome. The methodology includes the following steps:

Step 1. Compare the CITYLAB implementation with business as usual situation

The first step is to understand the differences between the actual implementation and the business as usual situation before the implementation. This first step is important to be able to get grip on the changes and effect of the implementation later on. The input data for this step is obtained via interviews with all the CITYLAB research partners of every implementation. The business as usual description focus on the local setting, the roles of stakeholders, their particular interests and position, influence and insight. Regarding the implementation it is necessary to understand the main changes and characteristics of the implementation for aspects such as for example stakeholders, activities, resources, customers, costs and revenues. Step 1 is largely based on the research performed within Deliverable 5.3, describing the latest status of implementations and their effects.

Step 2. Identify changes according to the business model canvas methodology

The second step is to identify the changes between the business as usual scenario and the actual implementation for key stakeholders. This second step is important because the changes and effects of the implementations comparing to the business as usual situation provide and input for upscaling scenarios later on. The descriptions from step 1 are used as input and structured to fill in the business model canvas. The business model canvas is used to analyse the business aspects that change.

The results of step 2 is a business model canvas for every stakeholder that faces a change of effect of the CITYLAB implementation. The filled in business model canvas does not contain the characteristics of the business model but only the changes that occur is each building block.

Step 3. Determine the financial and societal impact

The changes between the business model from the business as usual scenario and the CITYLAB implementations are expressed mostly qualitative due to the data restrictions described above. In the third step this data is combined with the CITYLAB dashboards, viability questionnaires from WP 2 and all quantitative data that is received from the partners. By combining these data sources, where possible, the changes as mentioned in step 2 are quantitatively estimated by the research partners. The qualitative information is of great value for a quantitative analysis of the effects as it feeds the required assumptions. This allows for an estimation of the financial and societal impact based from the implementation.

Step 4. Identify the difference in stakeholder support for BAU and the implementation

This step is performed with a help of MAMCA analysis, based on the data collected from implementations. In MAMCA, we compared BAU to the implemented alternatives. It helps to identify where the solution should be improved and is based on collected data (or at least as much as possible).

The fact that many stakeholders are affected by urban freight transport (UFT) decisions is commonly mentioned in papers and research project reports on the topic as well as the idea that successful UFT solutions should reconcile the interests of all of these stakeholders (Verlinde, 2015). It is impossible and not necessary, though, to develop UFT solutions that do not have any disadvantage to any stakeholder (Ystmark Bjerkan et al., 2014). It suffices that each stakeholder perceives the advantages of a measure to be greater than its disadvantages to “reach common ground” which requires reflective collaboration between the different stakeholders (Ystmark Bjerkan et al., 2014). We evaluate the CITYLAB solutions on the objectives of each of the stakeholders involved and use this as input for a multi-actor multi-criteria analysis (MAMCA). MAMCA was developed by Macharis (2000, 2005 & 2007) as an extension of the traditional multi-criteria decision analysis (MCDA) which explicitly accounts for the objectives of the stakeholders involved in a certain decision-making process. Output of MAMCA is a calculation and visualisation of how the solution or several solutions compare to business as usual for each stakeholder group individually as well as a multi-stakeholder ranking.

The MAMCA analyses will be also used later in the project. As part of WP6 (Task 6.2), we will organise 8 MAMCA workshops (one in each CITYLAB city and an additional one in Brussels for the 9 CITYLAB transfer cities). The workshops will take place in Q4 of 2017 and will be attended by local members/representatives of each stakeholder group. During the workshop, we will ask them how important each of the stakeholder criteria are to them and how they assess each CITYLAB solution would score on these criteria. Their assessment will provide insight in which CITYLAB solution would be suitable for the local context. To challenge these assessments and to provide the participants with some learnings from the implementations, we will also compare the local assessment to the MAMCA analyses based on the actual implementations and discuss the differences. Detailed explanation of MAMCA methodology is presented in paragraph 2.1.2.

Step 5. Define the baseline for upscaling

Based on the business model canvas for the implementations and the estimation of the financial and societal impact, in step 4 the baseline for upscaling is identified. The baseline includes not only a description of the implementation and its effects and impact but also uses data regarding the city and industry. This creates a complete description that is used as baseline for upscaling.

Step 6. Create upscaling scenarios and estimate the effects

In step 6, research partners are requested to propose viable upscaling scenarios. This for example includes expanding the implementation within a city, expanding to other city or extending the value proposition by additional services. For every city, two upscaling scenarios are developed by the research partners. Some cities (Southampton, Paris) conducted two different implementations. In this case, one single upscaling scenario was performed per implementation. In this step the baseline is scaled up with upscaling factors, determined by the change between business as usual and the actual implementation corrected by a factor that is determined by the change in city of industry data.

2.2 Impact assessment and upscaling tools

In this deliverable we use a set of tools for the evaluation of implementations and partnerships in living labs. This is not a new tool set, but tools and data selected and adjusted in such a way that it supports the city logistics living labs as good as possible. As mentioned before, the involvement of research partners differ per implementations. This causes differences in the availability and quality of detailed data. Based on the data, different tools are used to estimate the effects and impact after upscaling. The main tools elaborated in this section are:

- Business model canvas
- Agent-based model SYMBIT
- CITYLAB Dashboards

2.2.1 Business model canvas

The Business Model Canvas (Osterwalder and Pigneur (2010)) helps to map, discuss, design and create new business models. For urban logistics it consists of 10 building blocks, combining the regular revenue generating blocks (i.e. partners, activities, resources, value proposition, customer relationships and segments, cost and revenues streams) with potential societal and environmental impacts (externalities). Based on the experiences of city logistics projects (e.g. TURBLOG, Straightsol, FREVUE) the ten blocks of the Business Model Canvas can be grouped as follows:

- the customer-part (the right part including customer relationships, channels and customer segments) that results in revenue streams. This customer part on the right side of the model focuses on how value is being provided to the customer (through which channels and relationship models). The externalities-block contains the value proposition to relevant stakeholders in the urban logistics settings (for example residents), but it is often very difficult, if possible at all, to put monetary values on this proposition for the focal company. Based on what a customer is willing to pay for a service or product, a company can create revenue streams. The business model canvas shows that the three blocks at the right (i.e. customer segment, customer relationships and channels) together result in a revenue stream (which is in its turn a derivative of these three blocks).

- the organisational part (on the left side with the key partners, key activities and the key resources) that results in the cost structure. This part shows the elements that are necessary to make, produce or offer the value proposition by means of certain key partners and key activities.
- the financial model*:* The financial model shows the financial arrangements between the different actors in the value network.
- The value proposition and the value proposition to society (i.e. the externalities block) show the value that a company offers to the customers and the society.

The structure of the Business Model Canvas helps to analyse and compare which part of the business changes when a situation goes from business as usual scenario to the specific implementation situation. It also shows how this transition effects the value proposition, the cost and benefits of the operations to each particular stakeholder.

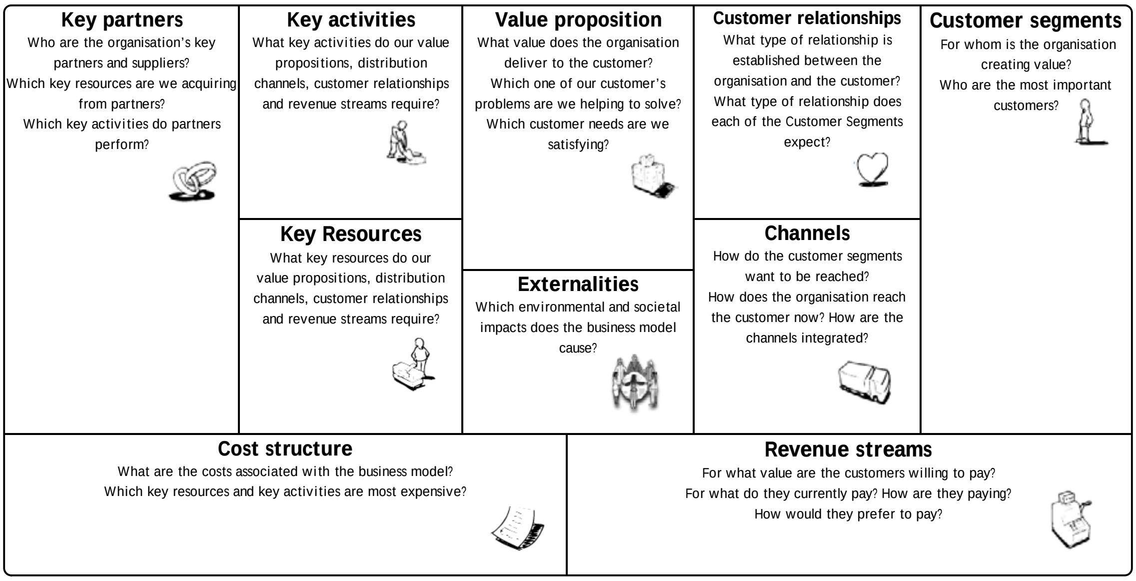

Figure 1. Urban Logistic Business Model Canvas (adapted from TURBLOG D.2)

2.2.2 Agent-based model SYMBIT

This model is only used for de CITYLAB implementation in Brussels. The SYnchronization Model for Belgian Inland Transport (SYMBIT) is an agent-based model that combines features of Geographic Information Systems (GIS) and Discrete-Event Models (DEM). It is capable of simulating freight transport processes at tactical and operational levels to account for intermodal transport in a flexible manner; also referred to as synchromodal transport (Ambra, Meers, Caris & Macharis, 2017). The modelling framework will serve as a computational basis for calculating optimal routes for the transport of loading units.

The purpose of the model for the CITYLAB implementation in Brussels is to simulate various business/bundling logic scenarios. The results are computed through simulation and not solved analytically. Simulation data is formed based on agent interaction. The output is twofold. On the one hand, it shows the impact on the operations of the owner of spare capacity when more delivery addresses are added. On the other hand, it allows assessing the costs and benefits to society (e.g., emissions).

2.2.3 CITYLAB Dashboards

Each local implementation is assessed using the same set of key performance indicators measuring factors such as objectives, scope, how they were implemented and with what result, business models, observed immediate effects and overall outcome. Key indicators necessary to this assessment are collected via the dedicated dashboards. For each implementation, the dashboards show how an implementation scores on a predefined set taking into account the objectives of the cities, the participating private actors, society and also monitoring the process.

2.2.4 Multi-actor multi-criteria analysis description and methodology

This section defines the concept of stakeholders in a decision-making process and explains MAMCA as an appropriate tool for solving complex decision-making problems.

It was Williamson (1991) who first introduced the concept of stakeholders in the field of strategic management. With the upcoming of corporate social responsibility it became clear that stakeholders needed to be taken into account by firms' decision taking (Donaldson & Preston, 1995). A stakeholder is a person, or a group of individuals, who is able to influence the objectives of an organization or can be influenced themselves (Freeman, 1984). In public decision making there are often multiple stakeholders, besides the government, like private investors and the society who all have different interests concerning the decision-making problem. That is why it is necessary to involve these stakeholders explicitly to evaluate the decision problem from the objectives of each stakeholder.

Complex processes like the evaluation of urban and inter-urban freight transport concepts involve multiple stakeholders who need to be involved explicitly in the decision- making process. This involvement will boost the rate of acceptance of a certain project proposal when the point of view of all stakeholders is taken into account (Walker, 2000). Implementing this extra dimension in the traditional multi-criteria analysis (MCA) is possible according to (Banville et al, 1998) by improving the integration of socio–political aspects into the decision making process. This integration is possible when using group decision support methods (GDSM), like multi-actor multi-criteria analysis (MAMCA) elaborated by (C. Macharis, 2005).

The combination of stakeholder involvement and MCA has known a significant evolution over the years. The goal of GDSM is achieving a consensus between the different stakeholders involved in the decision making process (Leyva-Lopez, 2010). This approach might have many pitfalls though: each stakeholder has its own unique point of view and expected outcome of a certain project. Over the years, many GDSM have been developed that rely on MCA to support a group decision making problem (for an overview, See Alvarez-Carillo et al, 2010). The difference between these methods is mainly based on how information is brought together. Overall, there are three methods for GDSM (Ampe & Macharis, 2008). The MAMCA can be viewed as a type three GDSM due to its explicit stakeholder involvement. Stakeholders can define their own criteria and to allocate weights to them.

Stakeholder involvement can be organized in many ways. It can be integrated into the whole analysis by performing well defined and structured steps but often, stakeholder input is only used in the first phases of the analysis to build an initial framework. Another possibility is that stakeholders are involved at the end of the analysis to provide feedback with regards to the outcome. A combination of the previous methods has also been applied in some cases. Despite the increasing attention for stakeholder involvement and GDSM, the idea of explicitly including them is a new concept. It is also possible that the level of stakeholder integration may vary depending on the MCA technique. Most of the time, the traditional MCA is expanded with extra steps before or after the MCA. A MCA can also be completely reformed or extended to allow for stakeholder participation (Ampe & Macharis, 2008).

These methods seem to be quite complicated. This is why this research will use a methodology where stakeholder input is seen as the most crucial element of the analysis: MAMCA.

MAMCA is an extension of the existing multi-criteria analysis (Fandel & Spronk, 1985) (Guitoni & Martel, 1998). MAMCA allows researchers to evaluate different alternatives (policy measures, scenario's, technologies …) with regards to the objectives of the different stakeholders that are involved in the decision-making process. This way, the MAMCA allows an explicit inclusion of the stakeholders in the analysis. The methodology has been used for many applications, mainly in transport related decision-making problems (for an overview, see (Macharis *et al.*, 2009)).

MAMCA consists of two main phases (Macharis, 2005; Macharis *et al.*, 2009). The first phase is mainly analytical and tries to gather all the necessary information to perform the analysis. The second phase is the synthetic or exploitation phase and consists of the actual analysis. These two phases are then divided into respectively four and three steps (Macharis *et al.*, 2009). This can be seen in Figure 2. The first step is to give a clear problem definition and to determine which alternatives will be evaluated. In the second step, all relevant stakeholders are determined as well as their objectives. These objectives are then translated into criteria in the third step. When the criteria are determined, it is crucial that the researcher finds out how important every criterion is. Weights need to be assigned to the different criteria to continue with the analysis. The fourth step tries to assign one or more measurable indicators to each criterion. These indicators allow evaluating each alternative with regards to a given criterion. These indicators can be either quantitative or qualitative, depending on the criterion. The fifth step performs the aggregation of the information of the previous steps into an evaluation matrix. The actual results are given in step six and are generated by using a MCA. This allows the researcher to analyse what the advantages and disadvantages of every alternative are. The seventh and last step is the actual implementation of the alternative that receives overall stakeholder support.

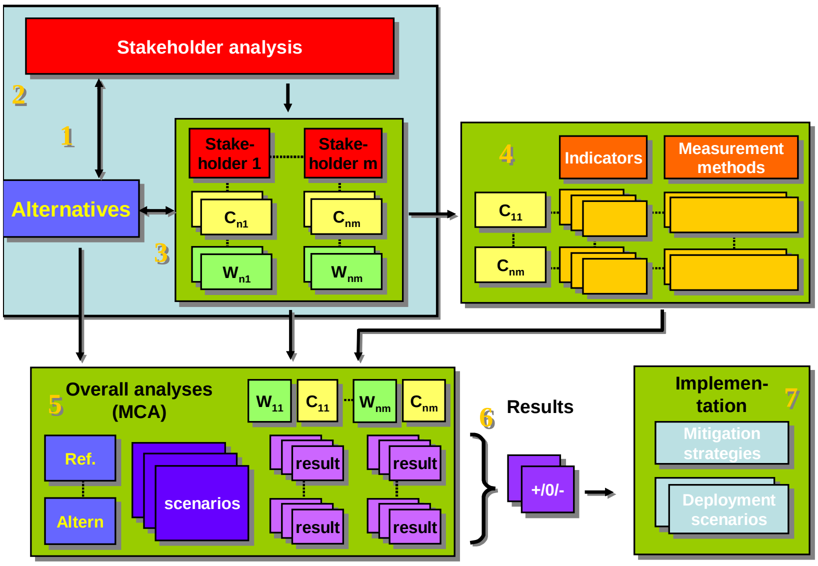

Figure 2. The MAMCA methodology (Source: Macharis *et al.*, 2004)

Step 1: Alternatives

Determining the relevant alternatives is the starting point of the whole analysis. These alternatives are determined with respect to a given problem. These alternatives can be policy measures, scenarios, strategies or other actions which could solve the problem at hand. The alternatives are then translated into concrete scenarios.

For the MAMCA analyses within CITYLAB, we compared business as usual (BAU) to at least one implemented alternative. Each time, we translated BAU and the alternative(s) into concrete scenarios that mention all important features of the solution.

Step 2: Stakeholders

Once the alternatives are determined, all relevant stakeholders need to be identified through a stakeholder analysis. According to Freeman (1984), a stakeholder is a person who has a certain interest (financial, legal, etc.) in the consequences of a certain decision or measure. It is crucial to determine what the objectives of each stakeholder are to perform the analysis. Their vision on the problem definition is crucial and it is possible that they could come up with a new alternative. This enriches the overall analysis (Ampe & Macharis, 2008).

Explicitly including the stakeholders in the analysis is necessary due to two main reasons. First, the quality of the final decision cannot be guaranteed by the sole fact that a researcher performs an analysis. He/she has limited access to important sources of information concerning the decision problem. Second, including stakeholders might be useful when the decision problem is highly controversial (Ampe and Macharis, 2008; Macharis, 2005; . Macharis, 2007; Macharis *et al.*, 2009).

CITYLAB solutions address UFT problems. Literature identifies different stakeholders for UFT. Ogden (1992) who was one of the first to write a comprehensive analysis of urban freight transport identified three main stakeholders with an active role in urban freight transport: receivers, carriers and forwarders. Most of the other authors addressing the topic of urban freight stakeholders also distinguish among these three, although some of them do not consider forwarders (also called senders) and receivers to be separate stakeholders (Taylor, 2005; Witlox, 2006; Quak, 2008; Behrends; 2011) or do not include receivers (Taniguchi & Tamagawa, 2005). The importance of policy-makers, decision-makers and local authorities as urban freight transport stakeholders is also commonly recognised (Munuzuri et al., 2005; Taniguchi & Tamagawa, 2005; Taylor, 2005; Witlox, 2006; Quak, 2008; Behrends, 2011; Russo & Comi, 2011; Stathopoulos, Valeri & Marcucci, 2011; Lindholm, 2012; MDS Transmodal Limited, 2012; Ballantyne, Lindholm & Whiteing, 2013; Lindholm & Browne, 2013; Ystmark Bjerkan, Bjorgen Sund & Elvsaas Nordtomme, 2014). Policy makers take the role of defending the stakes of all urban stakeholders that are affected by urban freight transport. Some authors suggest considering 'society' or 'citizens' as a fifth stakeholder (Taniguchi & Tamagawa, 2005; Taylor, 2005; Witlox, 2006; Quak, 2008). Ballantyne et al. (2013) argued that citizens and visitors have an interest in the system of urban freight transport but do not have a direct influence on the system. From that perspective, the authors differentiated between actors and stakeholders and also considered public transport operators, trade associations, commercial organisations and land owners/property owners as passive stakeholders. Some authors also include infrastructure providers and operators (Taniguchi & Tamagawa, 2005; MDS Transmodal Limited, 2012). The most extensive overview of the different stakeholders and their main interests in the context of urban freight transport can be found in MDS Transmodal Limited (2012).

For the MAMCA analyses of the CITYLAB solutions, we identified 5 types of stakeholders: shippers, receivers, transport operators, society and shopping centre owners. This is based on the description of the solutions in D5.3. We chose to merge local authorities and citizens in one stakeholder group (society) because the CITYLAB solutions are not policy measures for UFT. Stakeholder group shopping centre owners is only relevant for the Oslo implementation.

Step 3: Criteria and weights

The criteria of each stakeholder are determined based on the two previous steps (Macharis, 2007). In a traditional MCA, these criteria represent the effects of a certain alternative but this is not the case in MAMCA (Ampe & Macharis, 2008). In MAMCA, they represent the objectives of the stakeholders. Once these criteria are determined, they can be summarized by using a hierarchical tree (Macharis, 2005).

Determining the criteria is not enough. It is obvious that not every criterion is equally important for a given stakeholder. Therefore, this step also consists of allocating weights to the criteria (Macharis, 2005; Macharis, 2007; Macharis *et al.*, 2009). There are different methods available for determining the weights (for an overview, see (Nijkamp *et al.*, 1990).

For this analysis, we did not ask stakeholders for their criteria. We adopted the criteria identified in STRAIGHTSOL and a Belgian UFT project. STRAIGHTSOL was an EU-funded project comprising seven urban freight demonstrations. It ran from September 2011 to August 2014. Within STRAIGHTSOL, MAMCA was applied as well to assess stakeholder support the UFT demonstrations within the project. As part of the project, stakeholders were asked for their objectives and how they value them (STRAIGHTSOL Deliverable D5.2). Also in the Belgian UFT project for the city of Mortsel, stakeholders were asked for their objectives and how they value them (Kin et al., 2017). Table 3 lists stakeholders and criteria used in the CITYLAB MAMCA analyses. Table 4 shows which weights were used for which criteria and justifies how they were determined.

Table 3. List of stakeholders and criteria used for the CITYALB MAMCA analyses

STAKEHOLDERS	CRITERIA	DESCRIPTION
Shippers	High quality pick-ups	High quality pick-ups (convenient, on time and without damaging the goods)
	Low cost for transport	Low cost for transport
	High quality deliveries	Satisfied receivers
	Positive effect on society	Social and environmental ambitions, beyond the interests of the firm and beyond complying with the law
Transport operators	Profitable operations	Maximum positive difference between revenues and variable costs for providing transport services
	Viable investments	Positive return on investment
	High quality service	Shipper and receiver satisfaction
	Satisfied employees	Employees are satisfied with their work and working conditions
	Positive effect on society	Social and environmental ambitions, beyond the interests of the firm and beyond complying with the law
Receivers	High quality deliveries	High quality deliveries (convenient, on time and undamaged)
	Shopping environment	Attractive shopping environment for consumers (goods availability and pleasant physical shopping environment)
	Positive effect on society	Social and environmental ambitions, beyond the interests of the firm and beyond complying with the law
	Low cost for receiving goods	Low cost for receiving goods (also when included in cost for goods)
Society	Air quality	Low concentration of particulate matter, NOx and SO2
	Noise	Low exposure to noise nuisance from transport
	Fluent traffic	Fluent traffic flows on the urban road transport network
	Road safety	Low risk of a person using the urban road transport network being killed or injured
	Shopping environment	Attractive shopping environment for consumers (goods availability and pleasant physical shopping environment)
Shopping centre	Financial viability	Making profit by providing storage service
	Shopping environment	Attractive shopping environment for consumers (goods availability and pleasant physical shopping environment
	High quality service	High quality deliveries (convenient, on time and undamaged)

Table 4. Justification of weights used for the CITYLAB MAMCA analyses

STAKEHOLDERS	CRITERIA	WEIGHTS	JUSTIFICATION
Shippers	High quality pick-ups	21.78%	1. Average of STRAIGHTSOL and Mortsel. Difference between values <5% 2. After using the averages for the pick-ups and society, 62.22% was left to be divided between these two criteria. In STRAIGHTSOL, they were considered to be equally important, in Mortsel, shippers attached more value to satisfied receivers. We used the average values for STRAIGHTSOL and Mortsel to divide this 62.22%.
	Low cost for transport	21.40%	
	High quality deliveries	41.60%	
	Positive effect on society	15.22%	
Transport operators	Profitable operations	24.42%	1. Average of STRAIGHTSOL and Mortsel. Difference between values <5% 2. The scenarios that were compared in both MAMCAs deferred. In STRAIGHTSOL, scenarios were based on actual pilots where LSPs had an important role (and had to do considerable investments to implement the solution) and in Mortsel, the LSPs did not indicate prior to the survey that they were considering changing delivery method. That is probably why in STRAIGHTSOL, profitable operations and viability of investment were considered to be more important. The solutions in CITYLAB also require investments from LSPs so that is why we will follow the weights from STRAIGHTSOL for the other 4 criteria.
	Viable investments	25.43%	
	High quality service	22.79%	
	Satisfied employees	12.61%	
	Positive effect on society	14.75%	
Receivers	Low cost for receiving goods	26.38%	1. In STRAIGHTSOL, security was an additional criterion for receivers. We did not include in this version based on literature. We included it in the criterion high quality deliveries). Security was not included as a criterion in Mortsel. Because the criterion scored well in STRAIGHTSOL and in STRAIGHTSOL convenient high level deliveries also scored well, we will adopt the STRAIGHTSOL value and leave out the one of Mortsel. 2. Positive effect on society scored high in Mortsel, but this is not in line with literature which is why we will adopt the STRAIGHTSOL score 3. The remaining two criteria score different in STRAIGHSOL and Mortsel. In STRAIGHTSOL, cost is important, in Mortsel attractiveness of the shopping environment. From literature, we know that receivers usually do not pay for the transport cost, which is why we divided the remaining 56.93% according to the shares of Mortsel.
	High quality deliveries	27.84%	
	Positive effect on society	15.23%	
	Shopping environment	30.55%	
Society	Shopping environment	12.10%	1. Average of STRAIGHTSOL and Mortsel. Difference between values <5% 2. literature is not clear about how important exposure to noise nuisance is compared to fluent traffic flows. For that reason, we chose to work with the averages from STRAIGHSTOL and Mortsel
	Road safety	27.69%	
	Air quality	26.06%	
	Fluent traffic	19.79%	
	Noise	14.36%	
Shopping centre	Financial viability	41.00%	1. STRAIGHTSOL weights, we merged quality of service and security to be in line with the other stakeholders and their criteria
	Shopping environment	41.00%	
	High quality service	18.00%	

By introducing an extra dimension to the decision-making problem, there is one main issue. The question arises whether the stakeholders should also be weighed. The initial assumption is that every stakeholder is equally important. Depending on the decision-making problem, this assumption might not be optimal. The researcher always has the possibility to perform a sensitivity analysis to see if the assumption of equal importance is valid (Macharis *et al.*, 2009).

It is possible that a stakeholder group consists of several members. To determine the weight for a given stakeholder group, a common weight can be achieved through consensus. If this appears to be too difficult to achieve, the researcher can calculate an overall weight by taking the geometric mean of all the individual scores (Macharis *et al.*, 2009)[1].

Step 4: Indicators

Step 5: Analysis and ranking

Step 6: Results

Step 7: Implementation

The eventual outcome of the MAMCA is a classification of the proposed alternatives that revealing their strengths and weaknesses. It might be useful to perform a sensitivity analysis to test the robustness of the results (Macharis *et al.*, 2009). The overall classification is however not the only result the MAMCA provides. It results also in a ranking per stakeholder, leading to an identification of the most important stakeholders in the decision-making process along with their criteria. It will be possible to evaluate for each stakeholder which elements have a positive or negative effect on the sustainability of the proposed alternatives. The results will show who is in favour of the implementation of the city distribution concept and who has doubts about it. This stakeholder–based approach might be very valuable when taking a final decision (Macharis, 2005, 2007).

The final step is implementing a solution that receives overall stakeholder support. MAMCA supports a decision on which solution to implement but also on the implementation path. It might be possible that this step leads to the definition of new alternatives, which can lead to a restart of the whole analysis (Ampe & Macharis, 2008; Macharis *et al.*, 2009).

The fourth step consists of “operationalizing” the criteria by using measurable indicators. This allows the researcher to measure and evaluate how much a certain alternative performs on a given criterion. In other words, a scale is created by using indicators in which the contribution of an alternative can be measured (Macharis, 2007, Macharis *et al.*, 2009). Most of the time these indicators are of a quantitative nature, but it is also possible to use qualitative indicators (Macharis *et al.*, 2009). It is also possible that several indicators are used to measure the performance of an alternative on one single criterion and vice versa, that one indicator can be allocated to multiple criteria (Macharis, 2007). For the CITYLAB MAMCA analyses, the criteria are linked to one or more indicators in the Excel template developed for data collection in CITYLAB. The template was developed with the MAMCA in mind, so all criteria are covered by at least one indicator. For some indicators, we were not able to collect quantitative data. In that case, we used a qualitative assessment mentioned in the same Excel template or in CITYLAB D5.3.

To evaluate the different alternatives there are many different MCA methods available. Especially the MCA methods of the so-called Group Decision Support Methods are very useful

[1] The geometric mean of *n* numbers is given by multiplying these numbers and getting the n^{th} square root of the product.

to apply in the MAMCA methodology. These methods involve the PROMETHEE methods (Brans, 1982; Macharis *et al.*, 1998), ELECTRE (Roy & Bouyssou, 1988) and AHP (Saaty, 1988). The main advantage of these GDSM is that they offer a certain freedom to the stakeholders in terms of defining their own criteria, weights and preference structure and only at the end of the analysis the different points of view are being confronted (Macharis *et al.*, 2009). For this analysis, we used AHP.

Traditionally, the Analytic Hierarchy Process (AHP) developed by (Saaty, 1988) is used to allocate the weights. AHP uses pairwise comparisons, where all the criteria are matched one–on–one. By using a 9-point scale, the stakeholders' preferences are expressed. These relative preferences are then put into a matrix and normalized. This leads to a priority vector that represents the relative weights on a ratio scale. This method is able to use theoretically valid weights and is praised by users for its reliability and ease of use (Wang & Yang, 1998). Determining the criteria from a stakeholder–based perspective has one main advantage. When performing a MCA, the criteria are supposed to be independent or non–redundant. However, research has shown that there often is a certain level of dependence (Ozturk, 2006). The MAMCA solves this issue by letting the stakeholder determine the weights of the criteria (Macharis *et al.*, 2009).

3 Amsterdam

The Amsterdam implementation action aims to improve last mile logistics 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. Over the last couple of years PostNL has been exploring alternative options of goods deliveries in Amsterdam, trying to reduce the impact of congestion on its working processes in a sustainable way. The Amsterdam implementation is looking into the possibilities of more efficient last mile deliveries making a better use of the available infrastructure.

3.1 Implementation description and its effects

The CITYLAB Amsterdam implementation aims to improve last mile logistics in a sustainable way. This relates to the “highly fragmented last-mile deliveries in city centres” that is one of the four axes of intervention CITYLAB focuses on.

The Amsterdam implementation aims at a sustainable but economically viable last mile logistics solution that is reducing the pressure on the urban road transport network. The original idea was a floating depot in the canals. Through the living lab process it evolved into establishing micro-hubs in the city centre and serve these with electric freight bicycles.

3.1.1 Business as usual versus CITYLAB implementation

The initial idea for the first CITYLAB implementation was to ship parcels into the city by a vessel (the floating depot concept) with a mechanism to lift the goods onto the quays. From the quays, parcels were planned to be transported by clean vehicles or bikes to the final destination. After some challenging issues with stakeholders, the lack of governmental support and the lacking financial viability, PostNL decided to use conventional vans for these parcels.

In the second proposed implementation, PostNL considered the possibility to use a floating depot pushed by a hybrid-push boat from where clean vehicles would supply parcels to the many pubs, restaurants and hotels in the ‘de Pijp’ in Amsterdam. After unsuccessful attempts in finding a launching customer and another negative business case, the floating depot idea with a push boat was no longer considered on the short term.

In the third concept, PostNL planned to use locations like unused stores as a shared logistical micro-hub with other logistic service providers. From these micro-hubs, located in the city centre, electric freight bicycles will be used to empty public mailboxes and to collect and deliver mail to business clients.

The third concept has 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. It is important to know that the collection of mail and parcels from business clients is time constrained and should occur during a time window, specified by the client. The second trip from the truck in the evening is used to collect all mail from the micro-depots and transport this to a larger depot outside the city centre.

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.

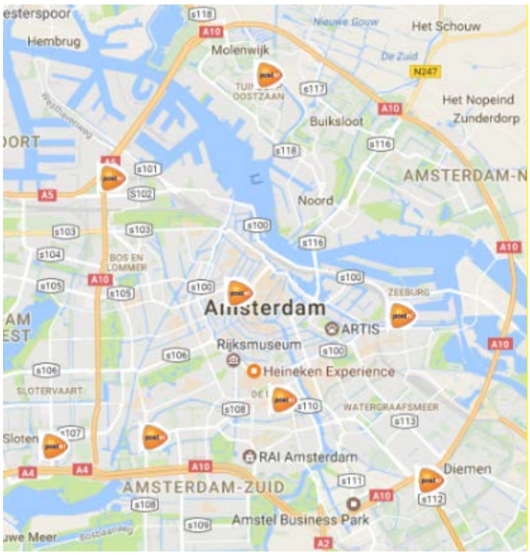

Figure 3. PostNL micro hubs in Amsterdam

Before the CITYLAB implementation, the delivery and collection of mail from business clients and public mail boxes was handled by vans from the larger depot outside the city centre. The most frequently used vehicle is the Volkswagen Caddy. About 150 trips per day were required to handle the 3500 orders. The drivers experienced a lot of stress from congestion and parking issues combined with meeting the client's specific time window.

With the CITYLAB implementation, 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. 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.

3.1.2 Role of stakeholders

Within the CITYLAB implementation, the government was mainly involved in the floating depot concept. Since the current implementation does not include a floating depot, the role of the city of Amsterdam is reduced significantly. Next to the government, shippers and customers are involved. Shippers still pay the same fee and receive the same quality of service. Another stakeholder that is closely involved with the CITYLAB implementation are several bicycle manufactures. PostNL is testing different models and provides feedback in order to further develop and improve the electric freight bicycles.

Table 5. Stakeholders participating in Amsterdam CITYLAB solution

Stakeholder	Role	Participation in solution	Interest
PostNL	Collection and delivery of mail for business clients, and clearing the public mailboxes.	Implemented the actual solution and worked together with the cycle manufacturers to design and improve the electric freight bicycles	Looking for ways to further improve and optimize their operations by limiting their environmental footprint and costs.
City of Amsterdam	No official role in this implementation, only informed via stakeholder meetings.	Agency that is responsible for permits.	Wanting to achieve optimal traffic throughput, traffic safety and clean air in the city.
Shipper and Customers	People sending post via public mailboxes and businesses that receive and want their mail being picked up.	They have a subscription with PostNL for the service which is now executed by bike instead of a van	They have no interest except for some sustainability motives and a less stressed PostNL employee
Cycle Manufacturers	Several companies, designing a electric freight bicycle	Close cooperation with PostNL to use their feedback to improve the design of bicycles	Conquer growing market for electric freight bikes.

3.1.3 Effects from CITYLAB implementation

This sections describes the effects of the CITYLAB implementation. The CITYLAB implementation in Amsterdam has significantly reduced the amount of trips made by vans. This has secondary effects on operational costs, emissions and diesel usage. The changes compared to the business as usual situation are defined in the business model canvas. The implementation is estimated to save about 220 kg of CO_2 and 2 KEuro per day in leasing, salary and diesel.

The implementation has a limited effect on the stakeholders because the city of Amsterdam has no significant role in this implementation. The municipality promotes cycling so it fits their strategy, but the initiatives is taken-up by PostNL itself. The customers of PostNL face only minor implications. Due to the limited capacity of the electric freight bicycles, a last minute additional large package is not always possible. PostNL has to send an extra vehicle to pick up this last minute parcel. The implications for customers is therefore limited to non because the package will only be picked up by another vehicle.

Data from PostNL is used to quantify the changes in key activities. The additional key activity includes two return trips to each of the 7 micro-hubs per day. Therefore 28 trips are made in total by the trucks every day. The average distance from the large depot to the micro-hubs is about 10.5 km. A return trip is therefore 21 km and is assumed to take 1 hour. The truck uses 25 litres of diesel (€1,25) per 100 km and emits 3,240 kg per litre (source: CO2emissiefactoren.nl). This corresponds to 810 gram/km. The truck is assumed to cost €18 per hour, three times as expensive as the given lease price of the van excluding a salary fee of €18 per hour. This additional key activity therefore is estimated to add 236 kg of CO2 per day to the operation as well as about €900 of operational expenses.

Key partners

PostNL
Customers and shippers
City of Amsterdam
Bicycle manufacturers

Key activities

PostNL has to supply the micro-hubs. This is done by trucks

Key resources

PostNL has changed its resources from vans to electric freight bicycles

Value proposition

PostNL is contributing to the reduction of emissions and the use of fossil fuels.

Externalities

The government has the advantage of less noise, emissions and contribution to congestion.

Customer relationship

Customers and Shippers face better on time performances, less stressed PostNL employees but also face less flexibility due to the limited capacity of the bicycle

Channels

No change

Customer segments

Bike Manufacturers expand their customer segment by trial and error of new electric freight bicycle models. This enables upscaling of freight bicycles outside postal services.

Cost structure

PostNL has the advantage of a lower leasing price and less diesel usage. Therefore costs are saved.

Revenue streams

PostNL faces no changes in the revenue streams.

Figure 4. Business Model Canvas for PostNL

The CITYLAB implementation includes a shift of the key resources from vans to electric freight bicycles. 2200 out of 3500 orders are therefore no longer served by van but by bicycles from a micro-hub. The bicycles are not affected by congestion or parking which save 13% on the average time per order. Therefore bicycles are able to handle more orders per time constrained trip compared to vans. Therefore, the amount of daily van trips is reduced by almost 100 and the total fleet is reduces by 12 vehicles. The access and egress times from the large depot into the city centre are consolidated to two trucks per day per micro hub. This saves on average 21 km and an estimated 20 minutes per van trip. Bicycles use the cycling infrastructure which results in a reduction in trip distance of 13%. The average trip distance for vans is 19.3 km and therefore 17.1 km for bicycles. Vans use about 8 minutes per order while the bicycles use about 7 minutes. The implementation of electric freight bicycles therefore introduce significant operational savings. All together this saves about 60 hours of operational hours per day.

PostNL and the use of electric freight bicycles might attract additional companies that perceive this sustainable solution as added value to their business. The solution offers the same service, quality and price as the business as usual and therefore the value proposition is only improved.

The CITYLAB solution has several benefits for the city, its inhabitants and the quality of life. Every day, fewer vans drive through the city of Amsterdam. Every day almost 100 van trips will be replaced by bicycles. It saves about 3900 van kilometres and accompanying noise. This saves about 220 kg of CO_2 per day.

The relation with the customers can be improved because this more environmentally friendly and sustainable way of transport is a good opportunity for an extra communication moment with the customers.

A new segment of customers might choose PostNL for environmental reasons, because they deliver more environmental friendly than their competitors.

The CITYLAB implementation has several cost benefits. The leasing price of bicycles are lower and bicycles do not require fuel. The costs related to the micro-hubs are unknown but the ones in use were already existing micro-hubs so it is assumed that no purchasing costs were involved.

3.2 Stakeholder support for Amsterdam solution

Figure below shows the multi-actor results for the PostNL implementation with e-freight bikes and micro-hubs in Amsterdam. The aggregated scores of the evaluation are shown on the y-axis (based on AHP eigenvalues method, see Saaty (1988)). The coloured lines represent the alternatives and show to what extent each alternative contributes to the criteria of each stakeholder (x-axis). The orange line represents BAU when mail and parcel pick-ups and deliveries of PostNL in Amsterdam (city-centre) are done by means of vans from a distribution centre located outside city-centre. The blue line represents the CITYLAB solution when mail and parcels are distributed from micro-hubs within the city by means of e-freight bike. The CITYLAB solution clearly contributes better to the criteria of the stakeholders than business as usual, except for shippers. For shippers, the alternative solutions score slightly better.

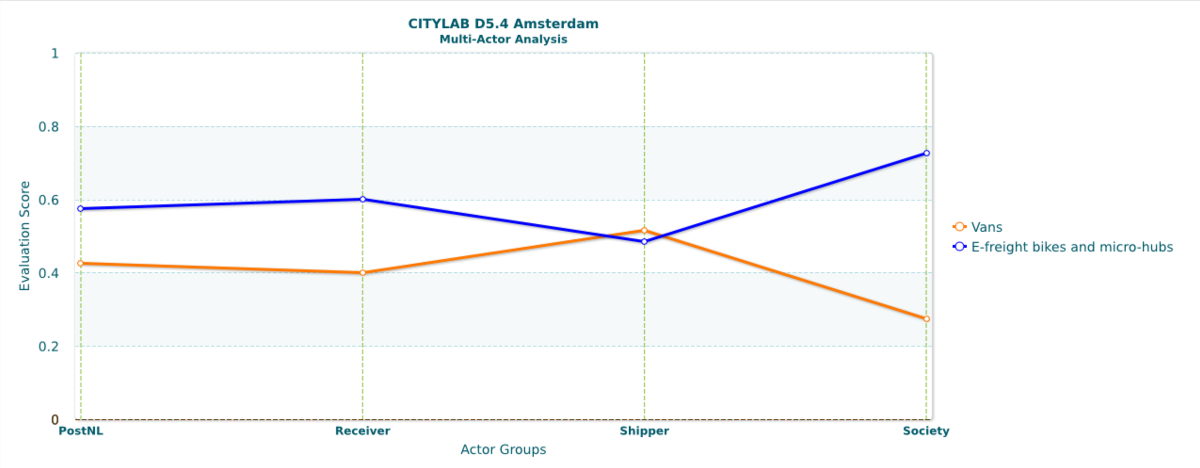

Figure 5. Multi-actor results for CITYLAB solution in Amsterdam

When looking at the mono-actor results of the shippers (Figure 6) we see that the lower score for the CITYLAB solution for shippers is due to the better score of BAU on the criterion high quality deliveries which is a very important criterion for shippers. The grey vertical bars indicate the importance of each criterion for each stakeholder group. For two other shipper criteria, both alternatives score equally (low cost for transport and high quality pick-ups). Overall, we see that BAU only scores slightly better than the new solution. Sensitivity analysis reveals that the slightly higher score for BAU for this stakeholder is not very robust. In our analysis, BAU scores 67% and the alternative scores 33% for the shipper's criterion high quality deliveries. From the moment that BAU only scores 63% and the alternative 37%, both solutions would receive an equal overall score for shippers. That the ranking for shippers is not very robust is also confirmed by the sensitivity analysis of the weights of the shipper. Based on surveys of shippers (in Europe and Belgium), we assumed that they highly value 'high quality deliveries'. When the high weight of 42% is decreased to 36% (and the remaining 6% is shared proportionately between the other criteria), BAU and the alternative solution receive the same score for the shipper.

The multi-actor view also shows that for most stakeholders, the difference between both alternatives is limited. For society, however, the difference is more important. They would certainly support the new solution. Sensitivity analysis of the weights of society reveals that the ranking is robust. Society highly values road safety and air quality but even when one of these weights is put to zero, the ranking of both scenarios does not change. Overall, we can state that it should be possible to adjust the solution in a way that it would be supported by all stakeholders when attention is paid to the quality of the deliveries. In ANNEX 1, you can find all mono-actor results for the implementation in Amsterdam and the table with justification for the various scores of the alternatives.

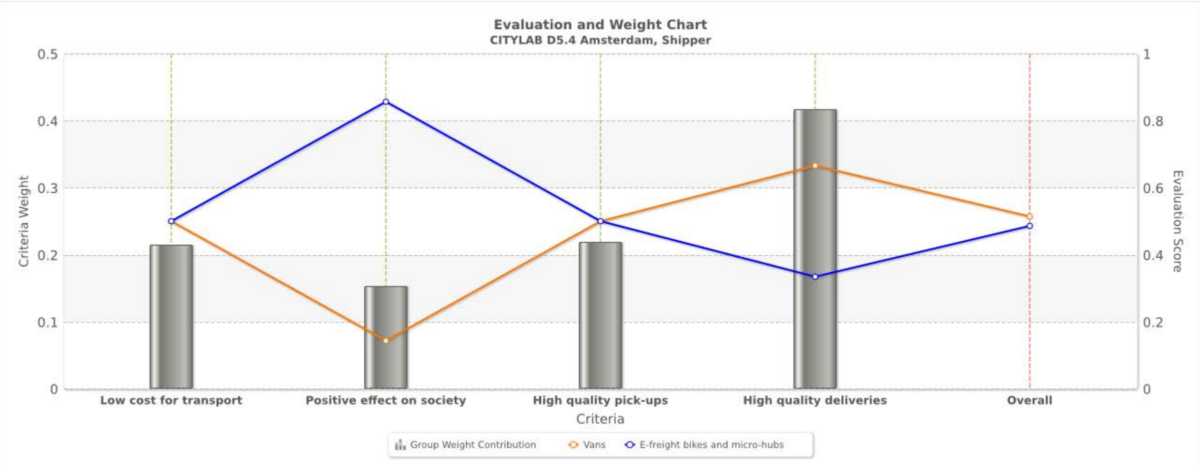

Figure 6. Mono-actor results for the shipper for CITYLAB solution in Amsterdam

3.3 Upscaling of Amsterdam implementation

3.3.1 Baseline for upscaling

PostNL provided data for the implementation only, together with some changes compared to the business as usual situation. Next to operational data for a day, PostNL also provided a map with all the depots and some basic fares. The map revealed that the average trip distance from the large depot to the micro-hubs is 10.4 kilometres.

Table 6. Baseline for upscaling CITYLAB Amsterdam implementation

Business as usual situation	CITYLAB solution
Calculations based on 3500 orders for the city of Amsterdam.	
• All orders by van • Average distance by van 13% higher • Average time per order is 13% higher • Average number of orders per trip is 5% lower Distance per trip does not include access and egress distance and time	• 2200/3500 orders by bike • Bike lease costs are €3/hr • Van lease costs are €6/hr • Salary is €18/hr • Time per order= 0.1177 hour • Average number of orders per trip = 24 • Average distance per trip = 17,1 km • The 7 micro-hubs are supplied by a truck, twice a day

Next to the received data, the following data was gathered by interviews.

- The van that was used is the Volkswagen caddy with a fuel consumption of 22 km/ltr (source: anwb.nl) and CO_2 emissions of 117 grams/ km.

The following assumptions were used to calculate the business as usual scenario:

- The caddy can do 2 trips per day within time frame and a bike can do 2.3 trips per day.
- The used truck has a fuel consumption of 4 km/litre and emits 810 grams /km.
- The diesel price is €1,25/litre.
- The truck's lease tariff is three times as expensive as the van. €18/hr

3.3.2 Upscaling scenario A: All delivery by electric freight bike

Scenario description

The actual implementation showed beneficial and promising results. 2200 out of 3500 orders are being handled by electric bike. The first upscaling scenario is therefore about upscaling the implementation by using the electric bike to handle all 3500 orders. This includes the following changes and assumptions:

- No more vans and used and all trips start and end at the microhubs.
- The supply trips to microhubs do not change. Twice a day to 7 micro-hubs.
- No capacity issues are considered.

This scenario was chosen because it gives insights in potential savings and environmental benefits, possible in Amsterdam with this solution. It is a more hypothetical scenario because in reality you always will have to drive for some sort of items that do not fit the freight bicycle and still need to be delivered by van or truck. Interesting is to see the effect of completely replacing all vans by consolidated truck trips to the micro-hubs.

Effects and consequences

Compared to actual implementation, additional savings come from the reduced leasing costs, lower diesel usage and a reduction of operational hours. The effects and consequences are compared to the actual implementation to understand the additional savings on top of the already realised savings.

All orders are delivered by 64 bicycles instead of by 77 vans. Additional freight bicycles need to be leased and it is assumed that the leased vans are no longer used. Due to the reductions in access and egress time and travel distance, the daily operation hours are reduced by 95 hours, almost 25%, mainly caused by the access and egress time of vans. The savings therefore are estimated to add up to 2 KEuro per day, compared to the situation before the implementation. CO2 emissions are reduced to about 240 kg per day, which is a reduction almost 500 kg, almost 70%.

It is likely that new or larger microhubs will be needed because the freight flows increases and possible there will be not enough capacity at the microhubs for this flow.

As this scenario is a copy of the Amsterdam implementation with only more volume, the business model canvas is the same as the one described above, only the described effects are slightly larger because the transport of more orders is transferred from van to freight bicycle.

3.3.3 Upscaling scenario B: CITYLAB solution applied to another city

Scenario description

The second upscaling scenario includes the translation of the previous scenario to another city. This scenario is based on plans of PostNL for further extension of the Amsterdam implementation. In July, PostNL started a trial in Utrecht involving 3 bicycles.

This scenario represents the Amsterdam case in Utrecht. Utrecht is a large city in the Netherlands, but smaller than Amsterdam; about 40% of the inhabitants and about 45% of the surface. Utrecht is a city that looks to a certain extent like Amsterdam. It also has a historic city centre with narrow streets and canals. The same issues with traffic in the city centres are experienced in Utrecht as in Amsterdam. Shifting to deliveries and pick-ups by freight bicycles will also help here in reducing these issues.

Table 7. Amsterdam and Utrecht population and surface

City	Population (x1000)	Surface (in km2)
Amsterdam	853	219
Utrecht	344	99

Effects and consequences

To calculate the effects, first the business as usual situation from Amsterdam is adapted to the parameters of Utrecht. Capacity of the vehicles remain the same, so reducing the amount of orders means equally reducing the amount of trips. The estimated scenario for Utrecht requires 48 trips by bike instead of 51 trips by van. This causes a reduction in operational hours of about 30 hours. Calculating the effect for the actual upscaling scenario results in cost saving of about 25% and CO_2 savings of about 60%. Therefore it can be concluded that the relative savings remain fairly equal. However the sensitivity of the amount of micro-hubs is large. The smaller the city become, the more significant the addition CO_2 emissions from the supply trips by truck become, compared to the savings cause by the electric freight bicycle.

As this scenario is familiar to the Amsterdam scenario the business model canvas is exactly the same as the one described above, only the described effects are slightly smaller because the transport of less orders is transferred from van to freight bicycle.

4 Brussels

In Brussels, urban freight transport both suffers from and contributes to severe road traffic congestion, with an average time loss of 38% compared to free-flow traffic (www.tomtom.com). Freight traffic is responsible for 14% of all vehicles entering the Brussels-Capital Region. However, the proportional burden on the environment and liveability is higher. Vans and trucks account for one quarter of transport related CO_2 emissions and one third of NOx emissions in the Region (Lebeau & Macharis, 2014).

4.1 Implementation description and its effects

4.1.1 Business as usual versus CITYLAB implementation

One of the contributors to congestion are the many delivery vehicles that are driving around with a low vehicle fill rate (VFR), particularly vans. For diverse reasons, it is not easy to maximize the VFRs of these vehicles. The CITYLAB implementation in Brussels focuses on synergies between different types of freight transport currently transported in vehicles with suboptimal VFRs. First, supply of fast moving consumer goods (FMCG) to small, independent retailers, or nanostores, of which there are an estimated 900 in Brussels. These stores often lack a storage room, meaning that a product is out of stock when it is not on the shelf. This leads to continuous inventory replenishment (Magalhães, 2010). Field research indicates that currently the majority of these stores in Brussels are supplied by the owners themselves who visit a wholesaler/retailer. Another type of suboptimal use of freight vehicle capacity is the vehicle use by service driven-companies (e.g. plumber, cleaning services). Their trips are difficult to capture in numbers but form a significant part of traffic (Cherrett et al., 2012). The aim of the implementation is to test whether fill rates can be increased by unlocking free capacity of service-driven companies to cost-efficiently supply consumer goods to nanostores.

In Brussels, products reach the nanostores through different channels. Storeowners indicated that they mostly purchase their products by going to the wholesaler on own account with their vehicle. Several storeowners also indicated that in addition to own account pick-ups, some products are delivered to the store by distributors. Exact numbers are not available for the vehicle movements generated by the supply of these stores in Brussels. A study by Dablanc (2011) shows that the supply of independent retail outlets is estimated to be between three and ten times per week. This is regardless whether products are being picked-up by storeowners or delivered to the store. Surveys prior to the implementation indicate that more than 50% of the storeowners visit the wholesaler at least twice per week. Information on VFR is difficult to acquire but a study in the city of Nijmegen, the Netherlands, indicates that VFR of own account vehicles is less than 25% (Buck Consultants International, 2005). During interviews, storeowners said they go to the wholesaler irregularly but frequently.

In CITYLAB Implementation Brussels, Procter & Gamble (P&G) is the owner of the implementation. A new online sales channel to reach the stores is introduced. Products are delivered by utilizing the spare transportation capacity of vans of existing service-providers. The goal is to reduce or eliminate inefficient storeowner pick-ups, and substitute them by utilizing the free capacity of service-driven companies, whereby load factors of these vehicles are increased. A distributor is subcontracted by P&G to manage, store and sell the products. The figure below depicts the new supply chain set-up with its physical, financial and information flows.

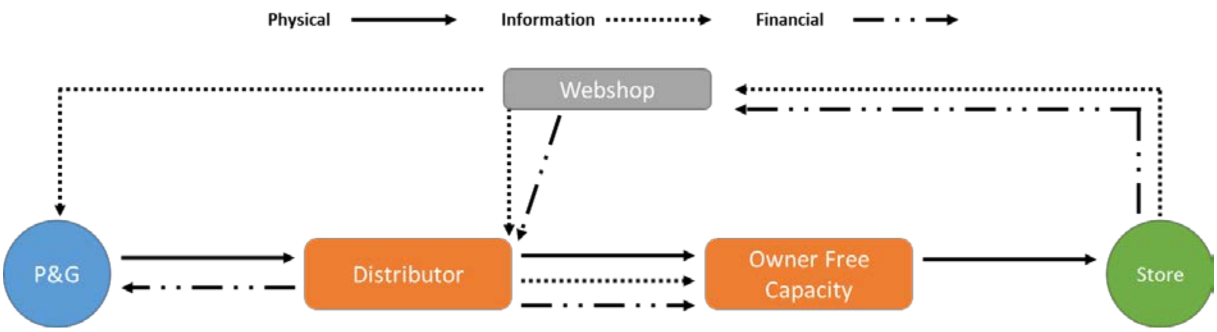

Figure 7. Set-up of the Living Lab implementation in Brussels.

A dedicated assortment of products is offered in a newly created webshop. These products are sold and delivered by P&G to the distributor. 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 (DC) of the service-driven company. The owner of spare capacity adds the additional delivery to his routing. At the end of the period, the owner of spare capacity charges the distributor in case of additional kilometres compared to its regular routes. Febelco, a distributor of pharmaceutical products to pharmacies conducted deliveries during the implementation in Brussels. Febelco has a dense network and uses small vans. When a storeowner places his order, the distributor notifies Febelco that a delivery is coming. The products are transported from the DC of the distributor to the one of Febelco, located in close proximity to Brussels. Febelco adds the delivery to one of its routes in the Brussels Capital Region whenever there is capacity available (pharmaceutical products are prioritized). The store is added as a regular stop and the software calculates the optimal routing.

Three groups of stakeholders are directly involved in the implementation:

- P&G is a FMCG manufacturer and owner of the implementation. Currently most nanostores in Brussels acquire FMCG products by going to the wholesaler/modern retailer on own account. Hence, products reach the stores indirectly and consequently P&G has no visibility to what extent their products are present and sold. The implementation is an opportunity to re-establish contact with the storeowner, with the aim to increase visibility of their products, more frequent replenishment and/or higher sales, and to contribute to more sustainable logistics set-ups. A distributor is contracted to store products, set the prices and manage the sales process.
- Service-driven companies (owners of spare transportation capacity): companies that are service-driven and execute specific delivery tours regardless of being fully loaded. In the implementation, they serve as transport operators delivering to the stores during their service-driven routes. For these companies, the purpose is to test whether transporting additional goods is financially and operationally feasible, and whether they can have more environmentally friendly operations.
- Nanostores: these stores are independent, meaning that they do not belong to a retail channel. They function as a receiver and primary customer in the implementation. The purpose is to reduce inefficient storeowner pick-ups by delivering directly to the stores.

As of March 2017, a sales representative introduced the concept to the stores and helped them to place their first order. Deliveries were conducted in April-May 2017. The deliveries by

Febelco did not lead to additional vehicle kilometres since the stores were located exactly on-route between two pharmacies.

During the implementation, the product assortment was limited to P&G products. In a later phase, P&G may also look into including food/non-food products that are relevant for small stores located in city. This may further optimize logistics costs, reduce CO_2 footprint and improve service to the stores.

4.1.2 Role of stakeholders

Table 8 outlines roles, actions and interest of different stakeholders in the CITYLAB solution in Brussels. A clear role specification is necessary to estimate the effects on different participants as well as to evaluate possible upscaling options. The input for the table is collected and validated with the respective stakeholders.

Table 8. Participating stakeholders in the Brussels CITYLAB solution

Stakeholder	Role	Participation in solution	Interest
Shipper (P&G)	Owner of the solution; Manufacturer; Shipper;	Bringing stakeholders together; Supply network design;	Higher in-store visibility; Higher sales; Create brand loyalty; High service; Satisfied customers; Relationship with storeowners; More sustainable UFT by reducing number of inefficient loaded vehicles
Shipper (Distributor[2])	Storing goods, selling to stores and sending to owner of spare capacity; Intermediary between manufacturer(s) and owner of spare capacity;	Managing product assortment and selling through webshop; Pricing of the products.	High sales; Low DC costs; Efficient DC operations; High service
Transporter (Owner of spare transportation capacity; Febelco)	Transport operator	Delivering goods to the stores during their regular service trips; Own service is prioritized and available capacity in terms of time and load factor of their vehicles is utilized.	Efficient vehicle use; High vehicle fill rate; Minimal interference with regular operations; Satisfied customers (pharmacies); Green image; Less congestion;

2 Not included in the Business Model Canvas because they were contracted by P&G to conduct regular operations.

Stakeholder	Role	Participation in solution	Interest
Receivers (nanostores)	Customer and receiver	Ordering and paying products online through a webshop rather than physically purchasing them at the wholesaler.	Lowest out-of-stock as possible; Convenient product acquirement (delivery and/or pick-up); Low transport costs; Low prices for products; More tailored product portfolio; Attractive urban environment

4.1.3 Effects from CITYLAB implementation

The business models of the different actors are described separately in the following paragraphs by means of the business model CANVAS. In this paragraph, we describe the differences between business as usual and the situation with CITYLAB solution.

Business Model Canvas for P&G

In Belgium, the majority of P&G (as well as other FMCG) products are sold through modern retailers and wholesalers – to individual consumers as well as to small businesses such as nanostores. Nanostores only form a very small part of the retail market in Belgium and the share is decreasing further. In 2015, the market share of independent retail was 4.7%, while it was 18.9% in 1985 (Nielsen, 2016). Main reasons as pointed out by Nielsen (2016) are increasing competition from organized supermarkets, inadequate sales and profit, and no funds to invest. Whereas in Belgium, as well as in other European and North American countries, the number of nanostores is relatively small, globally there are an estimated 50 million (Blanco & Fransoo, 2013). In emerging economies, these stores often compose the majority of the retail landscape as opposed to modern retail chains. For instance, in India less than 10% of the retailers are organized and in Latin America independent retail represents 61% of the market (Kin, Verlinde, & Macharis, 2017). Therefore, collectively such stores form an important part of the sales for FMCG manufacturers. It becomes, however, increasingly difficult to reach these stores. There are different supply models available (see Blanco & Fransoo, 2013). Regardless of the context, the problem eventually relates to logistics. Nanostores are a clear example of fragmented deliveries, something also observed in case of home deliveries. Drop sizes are generally low. This is partly caused by the lack of a storage room which leads to high replenishment frequencies and subsequent low VFRs (Kin et al., 2017; Macharis & Kin, 2017). On the one hand, this leads to inefficient urban freight transport, with consequent unsustainable effects. On the other hand, it has a commercial impact for the suppliers. One can therefore say that physical supply and sales are inherently linked.

There is a considerable difference whether a manufacturer sells his products through a modern retailer or a nanostore. The table below shows the main differences between modern retail and traditional retail (nanostores), including the difference in logistics.

For P&G, the CITYLAB implementation is an opportunity to find out whether nanostores can be reached in a more cost- and service-effective way. Although the implementation takes place in Brussels, it provides important learnings with regard to upscaling (more stores and/or inclusion products of other manufacturers) as well as for the transferability to other countries.

Table 9. Comparison modern retail – traditional retail (Blanco & Fransoo, 2013)

	Modern channel supermarket	Traditional channel supermarket (nanostore)
Functions	Professionals, dispersed	Single storeowner-operated
Logistics support	Distribution centres, cross-docks, 3PL	None
Financial flow	Formal credit, bank transfer	Cash, relationship-based credit
Line items	Full casepacks to store, pallets to retailer DC	Consumer units, mixed casepacks
Number of stock keeping units	Thousands to tens of thousands	Hundreds
Category depth	Half dozen to dozens	Single or double
Number of consumers served per store	Tens of thousands	A few hundred
Technology	Enterprise systems, POS scanning, EDI	Personal mobile phone

As owner of the implementation, P&G brought the different stakeholders together and designed the supply chain together with these stakeholders. They had a webshop developed and contracted a distributor to manage the product assortment and sales. An important learning that P&G planned to get out of the implementation relates to the feasibility of delivering small quantities to many addresses. The delivery costs when using a service-driven company must be lower than when hiring a regular logistics service provider.

With the help of the Business Model Canvas, Figure 8 below summarizes the changes to P&G's business model when supplying nanostores in the implementation compared to business as usual situation (indirectly through wholesalers).

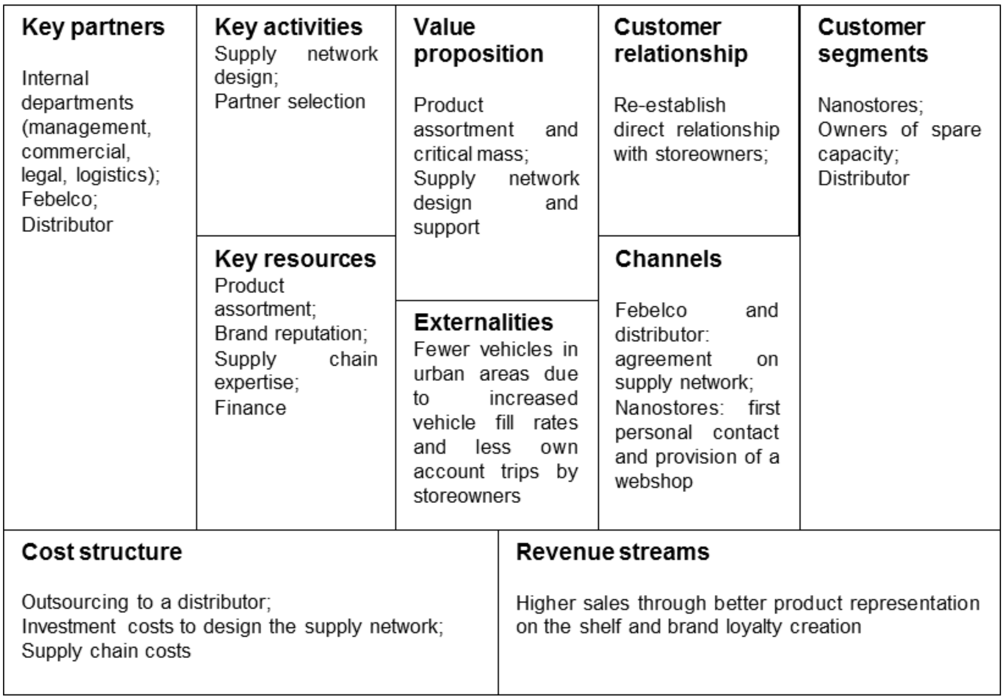

Figure 8. Business model canvas Brussels implementation – P&G

Business model Canvas for storeowners (nanostores)

The nanostoreowners are the receivers and main customers in this implementation. Around 900 nanostores were identified in the Brussels-Capital Region (i.e., small independent retailers and night shops). In Brussels, products reach the nanostores through different channels. In most cases, storeowners indicated that they go to the wholesaler on own account. Compared to the business as usual situation, the aim is to reduce the number of trips that are being made to the wholesaler. This is substituted with online ordering and payment, after which products are delivered directly to their store. During the implementation, only P&G products are offered which means that they still need to go to the wholesaler for other products. Collaboration between different manufacturers could further decrease the number of shopping trips by the storeowner.

Nanostore involvement is key to get the implementation running. Most indicated that they make shopping trips *‘’whenever necessary”, ‘’when prices are low”* or *‘’during promotions”*. The latter means that there is a high probability that trips are made for a limited number of products. This potentially leads to inefficiently loaded vehicles. Prices, followed by promotions and proximity are the main considerations for choosing a particular wholesaler.

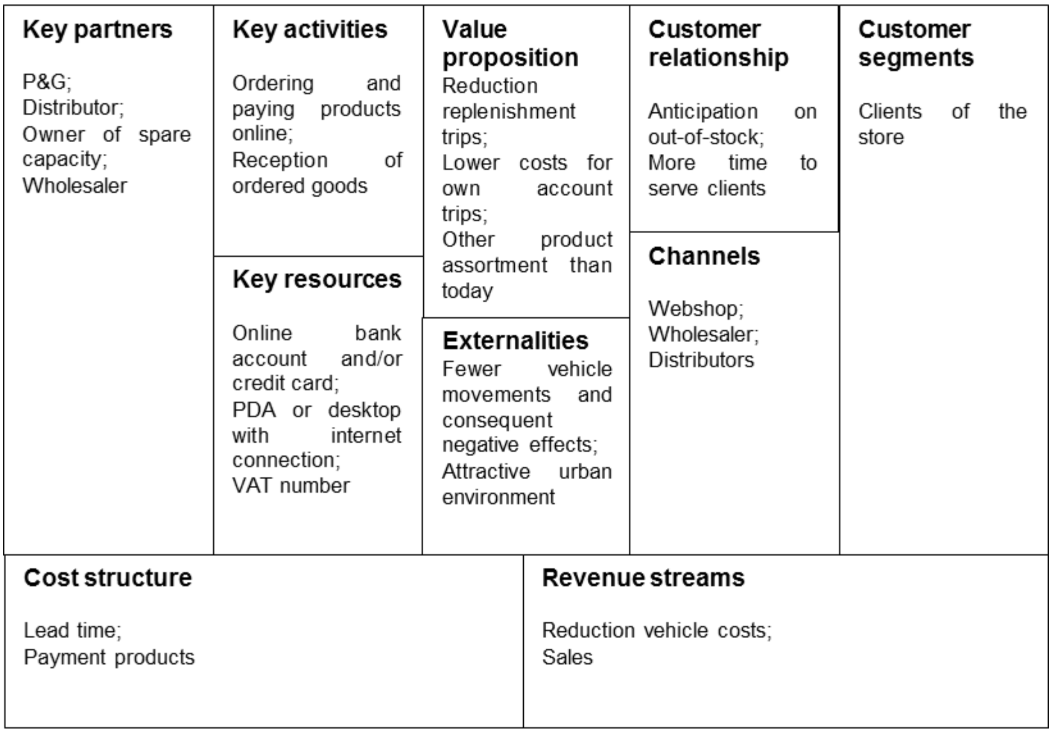

Figure 9. Business model canvas Brussels implementation – Nanostores

Store visits to prepare the CITYLAB implementation revealed that storeowners are only willing to consider online ordering when prices are low. Most of them currently buy during promotions. Several storeowners indicated that they go *‘’wherever there are promotions*’’. Few stores were willing to order products online during the implementation. There are varying reasons for this. Most do not see the problem of having to go to the wholesaler on own account, particularly since they acquire the products at time of purchase. Lead-time is thus an important factor. Storeowners do not see this shopping trip as a cost, while it actually is when vehicle costs are considered. In this regard, another consideration that has to be taken into account is the potential implementation of restrictive traffic measures in the future. In Brussels, the pedestrian zone was largely extended, which complicates supply of stores in this area (Verlinde, Kin, Strale, & Macharis, 2016). Other restrictive legislation can also be expected in the light of the goal of CO_2-free city logistics whereby especially older – and more polluting vehicles – are increasingly restricted (e.g., low emission zone in Antwerp). Nonetheless, store visits to prepare the implementation as well as store visit by the sales representative revealed that for several storeowners online payment is not possible and/or they do not want to pay prior to delivery. This is an important learning that is analysed further in the behavioural analysis.

Business model Canvas for owners of spare transportation capacity

The owners of spare transportation capacity are service-driven companies that do not provide a logistics service as such. Those companies have daily delivery and/or service trips and often need to design-in free capacity in both their vehicles and delivery network. Since they are service-driven, these companies are contractually obliged to execute specific delivery tours regardless of being fully loaded. These companies often use light commercial vehicles (i.e., vans).

During the implementation, deliveries were conducted by Febelco, a distributor of pharmaceutical products. As a wholesaler and distributor of pharmaceutical products, Febelco has a market share of 43% in Belgium. In total, 2500 pharmacies are delivered one to three times per day from 8 DCs across Belgium (www.febelco.be). Generally, pharmacies in Belgium can order multiple times per day with lead-times of just a few hours. Consequently from every single distributor/wholesaler DC, several thousand orders are delivered on a daily basis (for more information on the Belgian pharmaceutical distribution system, see Nsamzinshuti et al., 2017).

The Brussels-Capital Region (as well as a region to the east) is served from a DC located in Kortenberg. Each order that is placed before a certain hour is delivered on a fixed time. For example, in a contract with pharmacy x it is stated that if they order before 9h38 the goods are delivered at 12h14. The network is very dense and daily routes are fixed. Operationally, lead-times are short and most vehicles make three milk runs throughout the day. Nonetheless, VFR can be up to 75% (Febelco, n.d.). Mostly vans with a EURO 5 vehicle technology are used. Currently this supply model does not allow including store deliveries as this would impact the fixed delivery times. In case of time windows this would allow more flexibility. A possibility discussed within this supply model is to use a centrally located depot in Brussels from where the vans can pick-up the products and deliver them during their return trips to the DC (if there is idle time). In addition to this supply model, Febelco also has a daily delivery trip that is conducted on behalf of a wholesaler. These deliveries do not have a time constraint, but have to be delivered on that particular day. The store deliveries have been conducted by this vehicle. In case of store deliveries, the address of the store has been added to the routing. Febelco primarily participated because of green concerns and as a learning experiment. As agreed during the implementation, Febelco receives a compensation based on the additional kilometres that are driven to supply the stores compared to roundtrips with only pharmacies.

<table>
<tr>
<td rowspan="2">Key partners

P&G;
Distributor;
Nanostores;
Pharmacies</td>
<td>Key activities

Reception and short storage products;
Planning and delivering products</td>
<td>Value proposition

Deliveries at the store;
Efficient and professional deliveries;
Green image</td>
<td>Customer relationship

Participation agreement;
Learning experiment</td>
<td rowspan="2">Customer segments

P&G;
Nanostores;
Distributor;
Pharmacies</td>
</tr>
<tr>
<td>Key resources

Supply network including DC, vehicles, routing software</td>
<td>Externalities

Higher vehicle fill rates and more optimal vehicle use;
Less congestion</td>
<td>Channels

P&G and distributor: agreement on supply network;
Nanostores: physical contact</td>
</tr>
<tr>
<td colspan="2">Cost structure

Operating costs: extra picking, loading/unloading and stop time</td>
<td colspan="3">Revenue streams

Depending on additional kilometers, additional revenues;
Maximizing vehicle fleet usage</td>
</tr>
</table>

Figure 10. Business model canvas Brussels implementation – Febelco

Financial viability of CITYLAB solution

The owners of spare transportation capacity are service-driven companies that do not provide a logistics service as such. Those companies have daily delivery and/or service trips and often need to design-in free capacity in both their vehicles and delivery network. Since they are service-driven, these companies are contractually obliged to execute specific delivery tours regardless of being fully loaded. These companies often use light commercial vehicles (i.e., vans).

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Costs and benefits for society of CITYLAB solution

Out of the three stakeholder groups included in this analysis, there is not a clear beneficiary of the solution at the current scale. Nonetheless, the deliveries that were carried out did not lead to additional vehicle kilometres. When the replenishment by Febelco is compared to own account shopping trips (storeowners going to the nearest wholesaler), there is a positive trade-off for society. No additional kilometres were driven by Febelco. The same replenishment by own account shopping trips would have led to 19 kilometres. Consequently, this also led to more emissions of SO_2, NO_2, PM and CO_2. Moreover, little information is available on the type of vehicles of the storeowners, but observations show that these are relatively old. Contrariwise Febelco uses a vehicle fleet with EURO 5 vehicles and is anticipating on the use of electric vehicles.

4.2 Stakeholder support for Brussels solution

Figure 11 shows the multi-actor results for the P&G implementation in Brussels with an online shop for high-frequency storeowners (HFS) who are then delivered by vehicles of service-driven companies. The aggregated scores of the evaluation are shown on the y-axis (based on AHP eigenvalues method, see Saaty (1988)). The coloured lines represent the alternatives and show to what extent each alternative contributes to the criteria of each stakeholder (x-axis). The orange line represents BAU when HFS owners go to a wholesaler or retailer and supply themselves with P&G products (and products of other manufacturers). The blue line represents the CITYLAB solution when HFS owners order their P&G products online. Deliveries are done by service-driven companies with spare transport capacity but HFS owners still supply themselves with products of other manufacturers. Figure 11 shows a mixed picture. For the HFS owners and P&G, BAU scores better. For society, the CITYLAB solution scores better. Owners of spare capacity are undecided.

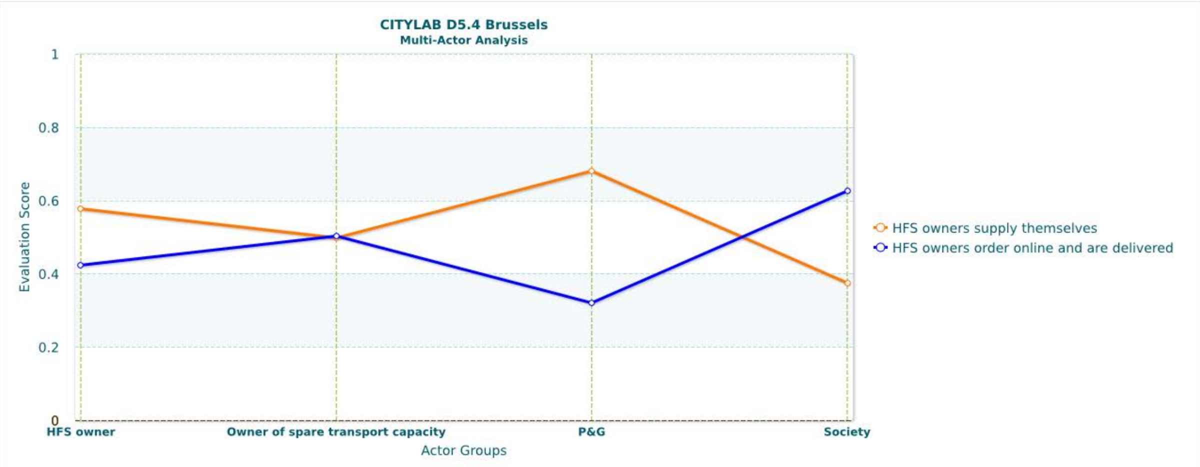

Figure 11. Multi-actor results for CITYLAB solution in Brussels

The biggest difference between BAU and the new solution is measured for P&G. When looking at the mono-actor results for P&G (Figure 12) we see that there are two of their criteria for which BAU scores high: low cost for transport and high quality deliveries. These two aspects need to be addressed to make the solution interesting for P&G. Sensitivity analysis reveals that the ranking of the scenarios is robust for P&G. Even if the weights for ‘low cost for transport’ or for ‘high quality deliveries’ were put to zero, the overall ranking of both alternatives would not change for P&G. The scores for the criterion ‘high quality deliveries’ for P&G is closely related to how both solutions score for the client of P&G (HFS owners). When looking at the mono-actor results for the HFS owners (Figure 13) it is mainly the low quality of deliveries and the worse impact on shopping environment of the solution which should be addressed. It could be that the HFS owners in this implementation (nightshop owners) pay value the criterion ‘shopping environment’ lower than a traditional retailer/receiver. Sensitivity analysis reveals, however, that even if that was the case and the weight of this criterion was put to zero, the overall ranking of both alternatives would not change for HFS owners. Overall, it means that the analysis is robust and that P&G and HFS owners, the most important stakeholders in this implementation, prefer BAU. In ANNEX 2, you can find all mono-actor results for the implementation in Brussels and the table with justification for the various scores of the alternatives.

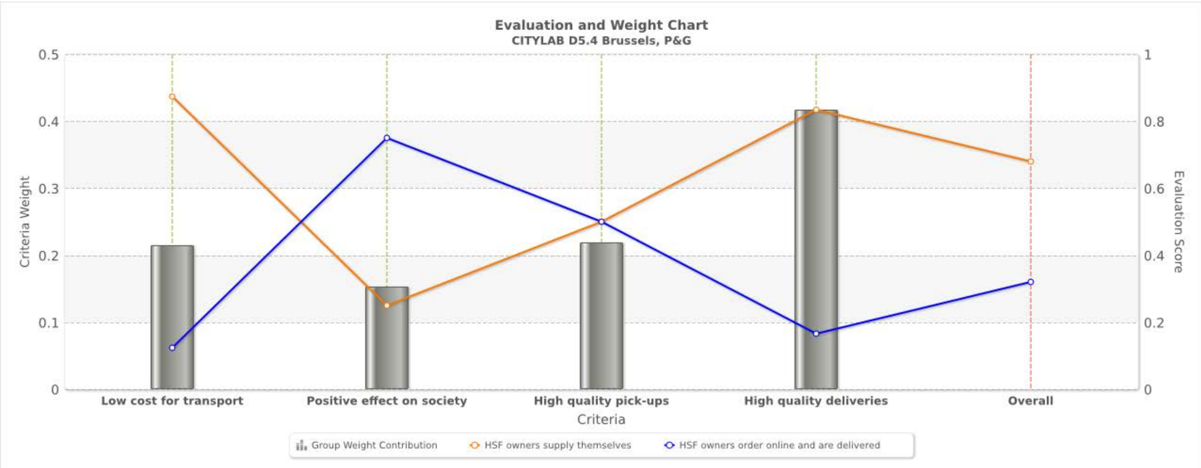

Figure 12. Mono-actor results for P&G for CITYLAB solution in Brussels

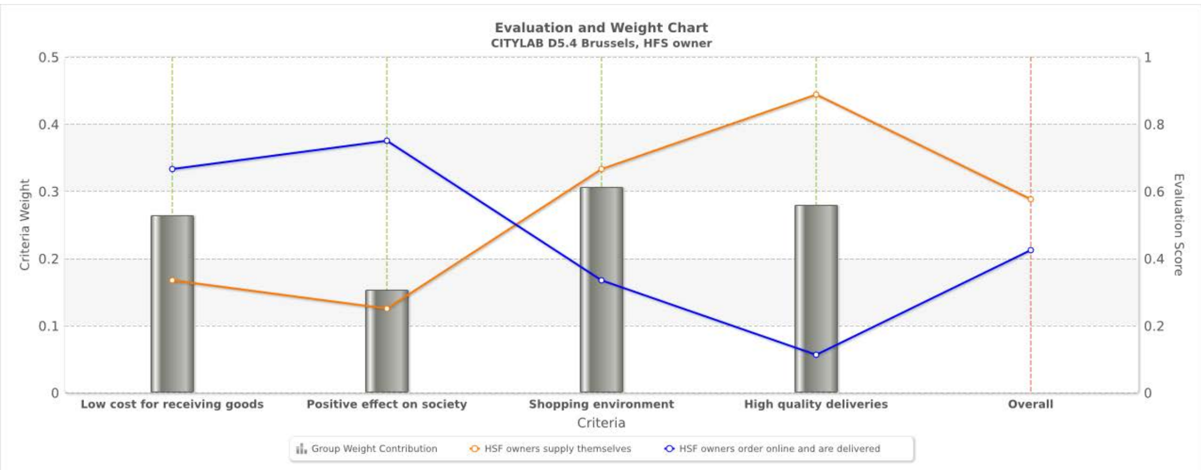

Figure 13. Mono-actor results for HFS owners for CITYLAB solution in Brussels

4.3 Upscaling of Brussels implementation

4.3.1 Baseline for upscaling

The scale of the implementation was small. Despite the low uptake of the solution, we would like to assess the impact when the solution is accepted and implemented on a larger scale. This section elaborates on a model that analysed different upscaling scenarios of the implementation, taking into account different levels of storeowners who go the supermarket themselves combined with online orders delivered by the owner of spare transportation capacity. First, the model is explained, followed by the context including the input parameters, and finally the results are presented and discussed.

4.3.2 Upscaling CITYLAB Brussels implementation

General model (SYMBIT) and application on CITYLAB Brussels

The SYnchronization Model for Belgian Inland Transport (SYMBIT) is an agent-based model that combines features of Geographic Information Systems (GIS) and Discrete-Event Models (DEM). It is capable of simulating freight transport processes at tactical and operational levels to account for intermodal transport in a flexible manner; also referred to as synchromodal transport (Ambra, Meers, Caris & Macharis, 2017). The modelling framework will serve as a computational basis for calculating optimal routes for the transport of loading units. SYMBIT is capable of simulating and assessing communication structures based on a certain level of transparency by the modeller (Ambra et al., 2017). This is possible due to the ability of agents to send and intercept messages, which makes it applicable to the CITYLAB implementation in Brussels. The implementation focuses on the interaction between different agents. Regarding the deliveries, the interaction is particularly important for the owner of spare transportation capacity and the nanostores.

The purpose of the model is to simulate various business/bundling logic scenarios. The results are computed through simulation and not solved analytically. Simulation data is formed based on agent interaction. The output is twofold. On the one hand, it shows the impact on the operations of the owner of spare capacity (Febelco) when more delivery addresses are added. On the other hand, it allows assessing the costs and benefits to society (e.g., emissions).

In the model, a distinction between three types of agents is made:

1) Moving agents: cars of the storeowners (‘ShopCar’) and the fleet of vehicles of Febelco (‘Ftruck’);
2) Stationary agents: the distribution centre of Febelco, night shops, supermarkets and pharmacies;
3) Decision-making agents: storeowners and Febelco planners.

The initial step is to geocode all the stationary agents. First, the nightshops are taken from the database as provided. Only nighsthops (215) are included as a sample since it cannot be expected that all 900 stores will order. The supermarkets (19) serve as the stores where the nanostore owners go to replenish. The pharmacies (244) were queried via Google. Location for each location of the stationary agents is generated via ‘Google Maps Geocode API’, and based on the coordinates this was converted into GIS space markup in ‘Anylogic’ software (www.anylogic.com). The initial location of ‘ShopCar’ was evenly distributed among nightshops, assuming that each storeowner has one vehicle at his disposal. The simulation run covers 1 month (August 2017). Figure 14 below shows the study area with the different agents indicated.

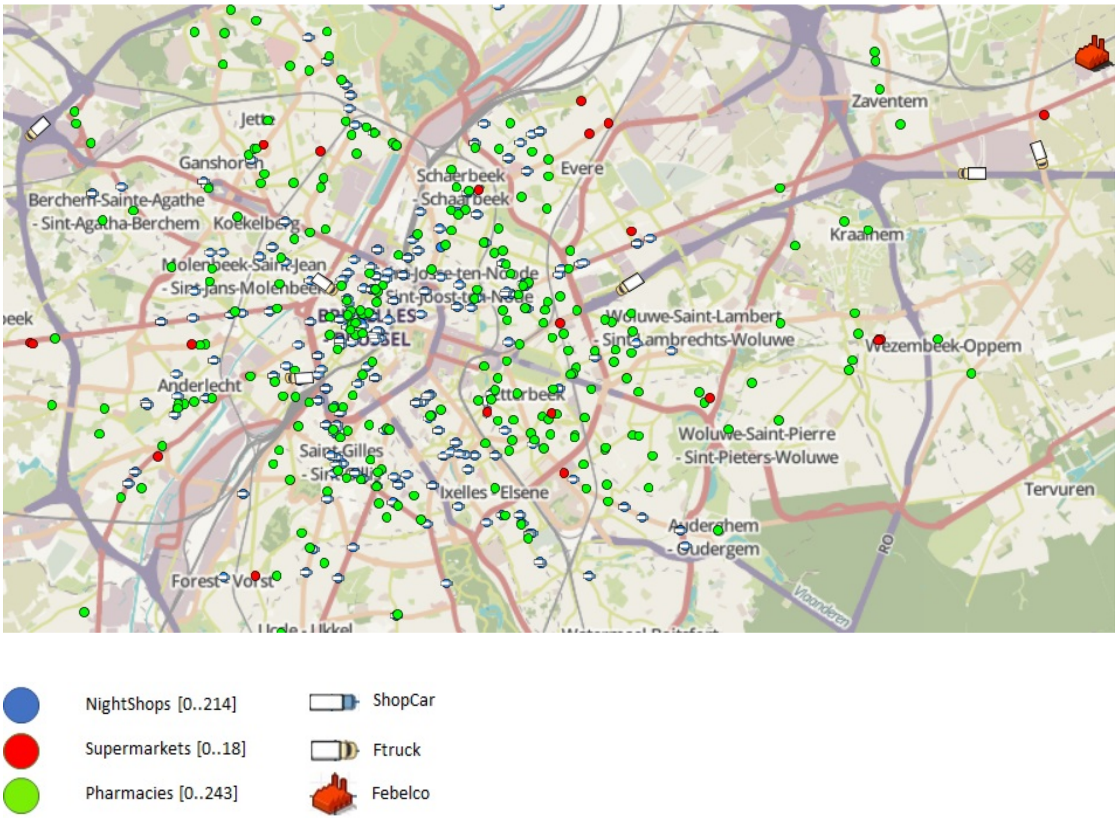

Figure 14. Illustration of the study area for the upscaling of the CITYLAB implementation in Brussels

Every pharmacy generates demand based on a rate. The rate is determined by a uniform distribution function ranging from one to three times per day. Pharmacies can order during working days (Monday-Friday/8am-7pm) and on Saturday (8am-12pm). When this demand is generated, an order is sent to Febelco's DC. When the pharmacy orders reach Febelco*,* an Ftruck is seized from the truck fleet. Truck loading time is set to a uniform distribution of 25 to 35 minutes and after this process, the truck departs to the geocoded locations embedded in the order parameter at an average speed of 50 km/h. Unloading duration at each pharmacy varies between one and five minutes after which the individual truck agent checks its individual order queue and continues to the next pharmacy. If there are no other orders to be served, the truck returns to its home location (Febelco DC). The trucks operate on three cyclic shifts (morning, noon and afternoon). After each shift, the truck always returns to its home location. This is to reflect that each truck needs to restock three times as pharmacies can generate demand up to three times per day. For instance, when a pharmacy generates demand in the afternoon, it is unlikely that the given truck, currently roaming the environment in Brussels, will have the product onboard from the morning's loading process. The main assumption is that deliveries are conducted by Febelco during their regular operations, whereby they deliver to their customers multiple times per day. Delivery times to pharmacies are fixed. In case a store order is assigned to the Ftruck, it will first prioritize all the pharmacy orders on board. Once the Ftruck's individual order queue does not contain any pharmacy orders, it will scan for store orders and depart to the store location. After the store delivery, the Ftruck returns to the DC.

The nightshops are agents that contain a decision node, which is initiated by a replenishment between three and six times per week. Every time a nightshop replenishes there are two options: via the website or by going to the supermarket. Every nightshop has a local parameter called ‘preference for website order’. This parameter contains values between zero and one where values between 0-0.5 mean ‘false’ and values between 0.5-1 mean ‘true’. A RandomTrue java function is used to generate random numbers between 0-1 bounds (see *a* in Figure 15). If the function generates 0.786, the condition will be more likely true (*b*) and the storeowner is keener on ordering via the website, which will be delivered by Febelco. If the function generates 0.221 as the website order preference, the condition will be more likely false (*c)* and the storeowner will be keener on going to the supermarket himself. For instance, based on a sample of 10 decision events, a website preferences of 0.221 would result in approximately 3 website orders and 7 own pick-ups.

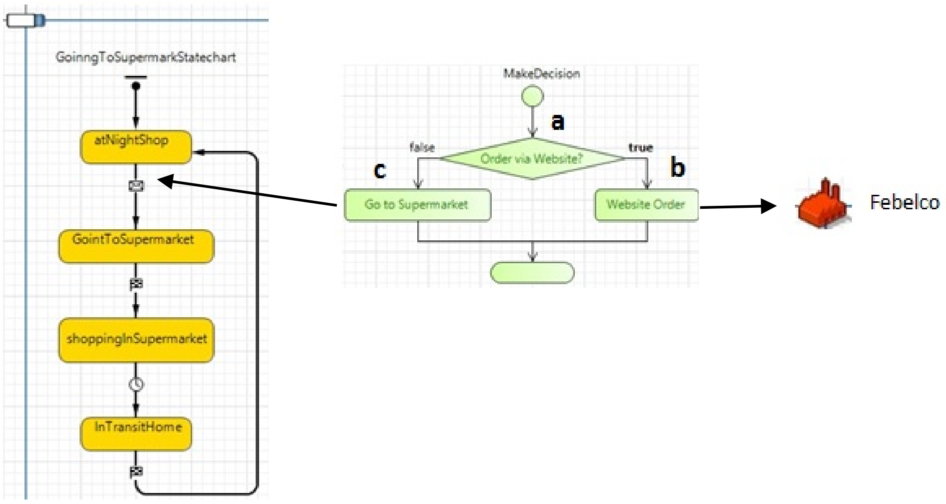

Figure 15. Decision-making logic for each nightshop agent

This approach is used for the ‘what-if’ scenario analyses. By varying the bounds for the RandomTrue function, the ‘preference for website orders’ affects the input parameters throughout the whole sample of 215 nightshops.

The following process is executed when the nightshop decides to:

1) Replenish by ordering via the website (*b* in Figure 15). There is no schedule for this event as there are no opening hours for placing a website order. A new shop order is generated and sent to Febelco’s order queue. The process flow is organized in discrete event blocks. During deliveries priority is given to pharmacy orders and shop orders are only delivered before returning to the DC, as described earlier.
2) Replenish by going to the supermarket. The journey is generated during opening hours of the supermarkets. In this case, ShopCar agents move to the nearest supermarket by following the fastest route (Figure 15 *c*, GoingToSupermarket). The supermarkets are part of the supermarket collection (19 in total). Once the ShopCar arrives at the supermarket, 20-60 minutes are spent for shopping and loading.

In total eight scenarios are simulated for one month:

- S1: the baseline scenario (‘Business as usual’) with 100% own pick-up and 0% of the replenishments are ordered online, Febelco uses its current DC.
- S2: 5% of all replenishments are ordered online, Febelco uses its current DC.
- S3: 10% of all replenishments are ordered online, Febelco uses its current DC.

- S4: 5% of all replenishments are ordered online. Febelco delivers to the pharmacies from their DC in Kortenberg. Pharmacies are delivered first, during their return trip they pick-up store deliveries (if there are any) at the centrally located DC and deliver those before returning to Kortenberg (see Figure 17).
- S5: same setting as S4, but with 10% of all replenishments ordered online.
- S6: 0% of replenishments are ordered online, Febelco uses a centrally located DC (Figure 17) and the DC in Kortenberg is ignored.
- S7: 5% of all replenishments are ordered online, a centrally located DC is used.
- S8: 10% of all replenishments are ordered online, a centrally located DC is used.

Scenarios descriptions

The table below shows the simulation results. For each scenario, the number of vehicle kilometres (veh km) for Ftrucks (to serve pharmacies and stores) as well as for the ShopCars is given (retour trips from their store to the nearest supermarket). It also gives the mean delivery time for the pharmacies as well as stores. Extra Ftruck distances are calculated from the point when the Ftruck drops off the last pharmacy order and, if there are any shop orders, initiates a nightshop delivery protocol (this may entail a direct delivery to the nightshop or a proceeding trip to a central DC if specified in the simulation).

Table 10. Overview results upscaling scenarios Brussels implementation

Order integration while using current number of Ftrucks					
Own pick-up/Website orders	**Ftruck distances (km)**	**Extra Ftruck distances to Shops (km)**	**ShopCars Distances (km)**	**Total distance (km) and share (%)**	**Pharmacy/Shop mean order delivery time (hours)**
S1: 4 165 (100%) / 0 (0%)	51 789	n.a.	9 286	61 075 (84.8/n.a./15.2)	1.3/ n.a.
S2: 3 899 (94.7%) / 218 (5.3%)	53 479	1 322	8 644	63 445 (84.3/2.1/13.6)	1.4 / 17.5
S3: 3 734 (89.6%) / 435 (10.4%)	53 124	2 445	8 380	63 949 (83.1/3.8/13.1)	1.5/ 18.1
S4: 3 964 (94.%) / 223 (5.3%)	52 847	3 472	8 379	64 698 (81.7/5.4/13)	1.4 / 11.1
S5: 3 737 (89.7%) / 429 (10.3%)	52 616	4 277	8 082	64 975 (81/6.6/12.4)	1.5 / 12.2
S6: 4 190 (100%) / 0 (0%)	32 865	n.a.	9 387	42 252 (77.8/n.a./22.2)	1.05 / n.a.
S7: 3 964 (95.0%) / 207 (5.0%)	32 998	1 176	8 836	43 010 (76.7/2.7/20.5)	1.1 / 9.3
S8: 3 738 (89.8%) / 425 (10.2%)	33 088	2 584	8 324	43 996 (75.2/5.9/18.9)	1.1 / 11.5

The baseline scenario (S1) yields 51 789 kilometres covered by Ftrucks to serve 244 pharmacies during one month. Pharmacy orders are delivered in 1.3 hours on average. The total travelled kilometres by ShopCars is 9 286. This represents the journeys of all ShopCars to and from the nearest supermarket.

The second simulation (S2) presents an initial parameter variation where 5% of the storeowners decide to replenish online. This results in a small decrease in ShopCar total distance and an increase in Ftruck kilometres. This is a clear consequence of serving extra locations, being the nightshops. However, the mean pharmacy delivery time remains almost equal, increasing by 10 minutes to 1.4 hours. This is caused by the later arrival of Ftrucks back to the DC due to the 218 extra stops at the shops and the 1 322 additional kilometres. The mean shop order delivery time is 17.5 hours which is rather high. It is important to point out that delivery times for shop orders may fluctuate widely as they may be placed at night and during weekends.

Figure 16 illustrates such fluctuations, ranging from 50 minutes to 63 hours, contributing to the higher mean value. Each column contains a number of hits between a given time horizon when the order was delivered. The mean values are depicted by vertical lines; green for pharmacy orders and blue for shop orders.

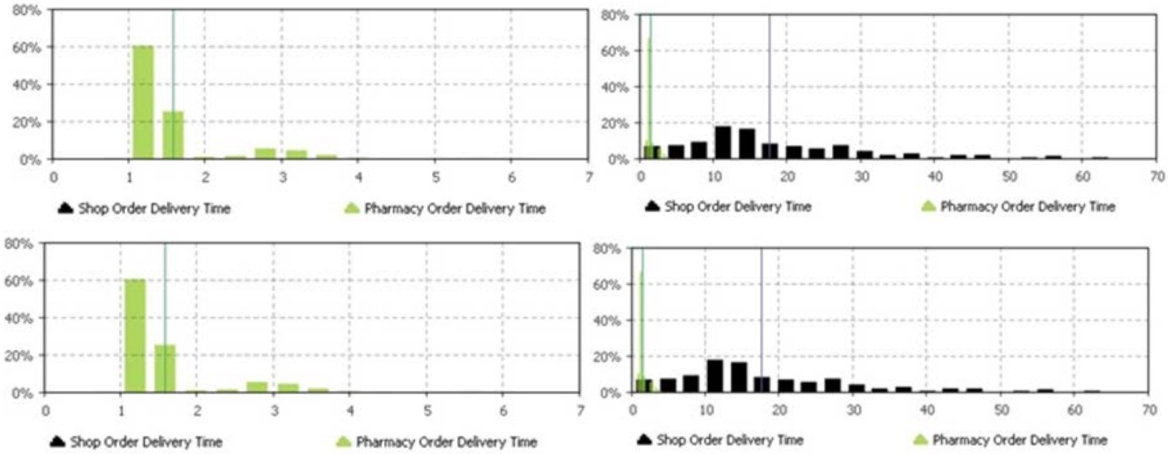

Figure 16. Histograms[3] representing probability distribution functions for each order type after a month for S1 and S2

For simulation S3, the bound of replenishment online is altered to 10%. This leads to an increase in Ftruck kilometres as Febelco has to deliver to more locations, whereas the distance of ShopCars slightly decreases; given that 10% less journeys to the supermarkets were generated. The overall impact in terms of distance is negative compared to the baseline, mostly because 10% of the ShopCars' distance to supermarkets was replaced by Ftrucks, which are not always located close to the nightshops. ShopCars did the nearest neighbour search, and consequently moved to the nearest supermarket. Therefore, their distances were always rather low. Contrariwise, the Ftrucks do not move to the nearest nightshop, but to the one that sends the order. Hence, the nighsthop awaiting a delivery may be located on the other side of Brussels resulting in subsequent increase in kilometres. Thus, this simulation resulted in 2 445 extra driven kilometres by Ftrucks. The simulation output also indicated that an extra truck would be needed to preserve initial service levels.

Simulation 4 (S4) assesses a 5% online placement of shop orders, but has a new (fictional) central DC location for these shop orders (Figure 17). This type of what-if scenario was tested in order to demonstrate other possibilities for a more significant increase in delivery efficiency. Combination of order bundling and a convenient strategic location may improve the overall performance of the current system. The particular location was selected for two reasons. First, it is located in the port of Brussels, which is one of the main logistical areas in the Brussels-Capital Region. Second, other prospected owners of spare transportation capacity might have DC's that are located more within the city limits of Brussels. The results show stable values for Ftruck distances as well as mean delivery times for pharmacy orders. This is sensitive

[3] The histograms have an explanatory purpose and are not provided for each simulation since the mean values are already displayed in the table above.

since pharmacies have a higher priority. However, having a central DC for goods ordered via the website, affected the shop order delivery times, decreasing the mean to 11.1 hours in S4 and 12.2 hours in S5. Extra traveled kilometres for Ftrucks changed as well, increasing to 3 472 kilometres in S4 and 4 277 kilometres in S5. The lower mean delivery times can be explained by a different notification timeline; the trucks are notified that there is a shop order awaiting at the Central DC, and only trucks which are operating in Brussels receive this message. Given that the Ftruck is already in Brussels, the pick-up and drop-off of the shop orders is faster since the distance to the central DC is lower. In other words, once the Ftruck, currently in Brussels, receives a notification and has finished all its pharmacy deliveries, it will go to the central DC from the position of the last visited pharmacy. This speeds up the shop order delivery process because the Ftrucks do not have to follow the initial sequence: 1) return to the Febelco DC; 2) load pharmacy and shop orders; 3) deliver pharmacy orders first; and 4) only then deliver the shop order. If the simulation runs for one week, excluding weekend and weekend orders, the shop deliveries are delivered within 3 hours on average. However, the orders would have to come in during operating hours and when the trucks are present in Brussels. The improved mean delivery times come at the expense of increasing the extra kilometres for Ftrucks**.** This is explained because in the previous settings (S1, S2, S3), the Ftrucks already had the shop orders on board and could go directly to the night shop after delivering all their pharmacy orders. In S4 and S5, the Ftrucks did not have the shop orders on board, as these were not loaded at the Febelco DC, but had to travel to the Central DC to collect the shop orders and then go to the night shops; hence, increasing the number of extra travelled kilometres of Ftrucks.

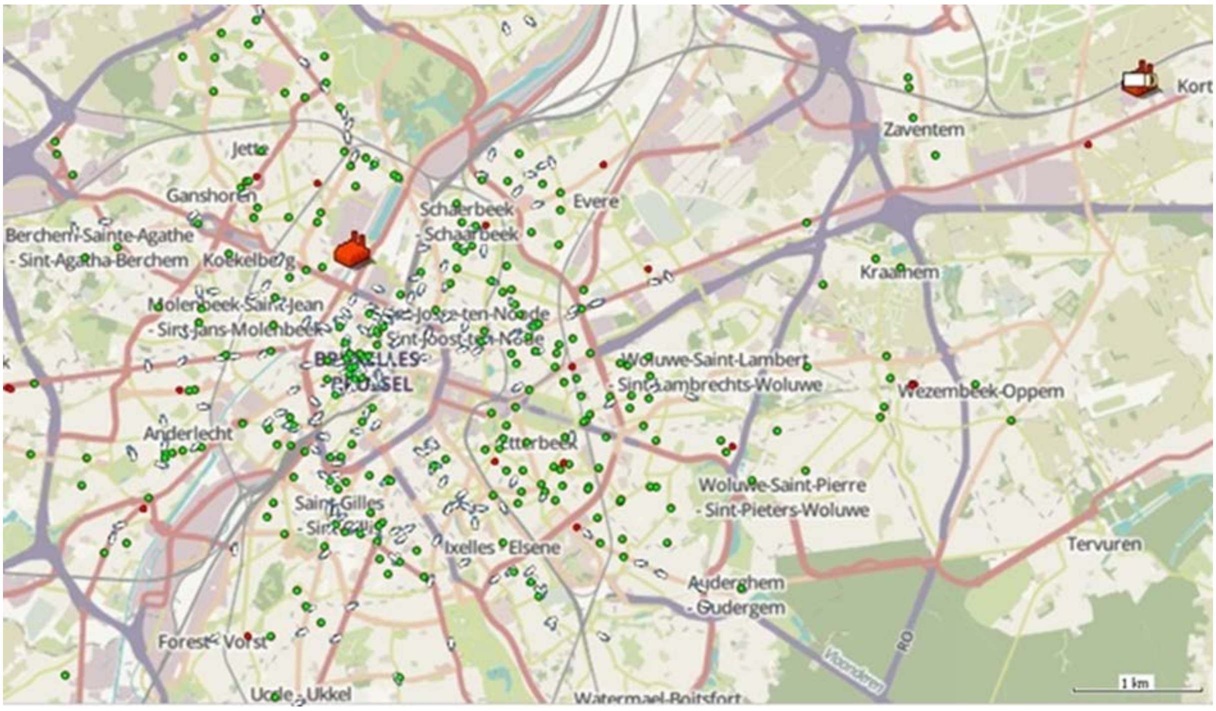

Figure 17. Illustration of the study area for the upscaling of the CITYLAB implementation in Brussels with the location of the central DC

An option that would significantly decrease the distance and increase delivery efficiency was assessed in S6, S7 and S8, where the central DC is also used for pharmacy orders. Compared to S1, when the Febelco DC was located in Kortenberg, the Ftruck distances decreased significantly by approximately 20 000 km per month. The pharmacy mean delivery times improved as well since the Ftruck do not have re-load in Kortenberg. Positive effects may be also observable when including 5% and 10% night shop online orders. The extra Ftruck distances are, more or less, the same since the same logic applies as in S2 and S3. However, the shop order mean delivery time decreased to 9.3 and 11.5 hours, having a very small effect on the pharmacy mean delivery time which decreased to 1.1 hour. When compared to S2 and S3, the pharmacy mean delivery time decreased by 30 and 40 minutes. This development may give the Ftrucks extra time to serve more shop orders and consequently reduce the number of ShopCars in Brussels. Additionally, a lower lead-time could be offered to storeowners, which might in return increase their likelihood to order online. As far as the system perspective is concerned, it can be inferred that the new central location has a very significant impact on the total number of kilometres driven as well as delivery times. The simulation output also indicates that an extra truck would be needed for a 10% online order placement (S8) to preserve initial service levels. This correlates with S3 when the online order bounds were also set to 10% and an extra truck was needed to accommodate the extra input of shop orders.

Effects and consequences

The different upscaling scenarios show the impact for Febelco, the total number of kilometres driven, including those by storeowners. The latter gives a clear picture of the impact on society. Additionally some general conclusions can be drawn on utilizing spare transportation capacity of service-driven companies on a larger scale.

Based on the results obtained with SYMBIT, several conclusions can be drawn with regard to deliveries by Febelco as owner of spare transportation capacity:

1) When the current DC is used, the total number of kilometres increases as soon as storeowners start to replenish online. This has to do with the fact that the DC is further located from the stores than the nearest supermarket for the storeowner.
2) When storeowners start to replenish online, the veh kms for Ftrucks increase quickly, while there is only a slight decrease in the veh kms of ShopCars, herewith increasing the total distance. The lead-time for pharmacies do increase slightly at a low share of website orders as they delay their return trips back to the DC. Ftrucks drove more kilometres but were utilized more efficiently in terms of time.
3) When the shop orders increase further to 10%, Febelco needs additional vehicles and the total number of kilometres driven rises.
4) A centrally located DC is an interesting option to reduce kilometres as well as lead-times. The latter relates to the pharmacy as well as store deliveries and therefore benefits the pharmacies. Nonetheless, it has to be taken into account that Febelco also serves other areas from the current DC. In another city, the DC might be closer to the delivery area. When using the central DC only for website orders, the Ftruck distances increase significantly as they need to generate extra trips to collect the goods from the central DC. This, however, improves the shop order delivery times.
5) A reduction in lead-time means that there is more time available to serve additional addresses, including stores.
6) A slight increase in the number of kilometres for Febelco might be offset by additional revenues. This has to be investigated further.
7) If lead-time becomes excessive for the storeowners, one can expect that the website orders decrease. The central DC location could avert this problem.

8) The average lead-time for nanostores is always longer than for pharmacies. This has to do with the fact that website orders can also be placed outside business hours, whereas this is not the case for pharmacy orders.

Febelco can also be replaced by another service-driven company. Based upon the results, more generalized conclusions can also be drawn. First, the location of the DC might be one of the considerations for choosing a company. At the same time, a company needs a dense network (like Febelco); many delivery addresses in a relatively small area, many trucks and different milk runs per day. This is important to provide a reliable service with a short lead-time. If this cannot be provided, willingness to place replenishment orders online might decrease. In other words, no reliable service is offered to the nanostores. After all, it can be expected that lead-time increases when another service-driven company has fewer delivery rounds and/or fewer vehicles. Most importantly, a service-driven company has a core business, which is not delivering to nanostores. Too many shop orders might hamper the core business with the risk of losing clients (reflected in lead-time). It is therefore interesting to consider using multiple service-driven companies to spread the shop orders. Additionally, the location of the store vis-à-vis the location of the service-driven company determines the choice for the company delivering to a particular nanostore. This can tackle the problem of veh km and lead-time.

5 London

The main public sector challenges for transport in London are climate change reduction, internalisation of external costs such as congestions, accidents and health impacts of noise and air pollutant emissions. These transport related challenges are to be tackled with targeted and effective policies, taking consideration of:

- A growing London population and associated pressures on land use and infrastructure (population is due to reach 10 million by 2031);
- Employment is set to grow by 14% in the next 20 years, centred on Central and East London;
- If not properly addressed, congestion will also go up by 14%, centred on Central and East London. Highway and road space capacity is diminished strongly in the last years;
- Mayor’s ambition to increase the number of cyclists in London will result in a further reduced traffic flow and capacity on the road network;
- Rapidly growing e-commerce industry and associated growth in van numbers: demand for goods and services forecast to rise by 15%.

5.1 Implementation description and its effects

5.1.1 Business as usual versus CITYLAB implementation

London CITYLAB implementation is investigating how to scale-up sustainable solutions, and what would be the most promising business case and growth conditions for clean deliveries with electric vehicles and tricycles. Recent years have seen several of these initiatives implemented. Even though they receive a public support, they remain on a low scale and experience further growth difficulties. In order to have the full scale effect from clean vehicles, more of the vehicles should run on the road. Thus, London CITYLAB implementation is looking into concrete case of the clean urban transport carrier in Central London using clean urban freight consolidation. The aim is 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). Implementation is looking into reducing vehicle kilometres by using a transfer depot closer to the delivery addresses in central London, so as to combat 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.

Business as usual situation for CITYLAB London implementation would be a regular case where several suppliers of goods are individually delivering their clients in the city centre. Usually all trips are taking place during rush hour in the morning traffic and are performed with diesel vehicles. These suppliers have their depots located in the suburban area of London which implies a long journey towards city centre during peak traffic (stem mileage).

In CITYLAB London implementation TNT from both national and international depots during out of rush hours deliver their goods to Gnewt Cargo West Central Street inner London depot (as well as some other Gnewt suppliers/clients). From there, Gnewt Cargo performs the last mile delivery to final clients with electric freight vehicles. In that case, instead of many vans, fewer bigger and better loaded trucks are used to transport the goods from the TNT depots to the Gnewt Cargo depot. 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.

5.1.2 Role of stakeholders

Table 11 outlines roles, actions and interest of different stakeholders in the CITYLAB solution in London. A clear role specification is necessary to estimate the effects on different participants as well as to evaluate possible upscaling options.

Table 11. Participating stakeholders in London CITYLAB solution

Stakeholder	Role	Participation in solution	Interest
Gnewt Cargo	Logistics service provider running delivery operations exclusively with full electric vans. These vans are servicing clients mainly in the Central London Congestion Charge Area.	Receive goods from shippers to depot; Manages inner London Depot; performs consolidation within depot; performs last mile delivery from depot to final clients	Increase its business share; perform more deliveries with clean vehicles
TNT	In BAU delivers the goods of the shipper to the receiver. In CITYLAB implementation delivers the goods of the shipper to the Gnewt Cargo depot	Changes its logistics scheme.	Increase the share of clean deliveries while maintaining a high service standard for customers
Other carriers	Carriers specialised in parcel services, performing mostly courier and home delivery services for online retailers and SMEs	Together with TNT use London Central depot of Gnewt cargo, participating in consolidation scheme	Efficient and clean deliveries
Shippers	Sender of the goods; provide goods to TNT	No active participation	Green delivery; more time efficient delivery
Receivers	Receive goods they have ordered	No active participation	Green delivery; less congestion; less pollution
Transport for London	Planning and policy making	Facilitate access to the logistics property in London city centre.	Reduce congestion, improve air quality, facilitate high logistics service levels for London businesses.
Researchers	Research, data collection, evaluation and reporting	Provide evidence through test design, data collection, evaluation and reporting	Good data demonstrating the benefits of the solution, good test design suitable for providing the right kind of evidence for decision makers

5.1.3 Effects from CITYLAB implementation

In case of CITYLAB implementation mainly the business models of suppliers (in this case TNT), that start using Gnewt Cargo consolidation and last mile delivery service, is changing. Gnewt Cargo was created directly as an emission free transport operator so there are no major changes for him. Shippers and receivers also do not experience direct business model changes from this solution: shippers are still in contact with their regular supplier and the only change receivers are observing is the delivery van that is bringing their package.

Business Model Canvas for TNT

Compared to business as usual situation, several things are changing for TNT. TNT needs to re-organise its key delivery activities. In business as usual situation, most vehicles need to drive during rush hours on the main axis towards central London.

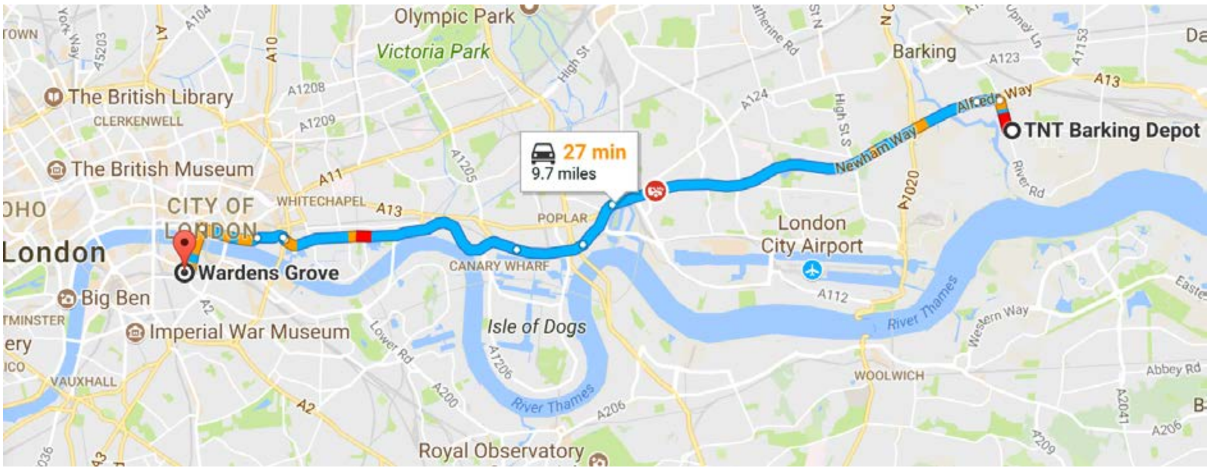

Figure 18. Business as Usual TNT depot and Gnewt Cargo depot: Location, distance and 100% peak traffic avoidance on the main axis when using the CITYLAB solution

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. In the CITYLAB implementation case, the trips between the TNT depots and the depot of Gnewt Cargo are occurring at night and during the early morning hours, avoiding morning congestion trips on the main axis towards city centre. On this main axis and at peak hour, the traffic reduction was therefore 100%.

Key resource for TNT are also changing: instead of many vans, 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 West Central Street, Wardens Grover or Bermondsey where the Gnewt Cargo vehicles are loaded. In some trials, the number of vans replaced by one truck was about 4. As an example, in the case of another client of Gnewt Cargo, three to seven vans are replaced by one truck. These trucks are better loaded on the way towards the city centre. Usually they return back empty. For TNT on the way back one truck per day is filled with collected parcels.

Even though, the solution improves internal logistics, flexibility and predictability of delivery, the overall value proposition to the clients is changing slightly. The green transport image is offered. The customer is reached by “clean” transport provider, therefore there is less interaction with final customers.

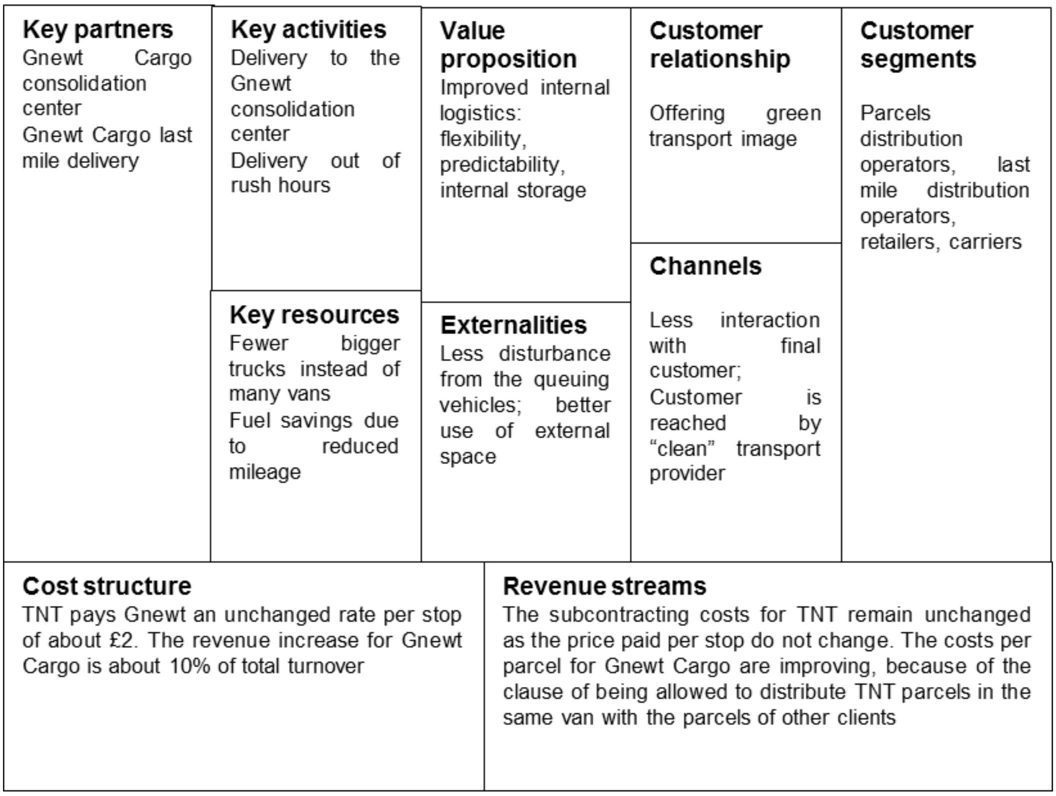

Figure 19. Business Model Canvas for TNT

Financial viability of CITYLAB solution

During the tests, the main business contract between Gnewt Cargo and TNT remained unchanged. The subcontracting costs for TNT remain, as was the price (£2 per stop, paid for the logistics service of last mile distribution, with the goods delivered at Gnewt Cargo by TNT trucks in early morning, and collected parcels delivered back at TNT depot by Gnewt Cargo in the late afternoon/evening). Costs do not change, compared to the price paid for any other subcontractor using the TNT depots in London.

In one revealing tested case, there was an issue for TNT with the large B2B parcels and goods that can only be transported by bigger trucks. Separating the parcels according to their size required an additional operation at the sorting/fulfilment depot. This was adding costs and time to the business as usual situation. Therefore it can be assumed that a similar additional sorting step would be necessary for those types of TNT business such as UK domestic parcels distribution. Since there is no bigger electric truck available on the market, this type of TNT business segment with large parcels or palletized goods is not competitive when using the Gnewt Cargo solution. To this aim, new bigger vans are being trialled. But for now, the upscaling scenarios refer to other, more suitable types of distribution businesses.

The TNT international business segment, which is based on smaller parcels, can be distributed by Gnewt Cargo in Central London without additional sortation. This type of business is profitable. In this business segment, the transport between depots remain unchanged, because the distance between the airport and the Central London depot of Gnewt is similar to the distance and travel times to the other London TNT depots such as Park Royal or Barking. The time and cost advantage for TNT is that all parcels incoming from the airport do not need to go via a TNT London depot, reducing handling costs.

The costs per parcel for Gnewt Cargo are improving, because of the clause of being allowed to distribute TNT parcels in the same van with the parcels of other clients.

Another observed benefit it the distance reduction per parcel, which has an impact on traffic and on costs.

Table 12. TNT distance reduction (Gnewt Cargo data from 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		5663	21,211	0.267
% reduction	0		77		67

The distance analysis is strongly influenced by the location of the depots and this result will probably change when upscaling, 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%.

In relation to the time spent, knowing that a driver in London spend only 20-30% of its working time driving on the road, and the rest is pedestrian time performing the delivery to the client, the overall time savings achieved by the solution are not very relevant for the business model.

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 have the same distance than the trips to the Gnewt Cargo depots in Central London.

The overall Gnewt Cargo business model is build up on the fact that using EFVs in the inner London is cheaper, due to the exceptions they are getting daily from the Central London Congestion Charge. Currently the amount is at £11.50 per vehicle per day.

Costs and benefits for society of CITYLAB solution

The trial is too small for London to have any substantial impact on the air pollutant concentration overall. The selected indicator is CO2 per parcel or NOx per parcel or PM per parcel, reported below. CITYAB Deliverable 5.3 summarizes computed effects for TNT for business as usual situation (TNT diesel deliveries starting from Barking depot to their clients) versus CITYLAB implementation case (using GNEWT cargo depot and services). The total fuel use and CO2 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 (only tailpipe emissions).

Table 13. CO2 reduction effect (Gnewt Cargo data, September 2016)

Before deliveries starting from Barking	**Number of vehicle trips per day**	**l/100km**	**Total litre/month**	**Litres/parcel**	**kgCO2e/parcel**
Van TNT domestic	10		2243		
Average		9		0.07	0.195
After Gnewt Cargo operations					
Electric Van Gnewt	10				
% reduction	0	100	100	100	100

A part of the direct effects from the CO2 emission reduction, CITYLAB implementation has general beneficial impacts on society. Those are both relevant to TNT individually (and, thus can be translated in financial benefits) but also beneficial for the whole society.
First, due to reduced amounts of diesel trips, there is also energy consumption reduction per parcel delivered. The energy use, expressed in grams 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 14. Energy reduction (Gnewt Cargo data, 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

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). CITYLAB reduces empty distance run by vehicles, improving load factors of the vehicles. 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 15. Reduction in empty distance (Gnewt Cargo data, September 2016)

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

5.2 Stakeholder support for London solution

Figure 20 shows the multi-actor results for the TNT and Gnewt Cargo implementation in London where B2B deliveries of large parcel carrier (TNT) destined for inner-city London are delivered by a small last-mile carrier specialised in electric freight deliveries (Gnewt Cargo). The aggregated scores of the evaluation are shown on the y-axis (based on AHP eigenvalues method, see Saaty (1988)). The coloured lines represent the alternatives and show to what extent each alternative contributes to the criteria of each stakeholder (x-axis). The orange line represents BAU when TNT deliveries in a certain area are carried out by TNT by means of diesel vans (20 routes). In London, multiple alternative scenarios were tested. The blue line represents the scenario in which TNT deliveries for that same area are carried out by Gnewt Cargo by means of electric vans (15 routes). The green line represents the scenario in which Gnewt Cargo is allowed by TNT to consolidate TNT deliveries with other deliveries in the same electric van route (20 routes). Finally, the purple line represents the scenario in which Gnewt Cargo changes its depot location which allows all parcels from multiple clients to be served from a single depot (20 routes). Figure 21 reveals that the changed depot location scenario is preferred by all stakeholders except by Gnewt Cargo. They prefer BAU which is remarkable.

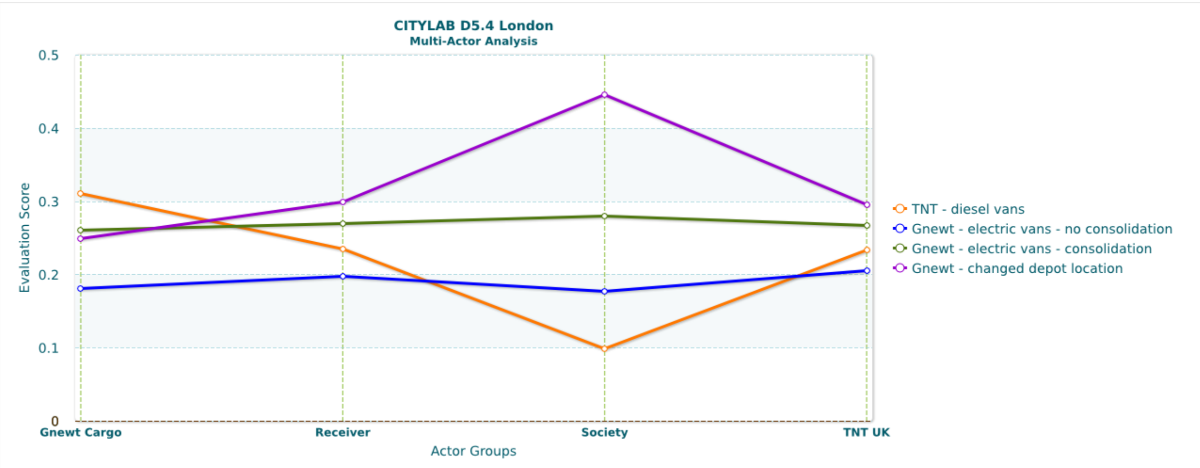

Figure 20. Multi-actor results for CITYLAB solution in London

Figure 21 shows that for TNT, BAU and the alternatives score within the same range. The two Gnewt scenarios with consolidation score slightly better than BAU, the one without consolidation scores slightly worse. Figure 21 reveals that two criteria are responsible for this ranking: high quality service and positive effect on society. Concerning high quality service:

during the implementation of the first alternative (Gnewt performing deliveries for TNT, but no consolidation with other Gnewt flows) a small decrease in quality of service was observed. Positive effect on society is based on the criteria of stakeholder society. For the analysis of this case, there was no information available on viability of investments for TNT. Based on a discussion with the local scientific partner, we assumed that both their revenues and investments remain the same when they work with Gnewt Cargo since they also subcontract in BAU. In our analysis, the 4 alternatives received the same score on this criterion (25%). To verify the impact of this criterion on the overall score for TNT, we performed a sensitivity analysis. From the moment that BAU scores considerably better on this criterion (45% vs 3 times 18.3%), BAU receives the same score as the best Gnewt Cargo scenario (with changed depot location). From the moment that BAU scores reasonably worse (18% vs 3 times 27.3%), BAU scores worse than all three Gnewt Cargo scenarios.

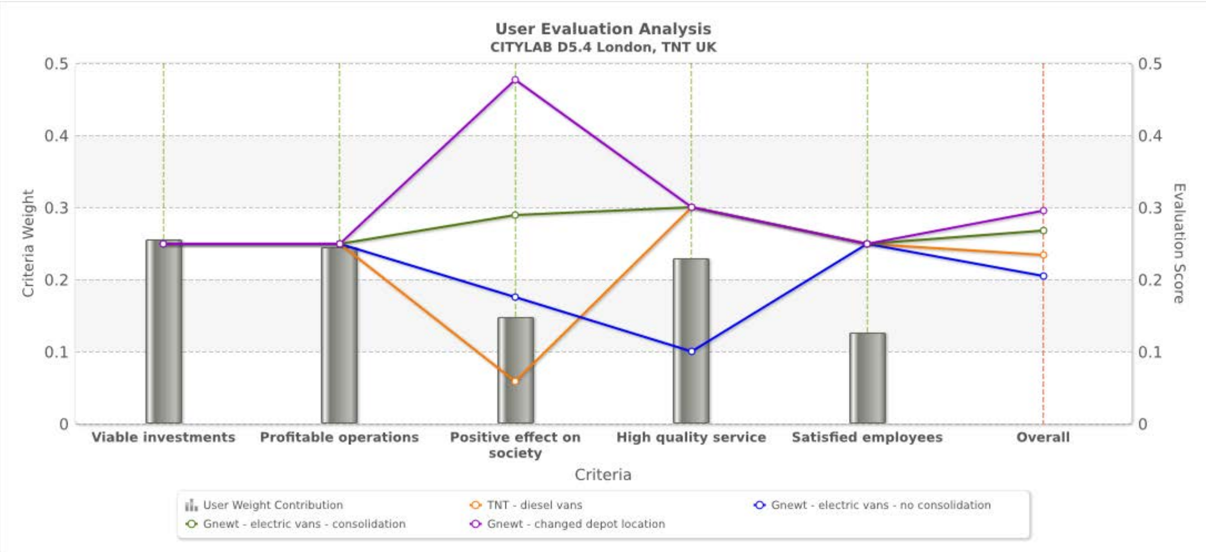

Figure 21. Mono-actor results for TNT for CITYLAB solution in London

On Figure 22, we notice that BAU scores best for Gnewt Cargo. The scenarios in which they are subcontractor to TNT do not score better. Figure 23 explains why. BAU does not score considerably higher on the criteria 'profitable operations' and high quality service' than BAU despite the fact that these criteria are important to transport operators. Service provided by Gnewt Cargo is not considerably better than service provided by TNTs traditional subcontractors (but also not worse) and Gnewt Cargo's operations are not more profitable because the main cost driver is the driver's wage and that does not change compared to BAU. Return on investment, which is their most important criterion, scores better for BAU than for the alternative scenarios. In the alternative scenarios, Gnewt Cargo is expected to make considerable investments, especially in the scenario with changed depot location, but that is not balanced by a sufficient increase in operating profit. What also heavily impacts preferences of Gnewt Cargo is the criterion 'positive effect on society'. Usually, transport operators do not attach great value to this criterion which is also reflected in the low weight for this criterion. It can be expected, though, that Gnewt Cargo will score this criterion considerably higher than a traditional transport operator. In the analysis, the criterion received a weight of nearly 15%. Sensitivity analysis shows that this criterion would have to receive a weight of 27% (and the other criteria proportionately less) to come to an equal ranking of BAU and one of the alternative scenarios (with changed depot location).

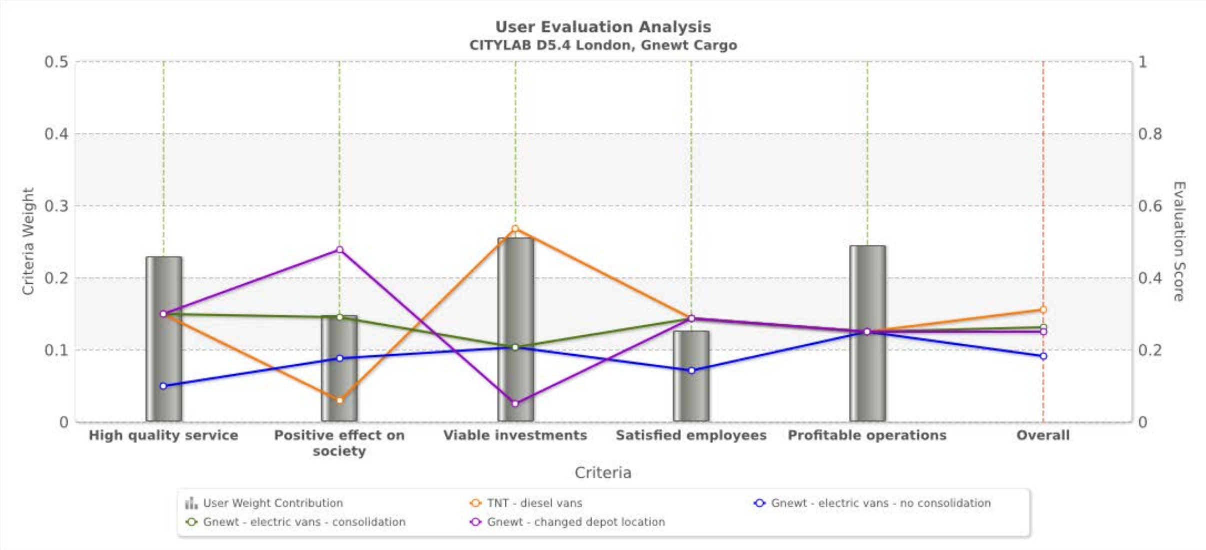

Figure 22. Mono-actor results for Gnewt Cargo for CITYLAB solution in London

In ANNEX 3, you can find all mono-actor results for the implementation in London and the table with justification for the various scores of the alternatives.

5.3 Upscaling of London solution

5.3.1 Baseline for upscaling

The following Table 16 provides the baseline for the upscaling scenarios. On the left, the main indicators relevant for the upscaling scenario analysis are presented. Selection criteria here is the relevance for businesses in future development of sustainable distribution activities in London and elsewhere.

Table 16. Overview of strategic business indicators relevant for baseline, tests and future scenarios

Baseline (Before)	CITYLAB implementation (after)
10 vehicle trips per day	
Monthly empty distance: 2,984 km Goe/parcel: 63 Fuel consumption (l/100 km) : 9 Fuel consumptions (l/per parcel): 0.07 KgCO2e/per parcel: 0.195 Monthly distance in km: 24647 km Parcels delivered during month: 30089 Distance in km/parcel 0.82	Monthly empty distance: 210 km Goe/parcel: 8.4 Fuel consumption: 0 Fuel consumptions (l/per parcel): 0 KgCO2e/per parcel: 0 Monthly distance in km: 5663 km Parcels delivered during month: 21211 Distance in km/parcel 0.267
Turnover for TNT, about £5 per parcel	Turnover for TNT unchanged
Total Turnover for Gnewt: index 100	Total turnover for Gnewt: index 110

Baseline (Before)	CITYLAB implementation (after)
Income for Gnewt Cargo: £1.9/parcel	Income for Gnewt: £1.9/parcel
Costs per stop for TNT: £2	Cost per stop for TNT: 2£ (unchanged)
Costs per parcel for Gnewt: index 100	Costs per parcel for Gnewt: index 95

5.3.2 Upscaling scenario A: The volumes through Gnewt will increase by at least 20% per year in the next 5 years.

Scenario description

In September 2017, as this scenario is developed, Gnewt Cargo was purchased by Menzies, a UK based logistics distribution company. TNT was purchased by FedEx, a global parcel service provider. It looks like Gnewt Cargo will remain a trademark, keeping all existing clients including TNT, but the decisions will be made by Menzies.

It is likely that the solution of using electric vehicles and central consolidation centres will expand much further, triggering the same beneficial impacts for businesses and the public. The number of parcels distributed by Gnewt Cargo with the same business model than the one tested in CITYLAB went from 2.6 mio in 2015 to >3 mio in 2016, without client change and very few additional vehicle rounds. Now Menzies is adding many new clients to the Gnewt business and the fleet is likely to grow accordingly.

In the realistic upscaling scenario A, the main assumption is that the solution A could:

- continue with the current growth rate,
- replicate the grow of 2.6 to 3 million parcels per year (+15%) further as average,
- and add the one-off hypothetical acquisition effect of say 25%.

This upscaling scenario, on average for the next 5 years, would represent an average growth in business volume of 20% per year. In this scenario, the number of clients of Gnewt Cargo is expected to growth further, from currently 6-8 to about 10-12. The number of depots remains stable, as it is manageable to use 4 or 5 depots for consolidation. A higher number of depot leads to inefficiencies and more empty return trips, which is costly. Therefore 4 to 5 depots are assumed in scenario A. However, Gnewt Cargo will move to at least one larger depot to accommodate the increased volume. The electric fleet size and the number of driver staff will increase at the same growth rate of about 20%.

Overall, for TNT, the upscaling is representing a further change in the business model. The changes through upscaling implies that TNT accepts to mix its parcels with other clients in the same vehicle, it implies that subcontractors of TNT are losing some routes which are done by Gnewt now. It implies that new depots are opened, other depots receiving less goods.

Effects and consequences scenario A

All beneficial effects of the trials are expected to be occurring in a very similar way in scenario A. 60% reduction in total distance driven in London for last mile deliveries, 100% CO_2 reduction at the tailpipe, more than 80% reduction in PM10 and NOx, and a strong reduction for all the other proven air pollutants associated with diesel combustion.

Using a Central depot means that large trucks are entering the city at night-time, and no diesel van is entering the Central London area via the main axis during the peak hours. This 100% peak traffic avoidance on the main axis is expected to continue in scenario A.

The main efficiency effect for the business operations is the changing from existing distribution pattern, reducing total miles per parcel for the last mile of the supply chain. A major additional effect could occur within the next 5 years if a large electric truck would become available for urban distribution. In that case the restriction for large parcels and palletized goods would vanish and the growth scenario would be much higher.

It is however unlikely that, even if a large electric truck is becoming competitive, a growth of more than 40 to 50% per year could occur. The managerial, human resource, space, financial and legal restrictions are getting too big in case of a growth above 50%. This hypothesis would be usually leading to much disruptions and difficulties. An average growth of 20% seems more realistic and achievable.

For the company, a growth of 20% in volume means 20% more driver staff each year, but not 20% more management staff. This also does not mean 20% more distance driven, as it is expected that the additional volume will be distributed in the same area within, or shortly around Central London. The distance increase is due to the fact that in the current system, most round trips are departing from depot with a 100% full van. Any additional parcel volume would mean a supplementary pick-up at depot, leading to more total distance driven per day for the same area. In the past year, the volume increase and the good knowledge of drivers has led to a situation where the distance per parcel was reduced. This efficiency increase is expected to happen again in future.

It would be safe to assume that 20% more parcel for the same area would also mean 20% more working time and therefore 20% more employment every year. Currently a driver is delivering 150 parcels per day. This is one parcel every 6 minutes. The best driver is currently capable of delivering 450 parcels per day, as annual average, with peaks at 600 parcels per day. However, the reasons for this high performance are not really understood. Starting from an average of 150 parcels a day, it was not possible to detect an increase in this annual performance and staff productivity during the testing of the CITYLAB solution. In the past 5 years, the annual average number of parcels was varying from 135 to 150. But we don't really know why, as too many business variables have changed in the past 5 years. So, due to the limited time available for the CITYLAB trials and observations, it would be wrong to assume that an improvement in the total number of parcels per day will continue to occur in parallel with the future growth rate of 20% per year.

Table 17. Key effects of scenario A

CITYLAB implementation	Scenario A
10 vehicle trips per day	20% more electric trips per year
Goe/parcel: 8.4 Fuel consumption: 0 Fuel consumptions (l/per parcel): 0 KgCO2e/per parcel: 0 Distance in km/parcel 0.267	Similar performance effects are expected per parcel.
Turnover for TNT unchanged	Unchanged
Total turnover for Gnewt: index 110	Turnover index 298 by 2022 assuming 20% annual growth
Income for Gnewt: £1.9/parcel	Unchanged
Cost per stop for TNT: 2£ (unchanged)	Unchanged
Costs per parcel for Gnewt: index 95	Reduced

Overall, upscaling of this solution will:

- Increase efficiency of the carriers operation
- Increase load factors of the vehicles
- Reduce time the vehicle spend in the city (including loading and unloading operation)
- Further retiming and rerouting of logistics activities

Besides positive financial impacts for operators, that will also have a beneficial impact on society, resulting in the reduction of CO_2 emissions, improvement of air quality, increasing of accessibility and improving traffic safety.

5.3.3 Upscaling scenario B: When more companies start using electric vehicle for the last mile.

Scenario description

Scenario B consists in the replication of the CITYLAB solution by other businesses during the next 5 years. It is assumed that the client TNT and FedEx would replicate the solution and scale up their electric vehicle fleet. To be realistic, the growth rate was derived from the observation of the sales growth of full electric commercial vans in Europe (http://www.eafo.eu/vehicle-statistics/n1), with numbers around 20% in the years 2013 to 2016.

It is assumed that the growth rate of yearly 20% in the use of commercial vans is due to two different developments:

- Operators active in urban distribution are replacing every year a small part of their fleet and are buying Battery Electric Vehicles.
- The carriers and contractors of large corporations using a fleet of 100% Battery Electric vans are seeing their business volume growing by 20% annually.

However, the starting point of this scenario is very low, as the year 2016 saw about 12,000 of such vehicles sold in all 28 European countries, 0.6% of all sales of new commercial vehicles (2 million new vans <3.5t). There was a sales growth in conventional diesel vans of +10% in 2016.

Effects and consequences scenario B

We are looking at the effects of scenario B for the next 5 years, until 2022. At the current rate, a 20% growth would mean following sales numbers in the next 5 years

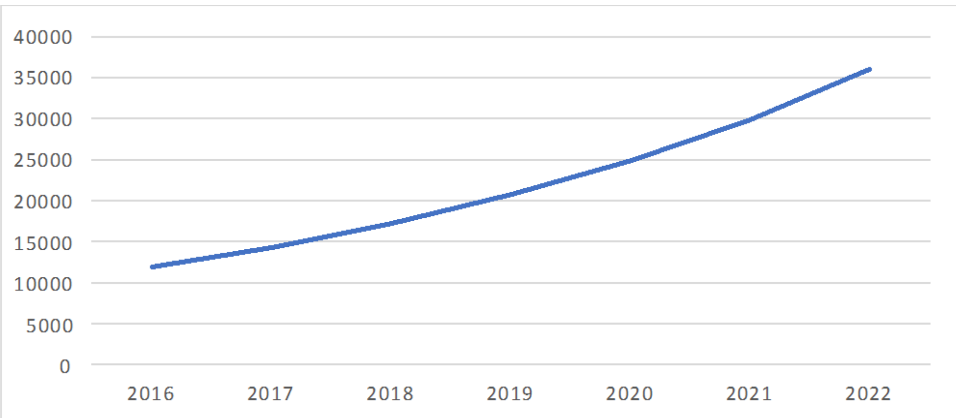

Figure 23. Sales of Battery Electric commercial vehicles in EU 28, 20% annual growth scenario B (European Alternative Fuels Observatory 2017, own projection)

It is clear that a 20% growth in sales of battery electric commercial vans is realistic, but that it will not influence the total sales by more than 2% and will not be sufficient to replace the existing diesel fleet in the near future. This realistic growth assumption of 20% per year will change nothing to the air pollution and traffic problems of the cities in the next 5 years.

6 Rome

Improvement of accessibility stands as one of the main goals of the New Rome Mobility Masterplan, as approved in 2014 by the City Council and in 2015 by the Municipal Assembly. Optimization and reduction of the freight vehicle movements directly contributes to this goal. CITYLAB Rome implementation aims at improving and optimizing waste collection and reverse logistics, increasing return load factors of the vehicles and eliminating unnecessary vehicle movements.

6.1 Implementation description and its effects

6.1.1 Business as usual versus CITYLAB implementation

CITYLAB Rome implementation is looking into how efficiently integrate recycling logistics flows into existing (non-dedicated) vehicle movements. The main idea is to test how to organise the transport for some categories of recyclable waste, collected at large attractors (such as universities, hospitals, public authorities), by non-dedicated trips, making use of an IT alerting system. The initial trial conducted within CITYLAB Rome implementation focuses on the collection of the plastic bottle caps at the premises of Rome Tre University.

In business as usual situation plastic caps are collected by involved people (students, professors, visitors, etc) on a voluntary basis, in the collection points located in various buildings of the University. Next, Mobility Manager (or another University employee) is asked to come and pick up collected plastic caps and deliver it to the central collection point located at the main office. This trip is done with a diesel car. The need to perform collection from peripheral collection points is signalled to the Mobility Manager of the University on a voluntary basis. Therefore, collection is performed on an *ad-hoc* procedure and many trips are made with extremely low load factors.

In CITYLAB Rome implementation a plastic caps collection containers were installed in 4 university buildings, equipped with automated signalling alert system, indicating when container is full. The key idea of implementation is that once container is full, the signal is sent to Post. The signal to Post when container is full is not automatic but it is provided by the Concierge Service Company. Than container is picked within a round perform by the postal men, who in any case have to perform courier delivery trip to that specific department. The postal men takes the plastic container and brings it to the final collection point at Post premises close to the University. These rounds are performed with electric vehicles. Finally, the plastic caps are brought by Post to the central collection point at the Rectorate where they are temporarily stocked until a sufficient amount is garnered so to be finally shipped to RMP Salari S.r.l. who buys them.

6.1.2 Role stakeholders

CITYLAB Rome implementation brings changes into the daily operations of several stakeholders. To see those, first that is necessary to identify the roles of stakeholders in implementation, look at their activities and interests they have in solution.

Table 18. Participating stakeholders in Rome CITYLAB solution

Stakeholder	Role	Participation in solution	Interest
Transporter / Poste Italiane	During their regular trips to the university department, post men collects full plastic cap container and delivers it at main post depot, first, and delivers it at the	It uses its trips to deliver plastic caps to the Main Office. It delivers collected caps to the recycling facility. (need to be changed according to the	Looking for new and potentially profitable markets.

Stakeholder	Role	Participation in solution	Interest
	rectorate, then.. There, storage for the caps is organized. And further transport to the caps recycling facility. (see above 1.1.1)	changes provided in the previous column)	
UR3	A large attractor where collection points are organized and caps are collected.	Act as a facilitator.	“Green” image and potential financial benefits
City of Rome	Owns and monitor the Living Lab. It is (will be) a customer	No active participation.	Looking for new methods to deal with urban waste.
Shipper and Customers	Students, professors, administrative staff, visitors of UR3. After using plastic bottles, they put caps into specially installed containers.	They put caps into specially installed containers.	They feel satisfied because of a new eco sustainable behaviour.
Meware	Develops and maintains the informatic platform for data collection.	Provides a software for the solution	Looking for a new potential customers and new solutions to develop.
Mobility Manager	In business as usual scenario was performing trips between departments to collect plastic caps. No active role in this solution.	Management of plastic caps storage in the Rectorate	Free time, less operational duties.
Concierge service company	Is using the web-based interface to communicate with PIT whenever a box in UR3 is full.	Facilitator. It uses the platform provided by Meware to notify PI about plastic caps	Looking for some new and potentially profitable markets

6.1.3 Effects from CITYLAB implementation

The business models of several actors are changed once CITYLAB Rome solution is implemented. The main impacts are experienced by UR3 and Mobility Manager as part of it, that have on one side, to develop relationship with new actors (e.g. Meware, Concerge service company) and on another side perform less duties for the plastic caps collection. Poste Italiane is also the main influenced by the solution stakeholder. Business Model Canvas is therefore developed for these two stakeholders. Other stakeholder are not directly involved in implementation of this new solution, even though are experiencing indirect benefits from it (municipality of Rome and citizens).

Business Model Canvas for Poste Italiane

CITYLAB Rome implementation introduces key changes into the activity of Poste Italiane. The scope of key partners is extended to the Concierge Service company, which gives a signal to Poste Italiane that container is full and it is necessary to pick it up.

The key activities performed by the postmen are also enlarged. Instead of just delivering a mail, once he got an indication of the full plastic cap container, the postmen have to take along an empty replacement container. Once at the university, postmen deliver mail and then replace a full plastic cap container with an empty one. Containers are located very close to the mail delivery location, meaning that additional time that postmen spends on the location is really minimal and is not considered as a barrier. The postmen picks up the full container and continues the regular mail delivery round. Once in the main office, he brings the full caps container to the dedicated storage area. This requires creation of a temporary storage place of the premises of Poste Italiane, as well as storage of empty containers.

Interviews of 500 potential participants in CITYLAB solution indicated that 24,80% will participate in the CITYLAB implementation, resulting in 40 people. If we further use this indicator as an adoption rate for the whole university, that will result in 8000 people (from 40.000 people visiting university on a daily basis). It is estimated that these 8000 people produce 5 kg recycled caps per month. The size of container and its weight is directly influencing the size of the vehicle Poste Italiane will be using. Currently only 40 people were participating in the trial and a container size of 2 kg was used, which perfectly fits in the Free Duck electric vehicle that Poste Italiane is using.

Key partners	**Key activities**	**Value proposition**	**Customer relationship**	**Customer segments**
Recycling facility Concierge service company	Collection of full caps container; delivery of it to the main Post Office; Changing containers at UR3; Temporary storage of the plastic caps; Delivery of plastic caps to recycling facility caps	Improved load factor of return trips	Extended value proposition to UR3	New customer segment (recycling)
	Key resources Storage place at main post office	**Externalities**	**Channels** Communication via meware IT solution	

Cost structure	**Revenue streams**
At current scale no additional cost	Re-selling of the plastic caps

Figure 24. Business Model Canvas Poste Italiane

The value proposition of Poste Italiane increases, internally and vis-à-vis UR3: it increases load factors of its return trips and at the same time, helps UR3 efficiently contribute to the recycling of waste. Though, new communication channels have to be established with the help of Meware software and assistance of Concierge Service Company, when post is automatically notified when container is full.

Overall, the cost structure for post is not changing, as there is no dedicated trip performed to collect plastic caps and collection is done within a regular mail delivery trip. The trip to the recycling facility, bringing collected caps have to be performed. The service of Concierge Service company are for free and software benefited an external financing.

On the revenues side, there is a potential to re-sell the plastic caps to the recycling company, which can create additional revenue for Poste Italiane. At the same time, it is difficult to calculate exact potential benefit, as plastic caps are pure PVC and their price fluctuates with a price of oil.

Business model Canvas UR3 and Mobility Manager (as a staff member)

The key change for the UR3 is that Mobility Manager does not have to perform caps collection, so has more time available for other functions. Other benefits are on the side of externalities, where less trips are performed on the territory of campus, which, improves air quality and accessibility. There are no direct costs for the UR3 from the implementation of this solution.

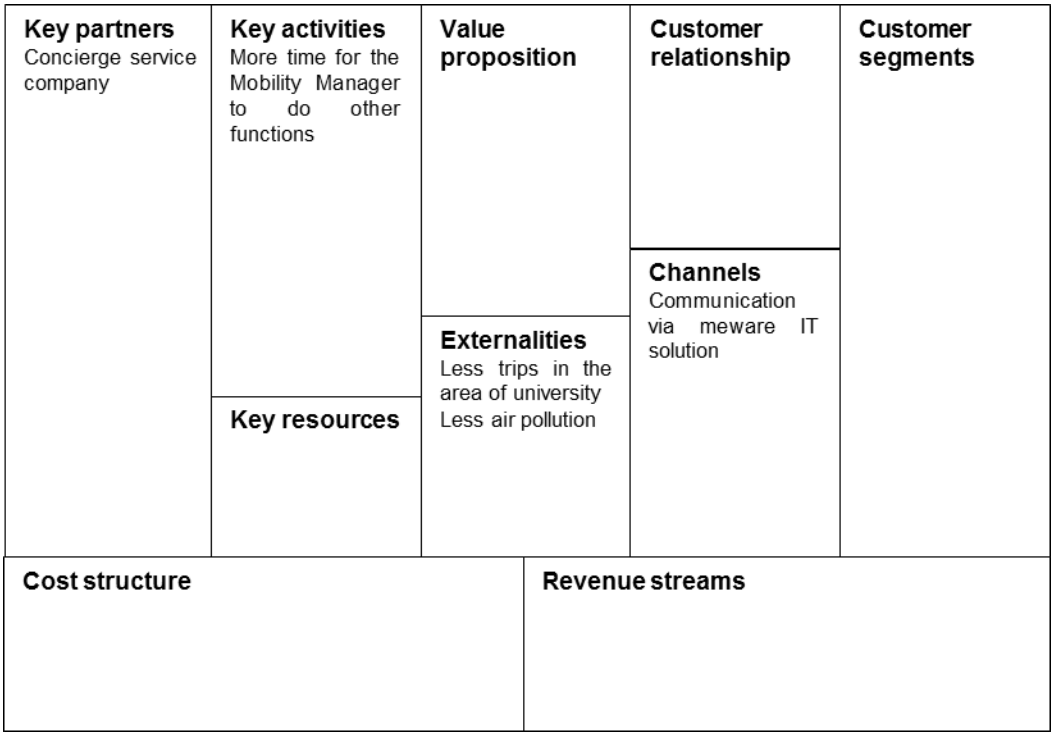

Figure 25. Business Model Canvas for UR3

Financial viability of CITYLAB solution

Financial sustainability of solution is described only from the perspective of Poste Italiane, as this is the main actor carrying out costs in this implementation.

From the interview with Poste Italiane it was known that an average operating cost, considered for the mail delivery is 1,50 euro/kg. Currently, operating revenue from the plastic cap resale is 0,20 euro/kg. Which brings Poste Italiane to the deficit of 1,30 euro/kg. Container used for the plastic caps collection is 2 kg box, meaning that the deficit of Poste Italiane per collection would be 2,60 euro. Including the avoided social costs linked to climate change and air pollution (Ricardo-AEA, 2014), the deficit decreases to 2.40€ per collection.

Costs and benefits for society of CITYLAB solution

There are several major society benefits from the CITYLAB Rome implementation. These are:

- reduction of the effort agents have to perform when recycling (e.g. no specific trips would be required to visit recycling facilities);
- reduction of number of trips collection firms need to perform to increase the amount of materials recycled;

- minimization of illegal discharging of toxic/dangerous materials;
- load factor optimization.

Since, within CITYLAB Rome implementation there are no dedicated trips made for caps collection, 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 the Business-as-Usual scenario.

Estimating environmental and transport indicators per collection (≈ 2 Kg - plastic caps transported) results in 3,5 km of dedicated trips avoided. In terms of emissions, that means, that per collection are saved:

- 2.75g of NO2;
- 0.29g of PM2.5 and PM10;
- 677g of CO2;
- 0.004g of SO2

6.2 Stakeholder support for Rome solution

Figure 27 shows the multi-actor results for the Poste Italiane implementation in Rome where plastic caps for recycling are picked up by Poste Italiane instead of through dedicated trips. The aggregated scores of the evaluation are shown on the y-axis (based on AHP eigenvalues method, see Saaty (1988)). The coloured lines represent the alternatives and show to what extent each alternative contributes to the criteria of each stakeholder (x-axis). The orange line represents BAU when an employee of University of Roma Tre drives a dedicated tour to pick-up the caps and brings them to the Rectorate. The blue line represents the CITYLAB solution when trips for pick-ups of plastic caps for recycling are integrated in delivery trips of Poste Italiane and are done by means of electric vehicles. Figure 26 shows that the CITYLAB solution is, by far, the preferred solution by all stakeholders. For all stakeholders, the new way of working scores better or at least just as good on all their criteria.

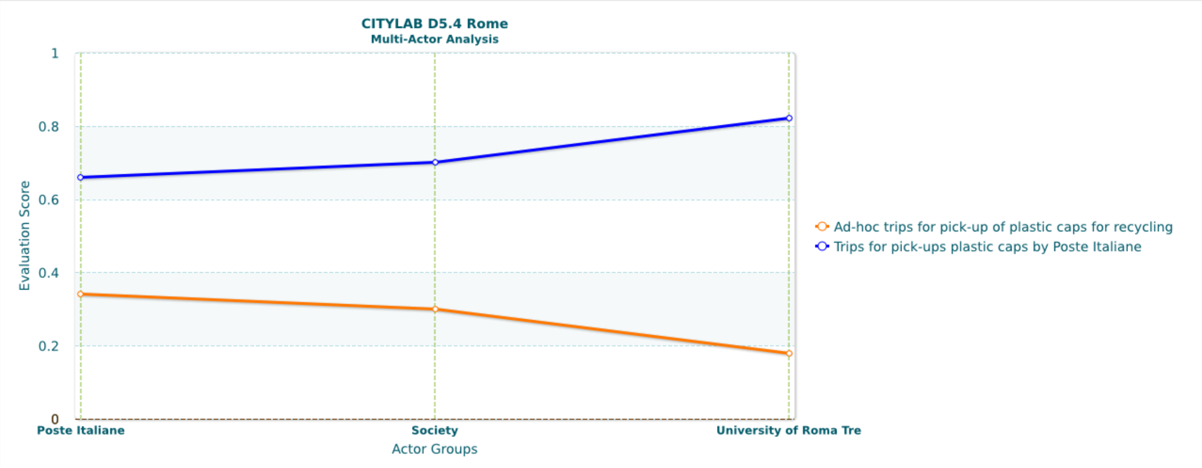

Figure 26. Multi-actor results for CITYLAB solution in Rome

In ANNEX 4, you can find all mono-actor results for the implementation in Rome and the table with justification for the various scores of the alternatives.

6.3 Upscaling of Rome solution

6.3.1 Baseline for upscaling

Currently, CITYLAB ROME implementation covers a relatively small area of around 1km2, involving all the buildings of UR3. Implementation have shown that it is 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.

Interview of 500 potential participants indicated that 24,80% will participate in the CITYLAB implementation, resulting in 40 people. If we further use this indicator as an adoption rate for the whole university, that will result in 8000 people (from 40.000 people visiting university on a daily basis). The results for the upscaled implementation are presented in the table below.

Based on the results achieved, the following indicators can be used as the baseline for further upscaling of this solution. Table 19 indicated both the numbers per collection as well as estimate of the results for the whole UR3.

Table 19. Baseline for upscaling Rome CITYLAB implementation

Baseline	Per collection	Per month
Results for the area with radius of 1 km2, 4 buildings, 2 kg of caps transported per collection, results per month		Results for the area with radius 1 km2, 4 buildings, 24,8% adoption rate, 8000 people participating per month
• 1700 caps • 40 kg caps • Collection performed ad hoc, with diesel vehicle, by the mobility manager of UR3	3,5 km diesel vehicle trips avoided Savings of : ✓ 2.75g of NO2; ✓ 0.29g of PM2.5 and PM10; ✓ 677g of CO2; ✓ 0.004g of SO2 For Poste Italiane • Operational cost 3 euro/collection • Operational revenue 0,40/per collection • Total deficit per collection (including social costs) 2,40 euro	43000 caps 108 kg of plastic caps 54 boxes transported (collections performed) 185,7 km diesel vehicle trips avoided Savings of: ✓ 148.53g of NO2; ✓ 15.60g of PM2.5 and PM10; ✓ 36,576g of CO2; ✓ 0.22g of SO2. For Poste Italiane • Operational cost 3 euro/collection • Operational revenue 0,40/per collection • Total deficit per collection (including social costs) 2,40 euro

6.3.2 Upscaling scenario A: Citylab solution applied to the whole Rome territory

Scenario description

In this scenario, CITYLAB Rome implementation is scaled up to the whole Rome territory. That means, that 1 km radius system, with a big attractor in the centre is reproduced and Poste Italiane considers these big attractors during its daily mail delivery trips. Large attractors can be hospitals, schools, shopping malls, big offices as well as residential areas there are many of these types of buildings. Poste Italiane is a perfect stakeholder for this kind of solutions because due to the nature of its activity it goes every day everywhere in the city, so can easily include recycle collection from the big attractors in its activities.

Effects and consequences scenario

Upscaling of the solution will lead to the overall growth of benefits for the City of Rome and its citizens, as a cumulative number of trips avoided will considerably contribute into reduction of congestion and reduction of emissions. Key financial and organisational impact will be on Poste Italiane, who will need to integrate much higher volume of flows in its operational structure. These changes are described within business model canvas, reflecting the change for the Poste Italiane from the CITYLAB implementation to the upscaling scenario A.

Key partners	Key activities	Value proposition	Customer relationship	Customer segments
Local Recycling facilities Concierge service company or agents with equivalent role	Collection of full container of caps and delivery it to the main Post Office Better integration of diverse return flows in postmen journey Changing containers at large attractors Temporary storage of the plastic caps Delivery of plastic caps to recycling facility	Improved load factor of return trips Requires better route planning Green image	Extended value proposition to clients	New customer segment (recycling)
	Key resources Larger storage place at main post office Software upgrade Larger vehicle	**Externalities** Reduced emissions	**Channels** Communication via meware IT solution	

Cost structure	Revenue streams
Cost of Concierge Service company Cost for additional storage place Cost of plastic containers Operational software upgrade Total additional time the postmen uses	Re-selling of the plastic caps The deficit per collection decreases because of economy of scale

Figure 27. Business Model Canvas Poste Italiane

Considering the whole population of Rome to be 2.869 million inhabitants, upscaling to the whole territory of Rome, will result in average into 7700 additional collection trips per month for Poste Italiane[4]. This is a considerable amount of return trips per month to be integrated into the Poste Italiane operations.

On the side of key activities and resources, it will require better route planning and software system upgrade integrating these return flows, translated into higher investments and time expenditures. Considering higher volumes, that is assumed that the cost of Concierge Service Company, servicing this solution will also increase and contribute to the monthly expenses for this solution. Potentially the total cumulative time that driver spends at different locations in picking up and replacing boxes can also increase. If larger return flows are integrated, there is also a risk that larger vehicle will be required to perform the trips. Additionally Poste Italiane need to think for the larger storage place as well as invests in higher amount of containers to perform the service.

[4] Total plastic caps collected for Rome: 2.869 mln/8000 people * 108 kg of plastic caps = 38700 kg of plastic caps. Assuming that collection volume will increase up to 5 kg per collection, that results in additional 7700 collection trips per month spread over Rome territory.

On the positive side, we assume that with economies of scale the deficit per collection will reduce. Load factor of the vehicle will be improved. Overall this service will also positively contribute to the green image of Poste Italiane.

For the society upscaling of the CITYLAB Rome solution is expected to produce several positive impacts: increase of freight vehicles load factors; reduction of vehicle movements (i.e. dedicated trips); increase of electric vehicles usage; enhancement of public awareness towards recycling and increase of its total amount. More specifically, using the logic described below, they can be translated into the estimation of the emission reduced. This motivation can possibly justify awarding public subsidies to the organization implementing the service.

The total area of Rome is 1,285 km with a population density of 2,236 person/km2. Assuming the same adoption rate of 24,8%, that means that the total amount of diesel vehicle kms avoided per month will be 66,695 v/kms[5]. The latter can be translated in the following emission savings per month:

- 53.31 Kg of NO_2;
- 5.60 Kg of PM2.5 and PM10;
- 13,128 Kg of CO_2;
- 0.08 Kg of SO_2.

6.3.3 Upscaling scenario B: CITYLAB solution applied to different materials

Scenario description

The Mayor of Rome, Ms Virginia Raggi has recently announced the guidelines for urban waste management of the city of Rome. The upscaling scenario B is combining the actual logistics process for urban waste management of city of Rome and is looking into extension of the CITYLAB implementation in terms of flows involved, sites and alternative waste recycled. The scenario refers to the various recycled materials that are already recycled via dedicated facilities (around 10 in Rome) thanks to the active involvement of citizens through dedicated trips. These are such materials, like exhausted batteries/oil/toner cartridges, electronic equipment. It also looks into recycling process of other valuable materials (e.g. paper, aluminium) that are collected thanks to a differentiated collection procedure through the dedicated trips by the waste management company (AMA S.p.A.).

For the upscaling scenario B we consider the following materials: exhausted batteries and oils, WEEE and Pharmaceuticals. During the 2016, in Rome AMA Spa collected: 90tons of exhausted batteries, 143tons of exhausted oils, 213 tons of pharmaceuticals and 7152tons of WEEE. Considering our 400.000 condominiums in Rome, we can say that every year an average condominium can produce: 0,225 Kg of batteries, 0,358 Kg of oils, 0,5325 Kg of pharmaceuticals and 17,88 Kg of WEEE. Assuming +153% as the result of CityLab implementation on the collected volumes, we have 0,57 Kg of batteries, 0,9 Kg of oils, 1,415 Kg of pharmaceuticals and 45,235 Kg of WEEE per condominium per year.

Despite a huge growth of the collected quantities, they don’t need so much space. For example a box for exhausted batteries that can contain up to 1kg of batteries has a capacity of 10 litres, about similar dimensions apply to oils and pharmaceuticals as well. A WEEE (e.g. phones) box can contain up to 3,5Kg of waste and has a capacity of 10 litres.

Poste can come and pick up wastes once or twice a month, using the same vehicle it uses right now. This is because every condominium needs several days to fill every box. All the

[5] Total Km saved (per month): (185.7*2,236/8,000)*1,285 = 66,695 v/km

materials can be further delivered by Poste to the ecological islands. If ecological islands are not on the daily routine routes of Poste, one of the internal storage places, like during CITYLAB implementation, can be used. The only extra investment for Post is signing in the list of waste transport authorized companies and maybe an extra wage for the postmen who will work with these kinds of waste, but it's marginal because the wage equals the marginal product of labour.

In order to apply CITYLAB solution to these types of waste a legislative assumption that recycled materials can go to the same truck have to be done. To make this scenario happen, also some changes have to be done by Poste Italiane. By Italian law, if you ship something that is called waste, you have to have specific certification. If same thing is not called waste, but can be used for further recycling, it can be transported. Also, some materials that are already being recycled are considered hazardous (e.g. exhausted batteries, toner cartridges) and special license is needed to handle them. At the moment Poste Italiane cannot transport (this type of) waste just because the company is not registered in the list of authorized companies. Postmen cannot touch even a normal battery as it is considered hazardous. In case if the market of recycled materials is profitable, Poste Italiane could think about necessary steps (fulfilling specific technical requirements) to make it possible.

Effects and consequences

Type of material has an impact on financial viability of the system. Due to regulation specific types of waste cannot be combined in a truck, which, of course, have an impact on the number of vehicles involved, number of trips produced and overall on the CO_2 emission of the service. Currently different companies come to recycle these materials. Economies of scale can be achieved if all materials can be recycled by 1 company. The overall positive impact from the upscale of the CITYLAB solution (with Poste Italiane) to other recycling materials are in terms of elimination or reduction of some negative externalities for society, like traffic jam (car crash risk, time to reach places, acoustic and air pollution), illegal disposal places, cost (fuel, maintenance).

Financial availability depends on the kind of waste. Caps are not as profitable as batteries, oils, WEEE and pharmaceuticals are. The latter are toxic, and the related cost for cleaning is really higher. Marginal cost for Poste Italiane is nearly zero, because the company already goes every day to every single house or condominium in Italy, so the postman has just to pick up a box.

7 Oslo

Emissions and queue are the main challenge to be addressed in relation to the freight transport in Oslo, but the main focus is on reducing emissions. In this respect, political administration of the city has set explicit local climate goals, to be cumulatively achieved by all sectors:

- o GHG emissions to be reduced by 50 % within 2020 (1990)
- o GHG emissions to be reduced by 95 % within 2030 (1990)
- o NOx emissions to be reduced by 60 % within 2022 (2010).

In Norway, around 31% of retail trade is concentrated in shopping centres (Stugu, 2015). Contributing to the emission reduction target, CITYLAB Oslo implementation action aims to reduce the negative impacts from urban freight movements in a city. It is focused on making more efficient deliveries, looking into the improvement of logistics processes at major traffic generators - multitenant shopping centres.

7.1 Implementation description and its effects

7.1.1 Business as usual versus CITYLAB implementation

The Oslo CITYLAB implementation assists the planning process of a new shopping centre at Økern, Oslo, looking into regulatory, technical, design, organisation and financing challenges, when constructing the shopping centre infrastructure with common logistics functions.

Large volumes of goods are daily delivered to the shopping centres. In the business as usual situation drivers have to bring all items from common unloading areas to the individual shops by themselves. This results in long dwell times and queuing for the vehicles in the freight receipt area. This contributes to inefficient use of space, increased use of fuel, as well as noise disturbance, traffic congestion, and contributes to driver stress levels (Browne et al., 2016).

Previous demonstrations and analyses (Straightsol, 2014) have suggested that having a common logistics function in a shopping centre can improve logistics operations efficiency. Common logistics function means creation of a dedicated service for handling freight from vehicle arrival to the individual tenants within the shopping centre and handling back flows in the case of returns and waste. In the framework of this service, 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. In that case the driver and the vehicle may leave the shopping mall directly after unloading the goods and all necessary procedures (scans, signatures, etc.) are being performed by the common logistics function. In a concrete example demonstrated in Stovner shopping centre (Straightsol, 2014) , instead of direct delivery at the shops, the truck driver delivered his goods to a security guard of the shopping centre. The security guard verified that the deliveries were according the order, signed the papers and placed the goods in a locked buffer storage area. The security guard took care of the internal delivery to the shops, at the time requested by the shop managers.

Oslo CITYLAB implementation supports development of the logistics services within Økern shopping centre. This centre is currently in a construction phase and is planned to be open in 2022. The shopping centre is located in Hovinbyen area - a part of Oslo were 27 000 new residences are planned to be built. The Municipality of Oslo estimates that 100 000 inhabitants will live there in 2030 (Løken, 2015). Steen & Strøm, the owner of the shopping centre, have for a long time planned to demolish and rebuild their shopping centre at Økern combining shops and restaurants with offices, cinema, hotel, and a waterpark. Current plans for the commercial shopping centre include a space of 51 500 m2 where 155 tenants, will be located, generating significant freight flows.

As Økern shopping centre will open its doors in 2022, that is not possible to estimate the effects from the introduction of the common logistics service based on the real-time data from the Økern centre. In order to estimate the effects of this implementation as well as the effects of the upscaled scenarios, estimations in the following sections are performed based on the several data sources:

- Straightsol project. In FP7 project STRAIGHTSOL, (2013), Steen & Strøm, on a small scale, tested common logistics in a Stovner shopping centre in Oslo (100 shops shopping mall, with testing performed for 5 shops as part of retail chain and 5 LSPs).
- 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 and mainly covered by the rent. Cost are registered for each delivery and invoiced as part of the tenants' rent.

7.1.2 Role of stakeholders

Table 21 outlines roles, actions and interest of different stakeholders in CITYLAB solution. Clear role specification is necessary in order to estimate the effects on different participants as well as to evaluate possible upscaling options. Table below reflects overall situation when shopping mall established common logistics service, which can be applied to any major shopping centre.

Table 20. Participating stakeholders in Oslo CITYLAB solution

Stakeholder	Role	Participation in solution	Interest
Shipper	Sender of the goods; provide goods to the retailers in the mall[6]. Information to shop of quantity and delivery time.	Label pallets with RFID tags or bar codes	Real time information on delivery to customer.

[6] In almost all cases the shipper is the retail chain's central warehouse. The retail shop is owned by the chain, or has a franchise agreement with the chain. The retail chain (i.e. shipper) has normally the main contract with the shopping centre owner with regard to the shop premises and centre services.

Stakeholder	Role	Participation in solution	Interest
Transporter / LSP	Delivers the goods from the shipper to the mall. In the business as usual, the LSPs deliver directly to the shop owners.	Scan the RFID tags or bar codes when pallets leave the warehouse. Deliver to the buffer storage of the shopping centre instead of to the retailer.	Shorter delivery time at the mall. More efficient planning.
Shopping centre	The owner of the shopping mall.	Responsible for collection and temporarily storage of goods that are delivered at the mall. Scanning of RFID tags or bar codes and communication with shop owners. Taking care of internal transport to the shops.	More attractive business/shopping climate for retailers and their customers.
Retailers	Shop owners in the mall. Sell to customers of the mall.	Communicate with shopping centre about when to receive the goods. Scan the goods at arrival.	More flexible, secure and bundled delivery. Saves time. Real time information on delivery.
Customers	Visitors of the shopping mall.	No active participation.	Less disturbance of freight delivery while shopping.

Source: adapted from Straightsol, Deliverable 5.3

7.1.3 Effects from CITYLAB implementation

The business models of several actors will be changed once common logistics function is implemented in the shopping mall: LSP, shopping mall and retailer. The key difference is whether logistics function will be obligatory for all the tenants or will be offered on the voluntary basis, which is not yet known for Økern shopping mall. The business models of the different actors are described separately in the following paragraphs with the help of the Business Model Canvas. In this paragraph we describe the changes from the business as usual situation to the situation with CITYLAB solution.

Business model Canvas for Økern *shopping mall*

Steen & Strøm is the owner of the Økern shopping mall. Compared to business as usual situation, introduction of the common logistics function requires more cooperation with tenants, as the new service is offered for them. It requires another contractual relationship with an internal/or additionally hired external logistic service provider that will be responsible for the maintenance of the common logistics function space and delivery of goods to stores. Experience of Emporia shopping centre in Sweden shows that in total 12 employees were hired for the common logistics function service in the mall (total area of commercial activities in the mall is 70 000sqm; with around 200 shops using common logistics function; with on average 2,07 pallets per week to individual shops). From 12 employees at freight receipt two were handling waste, two are in charge of the registration and scanning of goods and the rest perform deliveries to the stores.

Introducing common logistics function, Økern shopping mall improves its value proposition to the shop keepers: Steen and Strøm offers additional value with short term storage possibilities and to deliver the goods to retailers when they need it (at suitable times). Internal logistics system improves, resulting in a reduction in delivery times and delivery costs and improved predictability and flexibility. Value to external parties (e.g. LSPs) is improved as well, as they considerably reduce the time and operations they performed at mall.

Example from Emporia shopping mall illustrates that using common logistics function also has potential to improve utilisation of the urban space. At Emporia, 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. 3 of these are located in close proximity to the freight receipt and the remaining are located within a short walking distance from the freight receipt.

Additional resources needed for this service is registration equipment at supply chain reading points, buffer storage and equipment for internal transport of goods in the shopping mall. Related to this are the cost changes in the business model: the solution requires an investment in scanning equipment for RFID tags or bar codes. Appropriate cell phones or e-mail access is needed to read messages from the software. Personnel should be trained. Furthermore, the internal storage and transport of goods requires equipment, personnel and space. In order to have a successful business model, the investment costs should be compensated. Figure below with the help of the Business Model Canvas, summarizes the changes to Steen & Strøm's business model compared to business as usual situation (with no logistics functions).

<table>
<tr>
<td rowspan="2">Key partners

Internal logistics service provider

Logistics service providers

Owner of shopping centre</td>
<td>Key activities

Organisation of the common logistics function, hiring/training of new personnel</td>
<td>Value proposition

Improved internal logistics: flexibility, predictability, internal storage</td>
<td>Customer relationship

Extended service for tenants; better cooperation</td>
<td rowspan="2">Customer segments</td>
</tr>
<tr>
<td>Key resources

Storage space, scanning and reading equipment, employee for buffer storage (internal LSP), internal transport equipment</td>
<td>Externalities

Less disturbance from the queuing vehicles; better use of external space</td>
<td>Channels</td>
</tr>
<tr>
<td colspan="2">Cost structure

Training costs of the personnel

Costs for internal storage and transport</td>
<td colspan="3">Revenue streams

Depending on the business model applied, payment from the LSP and tenants.</td>
</tr>
</table>

Figure 28. Business Model Canvas for Økern shopping mall

Business Model Canvas for shop owners (retailers)

The customers of the shop owners are in the B2C market and will not directly notice the use of new logistics concept. There is also no direct influence on the value proposition and externalities from the perspective of the shop owner. The new logistics service gives the shop owner more influence on the time of delivery, as Steen & Strøm offers short term storage. The cooperation with the shopping mall intensifies.

A trial at the Strømmen shopping centre (April 2017) indicated that store employees would prefer to have the goods delivered to the store at an agreed time. This improves the control of the goods and the opportunities to execute a more appropriate staffing. The shifts of the employees than do not have to overlap in order to handle the pick-up of goods and will generate a cost saving for the stores.

Regarding cost structure and revenue streams**,** costs are made for the equipment to scan and read out RFID tags and/or bar codes. The shop owner will furthermore have costs for the training of personnel. More predictability within the supply chain may reduce the inventory costs. It is not certain whether and how the shop owner (and other retailers) will benefit from the potential cost savings of the LSP. It is also not sure whether they will face a rent increase of Steen & Strøm to compensate for the improved services inside the mall. Regarding the revenue streams, no direct changes occur. There is indirectly a potential for increased sales. Because the shop assistant can free up time to use on sales and customers, not on picking up goods. This is now done by the in-house logistics service provider.

Key partners	**Key activities**	**Value proposition**	**Customer relationship**	**Customer segments**
More cooperation with Steen and Strom	Communicating with internal logistics provider on delivery time	Improved internal logistics: flexibility, predictability, internal storage	Better planned deliveries More time to serve the clients	
	Key resources	**Externalities**	**Channels**	
	Scanning equipment	Less disturbance from the queuing vehicles; better use of external space		

Cost structure	**Revenue streams**
Less inventory and planning cost Training of personnel	Depending on the business model applied, payment from the LSP and tenants.

Figure 29. Business Model Canvas for shop owners

Business Model Canvas for logistics service providers

The direct customer of the LSP is the shipper and the receiver of the goods. With the introduction of the common logistics function LSP gets less contacts with retailers compared to business as usual and need to establish new contact with internal LSP that takes responsibility for the last delivery within a shopping mall. There is no direct influence on the relationships with shippers.

As the LSP need less time at the shopping mall for unloading activities, it can serve more clients a day, increasing its own efficiency. Experience from Strømmen shopping centre shows that in business as usual situation, the time used by truck drivers to deliver pallets from the vehicle to shops can be up to 30 minutes to deliver one pallet. The time spent increases with the number of pallets and/or stores, depending on the distance to the store and how many trips to and from the freight receipt area that are necessary.

Table 21. Time spent on freight delivery activities without common logistics function

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

When common logistics function is introduced, the experience of DB Schenker Norway from Stovner shopping centre, shows that drivers reduced delivery times by 4-14 minutes per pallet (Torekoven J A, 2016). It takes on average 2 minutes for the drivers to unload and deliver 1 pallet to the common logistics function compared to regular situation when on average it takes about 15-16 minutes to deliver one pallet to one store depending on its location at the mall.

<table>
<tr><td rowspan="2">Key partners
Internal LSP</td><td>Key activities
Less activities in a shopping mall</td><td>Value proposition
More efficient and predictable deliveries
Shorter delivery times</td><td>Customer relationship
Better planned deliveries
More time to serve the clients</td><td rowspan="2">Customer segments</td></tr>
<tr><td>Key resources</td><td>Externalities
Less emissions and disturbance because of shorter unloading times</td><td>Channels
Less face to face with final receivers</td></tr>
<tr><td colspan="2">Cost structure
Less delivery costs</td><td colspan="3">Revenue streams
Sender/receiver pays for transport services. It is not yet decided if the reduced delivery times for the LSP/transporter will give reduced prices for the transport services</td></tr>
</table>

Figure 30. Business Model Canvas for LSP

In terms of externalities from the transport activity it performs, emissions and disturbance will be reduced due to the fact that trucks are less queueing in the loading area. Overall, for LSP costs per delivery will be reduced, as less time is needed per delivery. As a consequence, more deliveries can be combined in a truck or in a day.

Financial viability of CITYLAB solution

Straightsol experience as well as experiences of other malls illustrate that the costs of the solution seem to be a major obstacle for further up-take of the solution: potential value creation resulting in the direct monetarized gains benefit one stakeholder, while all the direct costs for the development of the service are bared by another stakeholder. So cost-benefit redistribution is necessary in order to make implementation of this solution feasible for the shop owners. The table below summarizes potential value creation for major stakeholders.

Table 22. Potential value creation for the actors involved

The stores	The logistics service providers	The shopping centre
Increased control of the goods	Increased time window deliveries	Saved costs on wear and tear of inventory
More cost efficient staffing	Reduced costs per delivery	Satisfied shopping customers
	More efficient route planning and income on the car	

Source: CITYLAB Deliverable 5.3 (2017)

For example, LSPs delivering to the Strømmen shopping centre reported that for the LSPs 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. Many of the stores demand to have the goods delivered within specific slot-times or time windows during the day. This puts a strain on the driver in planning a cost efficient route. More flexibility and an increased time window for deliveries improves the utilization of the vehicles. In addition, time saved by delivering directly to the common logistics function frees 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. Altogether this should in turn result in reduced costs per delivered item for LSP.

As regards the costs for the establishment of the common logistics function, in case of the Strømmen shopping centre, the costs for the limited trial were covered by the management and not the users of the service. Initially it was voluntary for the stores to use the common logistics function and the tenants had to pay to make use of the offer. 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. Emporia shopping mall has developed another business model, where the service is compulsory for most tenants and mainly covered by the rent. Cost are registered for each delivery and invoiced as part of the tenants' rent. In this model the operator of the common logistics function 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.

Due to these circumstances it is clear that there should be a better distribution of cost and benefits between involved stakeholders and potentially the transportation companies should contribute to cover the expenses of the in-house logistics service.

Costs and benefits for society of CITYLAB solution

Summarizing experiences from above, LSP appears to be the main beneficiary from the introduction of the common logistics function: there is almost double reduction in time for the driver and overall less congestion from waiting/queuing of other operators.

Benefits to society are less tangible, and are closely related to the fact of improved efficiency of the LSP operations. Vehicles are less queuing, potentially reducing NOx emissions (CITYLAB Deliverable 5.3). The time savings are so substantial that potentially LSPs may be able to replan their routes and use a lower number of vehicles to serve the same number of clients within a day.

There are also potential benefits for the urban planning, as less loading space is required (due to the higher turnover of the trucks at the unloading bays), potentially this space can be used more environmentally friendly.

7.2 Stakeholder support for Oslo solution

Figure 31 shows the multi-actor results for the Steen & Strøm implementation in Oslo where a new shopping centre will be built with an integrated common logistics function. The most critical phase for ensuring the solution is the planning process. That is where the CITYLAB Oslo implementation actively contributes. To get insight in the transport, environmental and economic effects from having a common logistics function in a shopping centre, data were collected for existing shopping centres with or without a common logistics function. Figure 31 reflects these data for three types of shopping centres. The aggregated scores of the evaluation are shown on the y-axis (based on AHP eigenvalues method, see Saaty (1988)). The coloured lines represent the alternatives and show to what extent each alternative contributes to the criteria of each stakeholder (x-axis). The orange line represents a shopping centre without common logistics function. The blue line represents a shopping centre with a common logistics function: there is staffed goods receipt but the use is voluntary and receivers should pick-up their goods from the reception area unless they pay for it. Waste is also handled by the service provider if the retailer pays for it. The green line represents a shopping centre with a common logistics function: there is compulsory staffed goods receipt and deliveries are made to the store by the service provider who also handles waste. Figure 31 reveals that there is no clear preference among stakeholders. No common logistics function is worse for all stakeholders. Some of them prefer the scenario with voluntary use: the retailer and the transport operator delivering to the shopping centre. Shippers, society and the shopping centre owner prefer compulsory use.

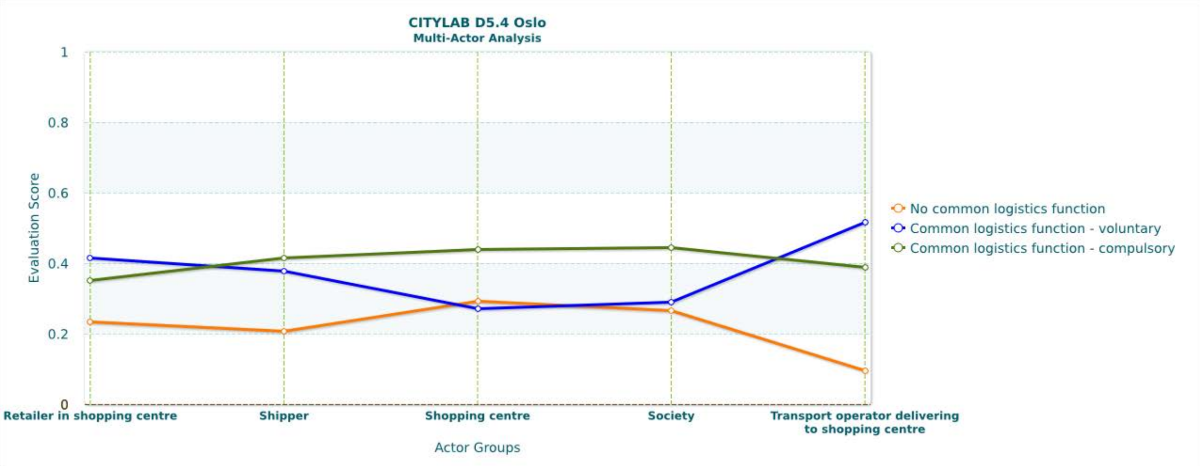

Figure 31. Multi-actor results for CITYLAB solution in Oslo

Retailers in the shopping centre attach great value to the shopping environment, high quality deliveries and a low cost for receiving goods. The scenario with compulsory common logistics function scores well on shopping environment and high quality deliveries but scores badly on the cost. The scenario without common logistics function scores badly on shopping environment and quality of deliveries but much better on the cost. It means that the preference of retailers really depends on how they value these three criteria. In the presented analysis, shopping environment, high quality deliveries and cost received weights of 31%, 28% and 26%. Sensitivity analysis shows that even if cost receives a weight of more than 60%, the voluntary scheme remains attractive to them (because they do not have to pay for the service). From the moment that cost receives a weight of 43%, BAU can compete with the compulsory scheme for the retailers (See Figure 32).

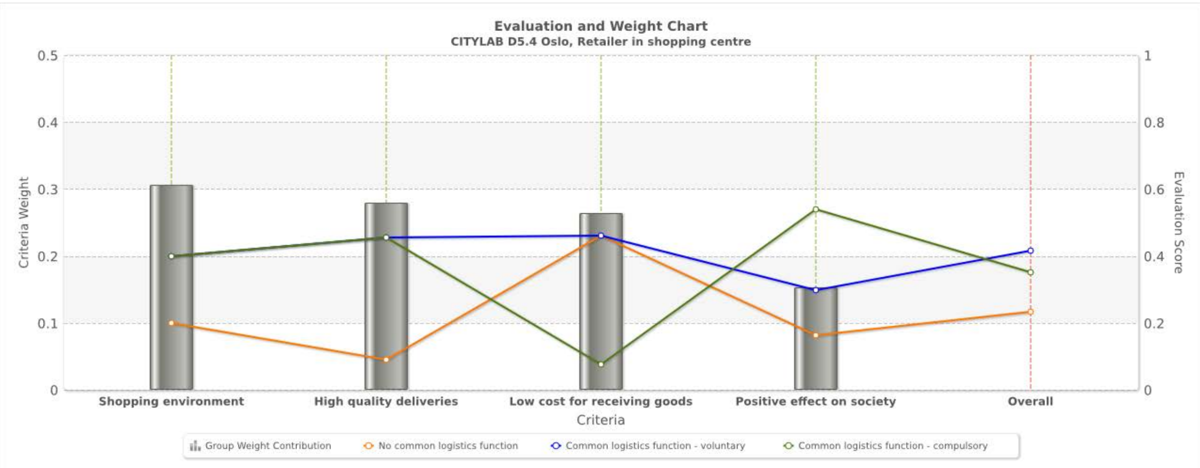

Figure 32. Mono-actor results for the retailer for CITYLAB solution in Oslo

Shopping centre owners attach most importance to the shopping environment and their financial viability. The low score for financial viability of the voluntary common logistics function scenario and the high score on that criterion for the other two explains the preference for the shopping centre owner (See Figure 33).

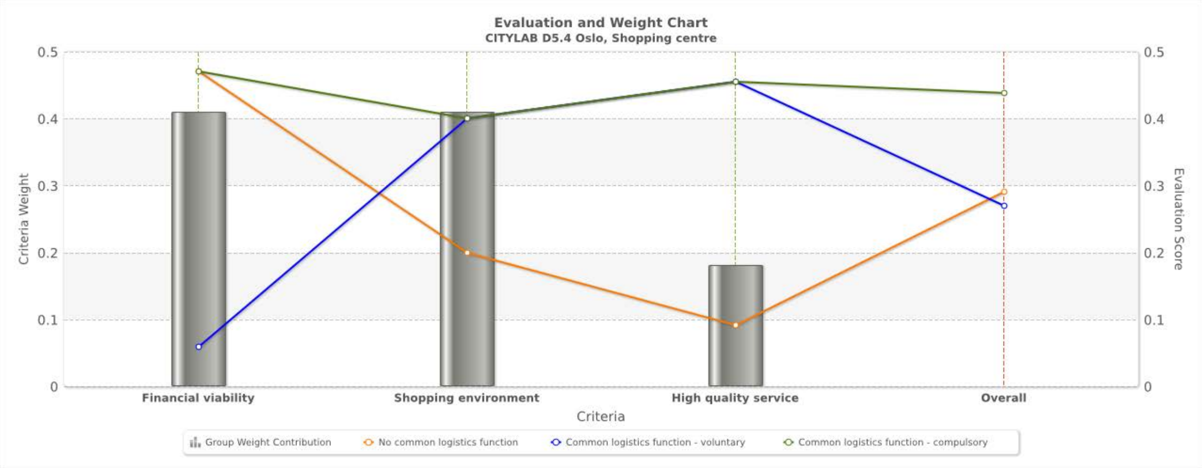

Figure 33. Mono-actor results for the shopping centre owner for CITYLAB solution in Oslo

In ANNEX 5, you can find all mono-actor results for the implementation in Oslo and the table with justification for the various scores of the alternatives.

7.3 Upscaling of Oslo solution

7.3.1 Baseline for upscaling

As it is not yet possible to get real life data from Økern centre, information from interviews among stakeholders at Strømmen and Emporia shopping centres and demonstration at Emporia shopping centre in Malmø is used for the Økern scenarios. In Strømmen shopping centre they started a demonstration with common logistic functions on 1. April 2017 and at Emporia shopping mall common logistic services have been mandatory from the opening. Emporia shopping centre consist of 70 000 m^2 with 200 tenants and Strømmen shopping centre consist of 47 222 m^2 and 200 tenants. Information from these 2 shopping centres supported with knowledge from other resources will be used as a basis for upscaling of the CITYLAB Oslo solution.

Table 23. Baseline for upscaling of CITYLAB Oslo implementation

Baseline	Implementation
Calculation based on 3.5 pallets per shop per week. 200 shops and 200 shippers in scope.	
• No storage buffer or information sharing • CAPEX zero • Time for LSP: 17 minutes' delivery per pallet and 5 minutes queuing at freight receipt • Time for shop owner: 30 minutes per pallet	• Storage buffer of 75m^2, and 5 hours p/w employed. • Time for LSP: 3 minutes' delivery per pallet and no queuing at freight receipt • Time for shop owner: 10 minutes per pallet. • Event tracking and monitoring services EUR 312 p/m per shop.

Source: CITYLAB Deliverable 5.3 (2017)

Økern shopping mall, as it is planned will contain 155 tenants (including HORECA). Assuming that from 155 tenants, 80 % will be retailers, using the common logistics function (as an obligatory solution being included in their rent) brings us to the column 3 of the table above, where the number of the shops participating in common logistics function within Økern shopping mall is estimated to be 125 shops.

Table 24. Estimated Økern baseline

Scaled Baseline	Scaled solution	Estimated Økern baseline
Calculation based on 1000 pallets monthly, 50 shops and 50 shippers in scope.		Calculation based on 9 pallets per month per store; pallets monthly, 125 shops, 80 shippers in scope
• No storage buffer or information sharing • CAPEX zero • Time for LSP: 17 minutes' per pallet delivered and 5 minutes queuing at freight receipt • Time for shop owner: 30 minutes per pallet	• Economies of scale w.r.t. storage facility: 150 m^2 and 40 hours p/w. employed. • Time for LSP: 17 minutes delivery per pallet and 3 minutes queuing at freight receipt • Time for shop owner: 20 minutes per pallet	• Economies of scale w.r.t. storage facility: 150 m^2 and 40 hours p/w. employed. • Time for LSP: 17 minutes delivery per pallet and 3 minutes queuing at freight receipt • Time for shop owner: 20 minutes per pallet • Event tracking and monitoring services EUR 75 p/m per shop.

Source: CITYLAB Deliverable 5.3 (2017)

In the scaled Økern situation, it is assumed that 50 shops and 50 shippers will participate. The yearly rent cost per m^2 in the shopping centre is EUR 93.75 (750 NOK). In the scaled scenario about 150 m^2 is needed as buffer storage, in addition to 6 full time jobs created for the collection of the goods at the storage buffer and the internal transport. The costs for the tracking and monitoring system per shop can be reduced significantly since a large amount of shops participate[7].

Delivery time for the transport operator remains the same as in the upscaled solution: decreased from 17 minutes (i.e. business as usual situation) per pallet to 3 minutes per pallet when delivering to the buffer storage. The time for queuing at the freight receipt reduced with 5 minutes from 5 (i.e. business as usual situation) to 0.

The time savings in the implementation situation are monetized by multiplying the time savings by the hourly wage/cost rate. This is EUR 31.25 (250 NOK) for the employees in the shopping centre (both in-house logistics employees and shop employees) and EUR 56.25 (450 NOK) for the transport operator and use of the truck. Average fuel consumption during idling time (which is 9 minutes in baseline and 3 minutes with solution) is assumed to be 2.3 litre per hour at a cost of 1.79 per litre (14.28 NOK). In the scaled situation, the time needed to deliver or receive a pallet are kept equal to the baseline and implemnentation situation. The queuing time, will remain 3 minutes per pallet, as was in demonstrations.

During the registrations at Strømmen shopping centre each shop receives 3.5 pallets a week, on average, 14 pallets per month per shop. This is not representative for the other shops in the mall, as many have fewer deliveries and some have more pallets per month. In the scaled scenario an average of 9 (2.07*4= 9) pallets per shop per month is assumed.

[7] According to GS1: in case of 50 shops; NOK 7,000 (€875) per year per shop should cover all costs related database access and user interface software, scanner app, WIFI-costs and a support agreement. Additionally, there is one time start-up fee (per database) of fixed NOK 10,000 (€1,250).

The external cost savings relates to the use of fuel. Burning fuel harms the environment and has a negative effect on people's health in terms of air quality. Fuel savings result from the reduction in idling time (from 9 to 3 minutes per pallet). The drivers, who often let the engine running during unloading, need less time to deliver the goods. The estimated fuel used during idling in the scaled scenario is 115 litres per month as opposed to 326 litres in the scaled baseline. This is a reduction of 211 litres, which equals 661 kilogram CO_2[8]. The reduction is however negligible considering the amount of fuel used during transport, and the value attached to the reduction. The external cost of 661 kilogram CO_2 is about EUR 26[9]. There will be some additional external cost savings in terms of NO_x and PM_{10} but this is limited, also due to the location where the emissions are emitted. The solution may lead to much greater external cost savings on the long term though, when LSPs are able to adjust their transport planning, because of the reduction in delivery time at the shopping mall. When they could save kilometres driven (in the inner city), savings on external costs will increase considerably.

7.3.2 Upscaling scenario A: Citylab solution applied to all biggest shopping centres in Oslo and Akershus

Scenario description

The main idea of upscaled scenario A is to see what the cumulative effects would be if common logistics function is introduced in all major shopping centres in Oslo and Akershus. For this, we are looking into shopping centres with a turnover more than 1000 mill NOK (Table 25). As a reference point, Strømmen shopping mall and Oslo city shopping malls are part of this overview.

Table 25. Shopping centres in Oslo and Akershus with turnover more than 1000 mil NOL

Centres in Oslo and Akershus	1000 m2 sales area	Turnover (mill NOK)	No of shops
Sandvika storsenter	56	3269	197
Strømmen storsenter	52	3021	202
Storo storsenter	27.5	2228	130
CC Vest	22	2117	105
Ski storsenter	29	2036	145
Alna senter	46.9	1975	23
Oslo city	19.4	1856	93
Jessheim storsenter	37	1784	145
Vinterbro senter	42	1450	85
Aker brygge	32	1407	65
Lambertseter senter	18.5	1154	83
Byporten shopping	10	1145	80
Metro senter	51.6	1127	100
SUM	**444**	**24569**	**1453**
Average	**34**	**1890**	**112**

8 Well-to-wheel emission factor of 3135 gram per litre diesel is used.

9 Source: IMPACT - Handbook on estimation of external costs in the transport sector

Effects and consequences scenario

Estimating effects and consequences of upscaled scenario for different stakeholders of CITYLAB solution, overall, there would not be major changes in the business model CANVAS for the shop owners and retailers. The major cumulative benefits will be again on the side of the logistics service providers. Main assumption here is that in the biggest malls there will be a high (80%) proportion of the same retailer tenants, using same (per retailer) LSPs for the delivery of these shops.

Having common logistics function within all biggest clients helps LSPs to get even higher benefits from the time savings that they get per pallet per day. If instead of two malls 13 are implementing common logistics function, this comes out for almost 7820 minutes per day[10] saved for the LSPS on delivering the pallets. However, this is not for a single LSP but for all the LSPs in charge of delivering the pallets to the 13 shopping centres. Being less related to the specific time windows also helps LSPs to plan their routes more efficiently during the day. Potentially this can also lead to the improvement of the load factor per truck and decrease in the number of trucks used to serve specific amount of shopping malls.

<table>
<tr>
<td rowspan="2">Key partners

In-house LSP</td>
<td>Key activities
Less activities in a shopping mall</td>
<td>Value proposition
More efficient and predictable deliveries
Shorter delivery times
Reduction of vehicles deployed</td>
<td>Customer relationship
Better planned deliveries
More time to serve the clients</td>
<td rowspan="2">Customer segments
Potential to have new clients due to the free time because of overall optimized deliveries</td>
</tr>
<tr>
<td>Key resources</td>
<td>Externalities
Less emissions and disturbance because of shorter unloading times</td>
<td>Channels
Less face to face with final receivers</td>
</tr>
<tr>
<td colspan="2">Cost structure
Less overall delivery costs</td>
<td colspan="3">Revenue streams
Sender/receiver pays for transport services. Higher benefit from the cumulative reduced delivery times for the LSP/transporter will give reduced prices for the transport services; potential possibility to have more clients a day</td>
</tr>
</table>

Figure 34. Business Model Canvas for the LSP in scenario A

With regard to financial viability of the solution, the costs/benefits for the shopping mall remain the same no matter if other centres have the same solution. However, if the operation of common logistics functions becomes widespread, the services will probably become more skilled and efficient, thus reducing the costs for each shopping centre. As benefits for the LSP are getting higher due to the fact that more shops are involved and time savings are higher,

[10] 2.07*52/300days= 0,35 pallets on average to each store a day. 0,35*1453(total number of stores in the 13 shopping centres)=521 pallets a day in total. 521*15(time saved per pallet)=**7820** minutes a day saved for LSPs on delivering all the pallets

there is also a higher chance that LSPs will be willing to participate in the costs for this optimization solution.

The external cost savings relates to the use of fuel. Burning fuel harms the environment and has a negative effect on people's health in terms of air quality. Fuel savings result from the reduction in idling time (from 9 to 3 minutes per pallet). The drivers, who often let the engine running during unloading, need less time to deliver the goods. The estimated fuel used during idling in the scaled scenario is 115 litres per month as opposed to 326 litres in the scaled baseline. This is a reduction of 211 litres, which equals 661 kilogram CO_2[11]. The reduction is however negligible considering the amount of fuel used during transport, and the value attached to the reduction. The external cost of 661 kilogram CO_2 is about EUR 26[12]. There will be some additional external cost savings in terms of NO_x and PM_{10} but this is limited, also due to the location where the emissions are emitted. The solution may lead to much greater external cost savings in the long term though, as LSPs are able to adjust their transport planning, because of the reduction in delivery time at the shopping mall. When they could save kilometres driven (in the inner city), savings on external costs will increase considerably.

7.3.3 Upscaling scenario B: CITYLAB solution applied to all big and medium shopping centres in Oslo and Akershus

Scenario description

In this scenario even more shopping malls have implemented common logistics function, with total amount of shopping malls being 29.

Table 26. Shopping centres in Oslo and Akershus with turnover more than 500 mil NOL

Centres in Oslo and Akershus	1000 m2 sales area	Turnover (mill NOK)	No of shops
Sandvika storsenter	56	3269	197
Strømmen storsenter	52	3021	202
Storo storsenter	27.5	2228	130
CC Vest	22	2117	105
Ski storsenter	29	2036	145
Alna senter	46.9	1975	23
Oslo city	19.4	1856	93
Jessheim storsenter	37	1784	145
Vinterbro senter	42	1450	85
Aker brygge	32	1407	65
Lambertseter senter	18.5	1154	83
Byporten shopping	10	1145	80
Metro senter	51.6	1127	100
Triaden Lørenskog	27	984	80
Tveita senter	14.3	891	70

[11] Well-to-wheel emission factor of 3135 gram per litre diesel is used.

[12] Source: IMPACT - Handbook on estimation of external costs in the transport sector

Centres in Oslo and Akershus	1000 m2 sales area	Turnover (mill NOK)	No of shops
Trekanten Asker	16.8	876	75
Oslo s shopping	13.7	857	25
Stovner senter	30	854	87
Manglerud senter	12	718	60
Bryn senter	15.3	714	42
Holmen senter	17.8	703	50
Linderud senter	13.7	698	76
Kolbotn torg	15.7	669	55
Steen & Strøm department store	12.9	657	48
Eger Karl Johan	11.1	616	27
Røa senter	6.3	570	20
Lillestrøm torv	22.8	550	84
Vestby storsenter	25.6	540	43
Fornebu S	24	526	80
SUM	**723**	**35992**	**2375**
Average	**25**	**1241**	**82**

Effects and consequences scenario B

If common logistics function is introduced in all the biggest and medium shopping malls of Oslo and Akershus, some potential changes may also have a bigger influence for the retailers. For instance, if the price of the common logistics function is part of the rent for all of the shopping malls and not equally distributed among LSPs, who is getting the main benefit out of it. The cumulative rent increase for the retailers can become important. This is with an assumption that 80% of the tenants in these shopping malls are the same retail companies.

As in the previous scenario, financial viability for the shopping mall remain the same no matter if other centres have the same solution. However, if operation of common logistics functions becomes widespread, the services will probably become more skilled and efficient, thus reducing the costs for each shopping centre. As benefits for the LSP are getting higher due to the fact that more shops are involved and time savings are higher, there is also higher chance that LSPs will be willing to participate in the costs for this optimization solution.

LSPs are benefiting from even higher time savings per day, their Business Model Canvas changes would remain the same as in case of upscaled scenario A, with the only difference in the scale of benefit.

8 Paris

Paris is among the cities that have an elaborated plan to act upon the air pollution, which is recognised as one of the city's major problems. It is recognized nowadays, that logistics sprawl is contributing to the creation of additional freight vehicle – kms on the urban and metropolitan roads, thus contributing to air pollution and CO2 emissions. It was estimated, just for the parcel and express market, that it has contributed 16000 tons of CO2 additional annual emissions comparing the situation in 1970s and 2010 (CITYLAB D.2.3.) Logistics sprawl is the spatial deconcentration of logistics facilities and distribution centres in metropolitan areas (CITYLAB D2.1): freight terminals and logistics facilities "flight" from the city dense areas to the suburbs.

The CITYLAB Paris implementation action aims to address the negative consequences of "logistics sprawl". It looks into the effects of the reintroduction of logistics terminals in the dense urban areas. CITYLAB Paris implementation assists with the evaluation of two different terminals located in Paris: Chapelle logistics hotel and Beaugrenelle urban consolidation centre. Beaugrenelle is already functioning and CITYLAB implementation is focused on its economic and environmental analysis. Due to confidentiality issues, an economic evaluation cannot be publicly reported. In the case of Chapelle logistics hotel, CITYLAB Paris implementation is not assessing volume or operational achievements (as the terminal is under construction), but regulatory, technical and economic challenges when constructing logistics buildings in cities. As the hotel is not yet in operation, economic and environmental data about it do not exist. Qualitative data on challenges when building a logistics hotel are available. Below, both terminals and an upscaling solution for each are described based on the data currently available.

8.1 Chapelle logistics hotel: implementation description and its effects

8.1.1 Business as usual versus CITYLAB implementation

The business as usual situation for Paris would be a case where no urban terminal is used. In that case delivery operations are being prepared from suburban terminals to different client locations within Paris.

The logistics real estate market has undergone fundamental changes in France since past 30-40 years. 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. In the Paris region's inner area (within the A86 ring-road), one square meter logistics rent can reach no more than €100 per year, whereas office property allows for rents that range from triple to the eightfold. Thus, the choice of warehouse location tends 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 D2.1, 2017).

Urban planning has witnessed a change of paradigm in favour of sustainable development and urban renovation since the 1990s. 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 PLU 2006 marked a new area of urban logistics with a clear ambition to develop rail/water-road intermodal terminals inside the city limits, in order to consolidate incoming shipments and reduce road transport. Following the promulgation of the PLU, “urban zones for large urban services” (UGSU) were set up including new or renewed public or private logistics infrastructure. Eight zones for logistics within former railyards were identified: Chapelle, Court Hebert Est-Pierres, Pantin-Villette and Batignolles in the north of Paris; Bercy, Tolbiac, Les Gobelins and Vaugirard in the south. The 2016 Paris zoning plan has reinforced this policy.

In this framework, the Chapelle International project is being built as a key element of the City of Paris’ strategy to reintroduce logistics activity in the dense urban area. That is a “logistics hotel”: a multi-user multi-story freight facility incorporating cross-docking and warehousing facilities as well as multimodal rail road terminal.

The area wide planning is a six hectare development, with an overall project made of two parts: the first part is an urban logistics facilities (the Chapelle logistics hotel, including sport facilities, an urban farm, offices, a data centre in addition to the logistics facilities) and the second part is a set of residential buildings and ‘SOHOs13’ as well as several public facilities.

The logistics hotel occupies 24,203 sq m total surface (42,000 m² floor area). It is 390 meter long, 27 meter large and 7 meter high. The building has two functional levels and an occupied roof. There is a ground level of 18,826 m² and an underground level of 17,758 m². The roof is a green zone with several facilities (sport and tennis courts) and an urban farm. The urban project of around 104,000 sq m net footprint includes: around 56,000 sq m of residential areas with 900 apartments, about 33,000 sq m of offices, 8,000 sq m of SOHO (small offices/house offices), 6,000 sq m of public facilities, 800 sq m of commercial areas.

The logistics incubator, running by the Rolling Lab, connects start-ups and big firms and promotes innovations for sustainable logistics. There are currently **9 projects incubating** by Rolling Lab that will move into the new logistics hotel from October 2017 when the building will be operational. More projects will enter after the selection of the call for projects closed in April 2017.

The Chapelle logistics hotel is currently nearly finished. The building will be delivered in Sept 2017 and the first tests for the train services will run after that, while the logistics incubator settles in. It is planned that in January 2018 the wholesalers will settle in and the logistics hotel will start its full operation. The construction of the residential part will start after completion of the logistics hotel.

8.1.2 Role of stakeholders

Various stakeholders are participating in Chapelle logistics hotel. Their roles, interests and main activities within solution are presented in table below.

Table 27. Participating stakeholders in La Chapelle implementation

Stakeholder	Role	Participation in solution	Interest
City planner	Adjusting legislations to reintroduce logistics activities in the city centre	Creating favourable conditions (for example reclassifying the site for logistics usage) for the realization of the new concept	Reintroducing logistics activities to the city

[13] SOHOs = “Small Offices Home Offices”

Stakeholder	Role	Participation in solution	Interest
	Setting standards for clean logistics operations in the city	Managing the urban farm and sport facilities in the roof and the logistics incubator in the building	Reducing pollution and improving living condition
National rail transport operator	Owner of the land that has been demolished and rebuilt Rail transportation planner	Clearing off the land before ceding it to Paris municipality for the construction of the logistics hotel Planning time window for freight transport to the logistics hotel	Revitalizing an abandoned urban train station
Logistics real estate developer	Design and construction of the logistics hotel. Operator of goods handling and of the building (Sogaris)	Building the logistics hotel and adjusting the site according to the specific needs of major operators Building partnerships to assure the full operation of the platform Organizing the upstream goods massification and downstream swap handling	Creating new spaces for logistics infrastructures in urban area
Logistics operators	Transporting swap bodies by rail to the logistics hotel (Eurorail) Upstream and downstream distribution road transportation of the goods (XPO Logistics)	Leasing freight wagons, and organizing the rail shuttles for freight, booking time windows with SNCF (Eurorail) Upstream transportation and downstream distribution of the goods to urban shops (XPO Logistics)	Shorter delivery time More efficient and clean last mile delivery
Shippers	Sending goods that will be stocked or distributed to urban area	Demanding adjustment of the site to fit its operation	Shorter delivery time and distance
Other users	Logistics companies and start-ups that occupy the offices and incubator	No active participation.	Benefiting from the clustering effects and various competences and services

8.1.3 Effects from CITYLAB Chapelle implementation

As Chapelle logistics hotel is not yet operational, that is not yet possible to have a straightforward quantitative evaluation of its activities (this was not the goal of the CITYLAB implementation). As this is a new building, not yet operational facility, that is also not possible to build a business modal Canvas, as that is not yet clear which will be concrete stakeholders that will considerably change their business model while using this solution.

Since its conception, the development of Chapelle International has overcome many obstacles. There are legal/administrative constraints, technical constraints and economic constraints, which provide the framework for various effects from the implementation.

Legal and regulatory complexity

Under the 2006 zoning plan (PLU), the sector of Chapelle International was classified as UGSU (urban zone with large urban services) regulated by specific rules under the article 2 of the PLU, and the usual uses of UG zones (general urban zones) were forbidden or strongly limited. Moreover, article L123-2 § a of the national urbanism code imposed a “waiting perimeter” that blocked the zone for a period of 5 years after the PLU was opposable and until a global development project has been approved by the municipality.

In 2012, as part of the general modification of the PLU, the Paris council partially lifted this perimeter to allow the construction of the urban railway logistics terminal. The land was also reclassified as UG zone in order to allow the introduction of logistics activities mixed with other activities. Meanwhile, a further five years block was maintained on the rest of the perimeter. However, the zone was too narrow for viable logistics activities. Thus, in 2013, the Paris Council voted to extend the logistics zone to reach the railway lines in the West and towards two areas, which were at the time under the blocked perimeter. Until this point, the perimeter of the Chapelle International project has been definitely set.14

The ceiling of the building (7 meters above ground level) is fixed by the regulation on the evolution of the Paris urbanism, which requires that housing buildings must provide a view of the Paris landscape (in the case of the Chapelle project, a view on the Sacré Coeur church on the Montmartre hill). In consequence, the freight terminal had to be limited to 7 meters, which proved to be insufficient for the movement of high volume vans. A final limit of 9 meters was finally granted.

On the other hand, the high standard of ICPE (classified installations for environmental protection) imposed by the 1976 Law on Classified buildings for environmental protection (Loi sur les installations classées pour la protection de l’environnement) increased investment and operational costs considerably. The number of environmental regulations relating to warehouses also went from three to about forties (Fournier, 2014), and they are not necessarily coherent and can change quickly. This increases the future costs to update the site to meet future standards. Moreover, the requirements do not apply in the same way from one municipality to another, which creates a lack of consistency and visibility at the metropolitan level (Laubard and Lissorgues, 2010).

Technical complexity

The first complication comes from the fire safety standards. Urban logistics projects must integrate the requirements of firefighters, who have considerable influence on infrastructure planning. They decide, for example, the location and number of doors and emergency exits, which can have significant effects on the progress of projects such as Chapelle logistics hotel, especially if their recommendations are given, and have to be taken into account, during construction, instead of initial conception (Ripert, 2016). This was the case of Chapelle logistics hotel. At the time of the application for the construction permit, the Paris firefighters department imposed their recommendations on the conception of the building, which generated a direct economic overcost of the project. Following their recommendations, additional stairs and emergency exits as well as an underground firefighter access had to be integrated, which saturated the basement and will have an impact on the logistics activities, generating additional costs.

[14] 2013 DU 218 Bilan de la mise à disposition du public et approbation de la modification simplifiée du PLU de Paris concernant la suppression d’une réserve de voirie sur la rue d’Aubervilliers (19e), la rectification d’une erreur matérielle et de légères modifications sur le secteur Chapelle International (18e).

Second, the soil, formerly industrialized, had several sheets of gypsum and needed to be depolluted, which was also the case for asbestos in the former railway facility. However, SNCF did not fully carry out these operations. In consequence, new heavy negotiations were engaged with Espaces Ferroviaires to cover the extra cleanup costs (1.2 million euros) and to continue the operations of depollution that delayed construction.

Third, as the concept of the project is to be adaptable to users' needs, Sogaris had to modify the plan of the project to satisfy the special requests of partners, which finally also led to important additional costs and delay.

Economic and operational risks

In France, as in many countries, road transport is favoured by logistics companies for several reasons. First, rail transport is more expansive and punctuality is a serious concern of logistics operators. As an audit for RFF and SNCF in 2015 shows, the current ageing rail network suffered under investment and as a result, meets with frequent delays. Strikes also can have an impact on operations.

The rigidity of rail transport represents also a major constraint. The train paths (slots) are fixed and must be booked well in advance; and if one slot if missed, the next will only be available at least 24 hours later. This does not match the high frequency and flexibility that urban last mile deliveries require. Concerning the project, according to the interviews made, although planned for 2 trains per day, current negotiations with SNCF have only secured five trains per week between 00h30 and 3h40 in order to avoid conflict with passenger transport. This raises concerns on the potential volumes that the TFU will receive daily and thus the economic viability of the TFU. The fact that SNCF did not join the partnership shows its doubt on the potential economic outcome of urban railway freight transport model.

In addition, there is currently an uncertainty linked to the transport equipment. Sogaris originally planned to acquire specific wagons to minimize handling operations in the TFU. However, the firm that produced the wagons went bankrupt. The wagon "modalohr" was once considered as a replacement. However, their use requires additional costs. At last Sogaris opted for flat wagons to transport swap bodies and a crane in the TFU. In October 2016, Sogaris was still in searching for a supplier.

8.2 Upscaling of Chapelle logistics hotel functions at full capacity

For the City of Paris, the Chapelle International project is a showcase of urban innovation, contributing to the city's objectives of sustainable urban development, social inclusion, economic development, and the renewal of industrial activities.

However, building the Chapelle logistics hotel has not been easy. It has been a ten to fifteen year endeavour for the city and its partners, among them the city's logistics real estate company Sogaris. The Chapelle urban logistics hotel example, the largest of its kind in Europe, demonstrates the obstacles facing these types of urban projects: regulatory and technical complexity, economic viability of the business model, and awareness and commitment of stakeholders. It is clear that a strong political coordination is essential to the implementation of such innovation. Is it the role of a municipality to go that far into the planning, design, promotion, and building process of a logistics facility, be it as innovative as this one is? Our conclusion is that the efforts made to build Chapelle were worth it because of the benefits the project brought:

- Data collection and better identification of obstacles. Knowing what went well and what went wrong during the planning and construction process of Chapelle has led to some actions: for example, the construction regulations regarding these types of facilities have been recently eased in the national building code in France. Sogaris and other investors are now preparing themselves to compete in yet other bids for tender for logistics hotels in Paris. Proposals have benefitted from the Chapelle experience, by adjusting their business models and building program according to the lessons provided by Chapelle.

- Positive image of a large industrial building in an urban environment. Media coverage is generally positive, and the logistics hotel has brought public attention not only in France but in many other countries. Chapelle is associated with innovative activities, such as a logistics start-up incubator and an urban farm, which is a welcomed change for a logistics facility.
- And, hopefully, provision of efficient logistics services for the Paris economy. Logistics real estate in urban environments is now missing, following a long period of "logistics sprawl" (logistics activities forced out of urban areas) (CITYLAB D2.1, 2017). Some logistics activities today require urban facilities in order to comply with customers' demands (same day, or 'instant' deliveries). The private real estate market will have to contribute, as companies such as Sogaris will not be able to meet all the demand for innovative urban logistics. Chapelle has provided a first real life example of how things can go.

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 and the first ring cities around Paris. When upscaling of Chapelle logistics hotel functions at full capacity it is estimated that logistics hotel will contribute to the reduction of reduce 700 daily truck flows, 7 120 km travelled per day, 460 tons of CO2 emission and 99% of NOx and PM pollution in Paris region.

Currently that is not yet clear whether last mile delivery from the logistics hotel to the final customers will be performed fully or partly with electric/natural gas vehicles. In case if clean vehicles will be used for the last mile delivery, the total positive impact on environment will increase, both as regards pollution and noise. There will be about 100 freight trucks a day coming in and out. It may have an impact on the neighbourhood around, however, the street design for the entrance to the site has been carefully planned so as to minimize impacts.

The ex-ante estimate for the total operation costs is 50 million euro per year. The front side of the building is occupied by offices and other services, which can hide the logistics operation from the future residential areas. A data centre of 2 000 m² occupies the southern part of the building. These can help to generate additional revenue and thus increase the long term financial viability.

8.3 Beaugrenelle urban delivery centre: Implementation description and its effects

8.3.1 Business as usual versus CITYLAB implementation

Beaugrenelle urban distribution space is located in the 15th arrondissement of Paris. It was transformed from an old parking and has been in operation since 2013. It is configured as an urban distribution centre to serve South-West Paris and immediate neighbouring cities. It is composed of a road logistics terminal of 2 565 m²operating parcel and express transport with two delivery areas and one customer reception area open from 9h-19h. Another area of 462 m² is dedicated to offices and sanitary/social infrastructure.

Chronopost is the sole operator of this urban delivery centre. Before operating from Beaugrenelle, Chronopost was running a regular service from a suburban cross dock terminal locatied 10 kms from Paris. The location of the depot has made a huge difference in operations because consolidated shipments arrive all the way to Beaugrenelle (with Chronopost trucks), then contractors take over. In Beaugrenelle the 11 employees and 50 drivers (incl. subcontractors) of Chronopost handle 6 500 parcels per day (distribution and collection) and 3 500 deliveries per day. Current Chronopost/subcontractors fleet is composed of 28 diesel vans and 2 electric vehicles.

The only difference from the initial operational plan is that the operator of the Beaugrenelle terminal has relied less on electric vehicles than initially planned. They recently decided to change from electric vehicles to natural gas vehicles.

8.3.2 Role of stakeholders

Stakeholders in Beaugrenelle urban delivery centre are presented in Table 28.

Table 28. Participating stakeholders in Beaugrenelle implementation

Stakeholder	Role	Participation in solution	Interest
City planner	Adjusting legislations to reintroduce logistics activities in the city centre Setting standards for clean logistics operations in the city	Creating favourable conditions (for example reclassifying the site for logistics usage) for the realization of the new concept Clearing the lands and launching the call for projects	Reintroducing logistics activities to the city Reducing pollution and improving living condition
Express operator **Chronopost**	Delivering the parcels to nearby urban areas	Scan the RFID tags when pallets leave the warehouse. Deliver to the buffer storage of the shopping centre instead of to the retailer.	Shorter last mile delivery time and kilometres. Higher volume
Logistics real estate developer	Operator of the site (Sogaris)	Transforming the abandoned site into logistics platform Managing the building	Creating new spaces for logistics infrastructures in urban area
Shippers	Sending parcels by express service	No active participation	Faster and accurate delivery More flexible solution to drop off the parcel
Receivers	Receiving parcels delivered by express service	No active participation.	Faster and accurate delivery More flexible solution to withdraw the parcel
Subcontractors	Delivering goods on behalf of Chronopost	In BAU delivering all way from the depot in outskirts of Paris, in current implementation – delivering from inner Paris to the clients	More efficient route planning

8.3.3 Effects from CITYLAB Beaugrenelle implementation

The assessment study, released in January 2017, shows an important decrease in freight veh-kms and emissions due to the new location of the depot (from suburban to urban). 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.

Costs and benefits for society of CITYLAB solution

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.

In Beaugrenelle, consolidation increases load factors for final deliveries and provides improved flexibility and quality of service for final deliveries, as well as substitution of diesel vans by clean vehicles (electric or CNG). The city of Paris and its citizens at large are impacted too, through a reduction of overall air pollution. Noise may also be an impact, as neighbourhood households could be negatively impacted by trucks arriving at the site.

Financial viability of CITYLAB solution

The reduction of 52% of annual km and the 8% of electric vans in the fleet can allow an economy of 60% of fuel consumption. The platform is equipped with 100% LED lighting system and a front with natural light in order to reduce energy consumption. The roof of the site is equipped with rain water recovery system.

8.3.4 Stakeholder support for Beaugrenelle solution

Figure 35 shows the multi-actor results for the Chronopost implementation where the company uses a logistics hotel for its deliveries and pick-ups in the 15^{th} arrondissement of Paris from where 25% of tours are done with electric vehicles. The aggregated scores of the evaluation are shown on the y-axis (based on AHP eigenvalues method, see Saaty (1988)). The coloured lines represent the alternatives and show to what extent each alternative contributes to the criteria of each stakeholder (x-axis). The orange line represents BAU when Chronopost deliveries and pick-ups in the 15th arrondissement of Paris are done from the Chronopost distribution centre of Chilly-Mazarin. The blue line represents the CITYLAB solution when Chronopost deliveries and pick-ups in the 15th arrondissement of Paris are carried out from the Beaugrenelle Urban Distribution Space with a fleet of 10 electric vans and 30 diesel vans. Transport between Chilly-Mazarin and Beaugrenelle is done by truck. Figure 35 shows that the CITYLAB solution could receive overall stakeholder support if the solution would also address the criteria of Chronopost. The other three stakeholders, receivers, shippers and society, already prefer the new solution.

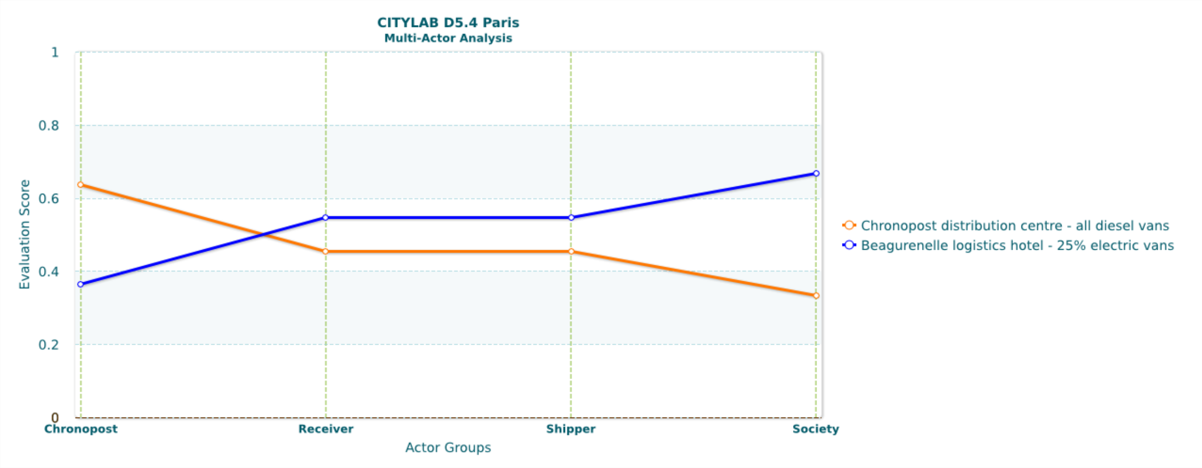

Figure 35. Multi-actor results for CITYLAB solution in Paris

The new solution scores considerably worse on the two most important criteria of transport operators: viable investments and profitable operations. Because of the electric vehicles, the new scenario appeared to involve higher costs and bigger investments. The new solution also scores worse on employee satisfaction because employees do not like the fact that they cannot take the electric vehicles home.

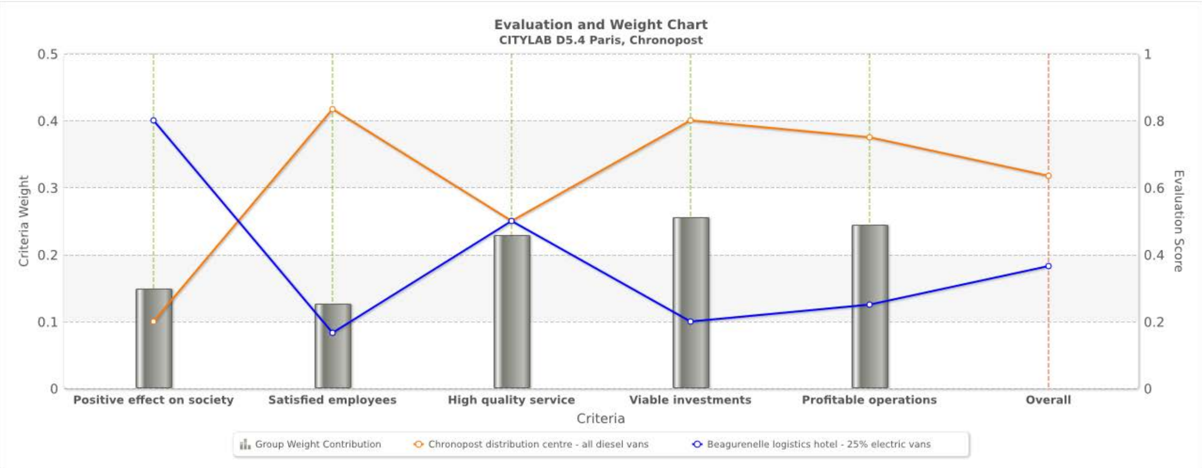

Figure 36. Mono-actor results for Chronopost for CITYLAB solution in Paris

In ANNEX 5, you can find all mono-actor results for the implementation in Paris and the table with justification for the various scores of the alternatives.

8.3.5 Upscaling scenario: Chronopost uses only clean vehicles in Beaugrenelle

At the end of 2015 deployed fleet of Chronopost at Beugrenelle was composed of: 8% electric vehicle, 5% Euro VI and 55% of Euro 5 vehicles. It also still has 33% of older vehicles, such as Euro III: 10% and Euro IV: 23%. These vehicles in general run 15.9 km and reaches 74 recipients in the 15th borough in Paris. As an upscaling scenario can be considered one, when Chronopost decides to use only clean vehicles from its depot in Beaugrenelle, using either electric vehicles or natural gas vehicles, or combination of those. Thus, brining emissions from the activities of Chronopost from this location to zero.

9 Southampton

Improvement of air quality is a fundamental policy objective of the City of Southampton. Other city objectives include to reduce the HGV movements in urban areas and to facilitate a structure that will enable economic growth to continue unhindered by issues of congestion and, in particular, to maintain effective operation of the Port of Southampton. These objectives have to be achieved in the general city context, characterized by: high pollution levels in and around the port of Southampton and along some key corridors around the city, increasing congestion levels and limited municipality budgets.

Within the Citylab project, the aims of the Southampton implementation actions are to support the policy objective acting on reduction of freight vehicle movements and increasing the number of less-polluting vehicles. It was chosen to focus on the freight transport generated by large municipal organisations (LMOs), such as 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. The CITYLAB Southampton implementation considers two different strands to reduce the environmental impact:

- Use of the Southampton Sustainable Distribution Centre by LMOs
- Use of electric vehicles by Southampton City Council for their in-house operated services.

9.1 Southampton Sustainable Distribution Centre: implementation description and its effects

9.1.1 Business as usual versus CITYLAB implementation

The Southampton Sustainable Distribution Centre (SSDC) is operated by Meachers Global Logistics (MGL) from their premises on the outskirts of Southampton (Nursling Industrial Estate just off the M271 motorway.) They already run this as a commercially successful operation with several private sector clients including Carnival (cruise liners) and the Steve Porter Group (a transport company based on the Isle of Wight) and some use by Southampton City Council for records storage. The CITYLAB Southampton implementation sought to expand its use to other LMOs (e.g. hospitals and universities). Three consolidation opportunities, fully described in CITYLAB Deliverable 5.3, were investigated:

1. Assessment of consolidation opportunities for St. Mary’s Hospital, Newport, Isle of Wight, indicated that substantial numbers of delivery vehicles can be removed through consolidation. The Trust ultimately 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).
2. Planning of consolidation opportunities for Southampton General Hospital was already on-going prior to CITYLAB and continued during the project. A delivery service plan undertaken for the three main goods-in points of the hospital indicated the extent of freight operations: 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 small-scale implementation of temporary storage and transportation of around 12 automated dispensing cabinets (Omnicell), using the SSDC, and this is now being rolled out to the whole hospital, with a fixed space booked at the SSDC for the next 18 months, including an office and an assembly unit.

3. Consolidation opportunities for University of Southampton (UoS) and Southampton Solent University (SSU) student halls of residence, described in more detail below.

University students are a particularly active group in terms of online purchasing behaviour, contributing to the major freight traffic flows at university halls of residence. Considerable numbers of parcels for students are delivered to different resident halls of these universities. Courier companies are visiting the halls several times a day delivering individual packages. These deliveries are often done by vans. Surveys conducted at residential halls for both universities have illustrated that individual halls may typically be serviced by ten or more different couriers each day. Results of the survey are described in detail in Cherrett et al. (2017) and are used in this document in to describe the effects of CITYLAB implementation.

Table 29. Key statistics by hall (28 November – 4 December 2015 (Solent draft proposal, 2017)

Hall	N students	N parcels	Volume (m3)	N courier visits
Chantry	208	75	3.8	30
Deanery	422	329	9.3	49
Emily Davies	240	121	4.3	26
Hamwic	228	88	3.5	28
Kimber & David Moxon Annexe	391	171	6.6	34
Total	**1489**	**784**	**27.5**	**167**

When packages are delivered to a hall, they are first received by the residence manager or assistant. The interview with the residencies manager at Southampton Solent University indicated that around 45% of their time is spent dealing with post, of which one to two hours can be spent daily on booking received items into their internal postal system (Omnipost). The interview identified the following other impacts from dealing with deliveries:

- Continual interruptions caused by deliveries arriving throughout the working day, making it difficult to complete other tasks satisfactorily;
- Some couriers are unwilling to make any redelivery attempts and can become confrontational when they cannot deliver;
- Reception staff are often fearful of leaving the reception desk in case a delivery is missed, as couriers are often not prepared to wait;
- If the reception staff do miss a delivery, it is often taken by the carrier to another hall of residence so parcels need to be carried by hand between the residences by the staff;
- At least once a week, each residence will spend some time trying to track down where a specific parcel was delivered.

The implementation idea is that all parcel and mail deliveries to student halls would be made via the SSDC. In practice this would mean, that when ordering an item online, the student would give their delivery address as “Hall name, c/o SSDC address”. MGL would receive parcels and sort them into suitable delivery containers for subsequent delivery to halls. Each hall would receive a single delivery each day from MGL at an agreed time, by a single delivery vehicle.

Consolidating deliveries adds some time to the overall delivery process. A cut-off time for receiving goods would be applied by MGL to guarantee delivery on the same day. Otherwise the goods will be delivered overnight or during the next day. For urgently required items the delay is probably not acceptable, as students may have paid a premium to receive the goods same day or next day. These items potentially might be excluded from the consolidation service.

9.1.2 Role of stakeholders

The table below outlines roles, actions and interest of different stakeholders in CITYLAB solution. Clear role specification is necessary in order to estimate the effects on different participants as well as to evaluate possible upscaling options.

Table 30. Participating stakeholders in Southampton consolidation solution

Stakeholder	Role	Participation in solution	Interest
Large municipal organisations (LMOs)	Generators of large volumes of incoming goods and related delivery visits through their purchasing activity. In BAU, not really interfering in the delivery process; in CITYLAB implementation – setting up scheme of using SSDC	Set up delivery plans that require certain logistics service providers (LSPs) to deliver goods via the SSDC	Cost optimization Reduction of vehicles in the university areas Time savings for the university personnel Increasing “sustainable” image Better living and working environment
Shippers	Not directly involved	Address labels to include a “care of SSDC address”	None
Receivers (staff or students at LMOs)	Passive	Need to supply a “care of SSDC address” when ordering goods	None
Couriers and other carriers of goods	Delivering goods from shipper to receiver in BAU. In CITYLAB implementation delivering from shipper to SSDC	Indirect – they follow delivery instructions	Indirect – consolidation may allow them to operate more efficiently
Consolidation service provider (Meachers)	Operator of SSDC	Performs consolidation of goods in the SSDC, perform a last mile delivery to the clients	Profit from increased use of SSDC Reputation

9.1.3 Effects from CITYLAB Southampton consolidation implementation

Once the solution with consolidation is introduced in the five residence halls, operations and business models of several stakeholders will be affected. For example, students will need to change behaviour, keeping in mind to indicate another delivery address while performing delivery; MGL and SSDC will get an additional client and will need to integrate new volumes in its logistics and delivery activities. The major changes will be the University residence halls and residence halls manager/assistant activities. That is why, below, we describe potential changes from the business as usual situation to the situation with CITYLAB solution for the Southampton Solent University.

Key partners	Key activities	Value proposition	Customer relationship	Customer segments
MGL and SSDC	Informing the students about delivery address Receiving delivery from MGL	More time for residence manager; Fewer losses of parcels; Improved resource management	"Greener" image of university; better university carbon footprint More accurate service for students	
	Key resources	**Externalities**	**Channels**	
		Less congestion in the university area Overall reduction of vehicle/kms	Delivery via SSDC	

Cost structure	Revenue streams
Payment for the SSDC	Time gains of the residence hall manager

Figure 37. Business Model Canvas for Southampton Solent University

As illustrated in the table above, the CITYLAB Southampton implementation would significantly benefit the residence managers and staff: instead of receiving irregular ad-hoc deliveries by drivers they would receive a single full delivery load from MGL at an agreed time of day. The associated time savings for staff was estimated to be 1.5 hours per day per individual member of reception team (Table 31).

Table 31. Estimated time savings for individual member of reception team per day

	Time spent (minutes)	
	Now	After consolidation
Receiving goods from courier	60	30
Logging parcels onto Omnipost	100	20
Retrieving parcels delivered to another hall	20	10
Handing parcels over to students	30	30
Total	210 (3.5 hours)	90 (1.5 hours)

The parcels will be pre-sorted, making further distribution to the students easier and improving the accuracy.

Overall, this solution increases the value proposition of SSU: it would benefit from having the consolidated deliveries at a pre-arranged time of a day, which could significantly improve resource management at the halls. That will also improve the management of the student expectations as to when their parcel will arrive. Directly, customer relationship will improve: fewer losses of parcels as a result of adopting formal goods receipting procedures used by MGL. Students, university staff and other local residents would benefit from a reduction in the number of delivery vehicles in their immediate surroundings. Traffic congestion and air pollutant emissions will decrease and safety improved.

However, current barriers to implementation are concerns about delaying deliveries, especially for the most urgently wanted items, and the cost of the service, despite this being quite modest at around £18-21 per student per year, depending on uptake.

Due to the lack of any significant take-up of consolidation, to date, by the LMOs, the effects from the CITYLAB Southampton consolidation implementations reported here are based on measured ‘before’ data (for five residence halls) but estimated ‘after’ data, based on stated assumptions about anticipated effects once implementation takes place.

Costs and benefits for society of CITYLAB solution

It was estimated that the total number of visits with consolidation would be reduced by 45%. Instead of the 167 visits observed over 5 days in the BAU situation, MGL would perform 25 visits (5 halls x 5 days), plus carrier visits made for urgent items.

Overall society benefits from CITYLAB Southampton consolidation implementation are:

- increased average vehicle loads;
- reduced vehicle kms driven by couriers and centralized logistics providers;
- associated reduction in vehicle emissions.

Financial viability of CITYLAB solution

MGL estimated the annual cost (5 days a week, 52 weeks a year) of a consolidation delivery service to all Southampton Solent University halls of residences (2294 students) to be £47710, equivalent to £20.80 per student per year. These costs are detailed in the table below. These costs would have to be paid by the university.

Table 32. Estimated costs for Southampton Solent University halls

Item	Requirement	Daily rate	£ per day	£ per year (5*52 days)
Driver and vehicle	2.5 hrs/day	£35/hr	87.50	22750
Warehouse admin	4 hrs/day	£18/hr	72	18720
Warehouse space	1000 sq.ft	£0.06/sq.ft/day	24	6240
		Total	183.5	47710
		Cost per student (= total/2294)	0.08	20.80

At the present time, Southampton Solent University 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).

9.2 Upscaling of Southampton SSDC solution

9.2.1 Baseline for upscaling

Table 33. Baseline for upscaling Southampton solution

BAU situation	CITYLAB implementation
For each hall of residence (on average)	
Number of vehicle visits: 33.5 per day	Number of vehicle visits: 1 to each hall per day
Time spent by residence manager: 210 minutes	Time spent by residence manager: 90 minutes
Costs of solution: 0	Costs of solution: £47710 per year, equivalent to £20.80 per student per year

9.2.2 Upscaling scenario: All residence halls of University of Southampton and Southampton Solent University use consolidation centre for combined deliveries

Scenario description

The CITYLAB Southampton implementation action assessed financial viability and benefit in terms of time savings of university stuff of the deliveries consolidation for Southampton Solent University residence halls. The upscaling scenario considers costs and benefits if all the residence halls of both Southampton Solent University and the University of Southampton adopt consolidation.

Both universities together account for 14 halls with 8886 students living there. Considering both universities and seasonal trends in annual goods receipting data, it was estimated that around 128000 packages per year are delivered with an estimated volume of 4149 m^3, resulting in 13,512 vehicles visits.

Effects and consequences scenario

The cost of providing a consolidated delivery service to both universities was estimated by MGL to be around £160,000 a year, or around £18 per student per year. Thus the upscaling would reduce the cost by around £3 per student per year. Time savings for the hall reception staff remain the main benefit for the university. The usefulness of the time savings would depend on whether that time could be used effectively elsewhere or whether staffing hours could be reduced.

Consolidation was estimated 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) performed by couriers (for urgent items) plus 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.

9.3 Small electric vehicles: Implementation description and its effects

9.3.1 Business as usual versus CITYLAB implementation

Southampton City Council (SCC) policy states that "SCC is committed to being at the forefront of the electric vehicle revolution, transforming its own fleet and vehicles on the city roads. This will deliver a reduction in our costs, improve local air quality and attract investment in to our local economy.

The Council has secured funding from government to fast track the introduction of electric vehicles into its own fleet and explore the opportunities presented by other low emission fuels. Following the successful trial of an all-electric vehicle in our courier service we plan to switch all vehicles operated by our Parking Enforcement Service to EV's this summer. This is the beginning of a staged programme that will see zero emission, electric vehicles become our default vehicle of choice. Ninety further vehicles have been identified for replacement with EV's and by 2020 we aim to see at least 20% of our fleet comprising of EV's (double the average figure that is predicted for most fleets in the UK).

We are working with Hampshire County Council on a procurement framework for electric vehicle charging facilities and services. From this autumn we, and other public sector organisations in the region, are aiming to start delivering an effective network of chargers on our sites for public use. The Council has secured funding to ensure we can provide the facilities and coverage needed by existing and future EV drivers.

We will be exploring opportunities to inform and support businesses, community groups, residents and visitors regarding the potential of low emission and EV's. This has already started with the delivery of the GreenFleet roadshow attended by 50 business representatives in the City last month and a 90% discount now available for EV's using a City Centre season ticket. Southampton was also a focus city as part of the National Clean Air Day campaign on June 15th, during which the virtues of EV's were promoted and an EV event was held at the city's Bargate.[15].

Prior to this policy statement, (SCC, with help from the University of Southampton, reviewed the work activity of their in-house fleet of 472 vehicles (as of 2015) which might be suitable for transfer to electric operation. Internal fleet management system provides a detailed overview of SCC own fleet and its operations in terms of types of vehicles used, vehicle kms driven and fuel consumed.

CITYLAB Southampton electric vehicle implementation audited six different vehicle fleets within SCC, studying their working activity and assessing the feasibility of their replacement with electric vehicles (EVs). The results of the audit are presented in detail in Leong et al (2017). Electrification of council vehicle fleets: understanding economic and operational efficiencies of local authority vehicle fleets, and exploring the potential for electric vehicles and are largely used in the description of the implementation and its effects below.

As of April 2017, SCC has one EV in operation - a Renault Kangoo ZE. The scope of assessment performed within CITYLAB implementation was limited to vehicles in Service Areas that have the following characteristics:

- Only vehicles of a Gross Vehicle Weight (GVW) of 3,000 kg and below are considered. This is because current EV technology for these classes of vehicles is more matured.

[15] https://www.southampton.gov.uk/Images/Frequently-Asked-Questions-CAZ1_tcm63-394636.docx

- Only Service Areas with *travel distances* and *workloads* that lend themselves to be suitable for EVs are considered.
- Only Service Areas that have expressed any form of interest with electrification and subsequently agreed to participate in this study have been considered.

The fleets considered involve those working in: housing operations, animal welfare, courier services, libraries and waste management. The summary of the services areas and vehicles types pre-selected for the replacement are summarized in table 35. Each service area has different requirements for the vehicles and its operational characteristics, it is also characterized by different route characteristics and daily routines performed by the vehicles.

Table 34. List of SCC's Service Areas and vehicles that are within this study's scope

Service Area	No. of vehicles	Fleet number	Vehicle
Animal Welfare	1	F 1456	Ford Transit Connect 220 SWB
Clinical Waste, Hygiene & Pest Control	3	F 2411	Ford Transit Connect 230 LWB
		F 2415	Ford Transit Connect 230 LWB
		F 2416	Ford Transit Connect 230 LWB
Emergency Planning	1	F 2430	Ford Transit Connect Tourneo
Library Services	1	F 1907	Vauxhall Combo
Parking Operations	6	F 0317	Fiat Doblo
		F 0812	Volkswagen Caddy Maxi Life
		F 1438	Ford Transit Connect 230 LWB
		F 1909	Ford Fiesta Van 1.4 TDCi
		F 2410	Ford Transit Connect 200 SWB
		F 2414	Ford Transit Connect 200 SWB
Waste & Recycling	4	F 1402	Ford Transit Connect 230 LWB
		F 1437	Volkswagen Transporter BlueMotion
		F 1458	Ford Transit Connect 230 LWB
		F 1901	Ford Fiesta Van 1.4 TDCi
Total	**16**		

Currently, Fleet Services keep tracks of each vehicle's mileage each time they come in for servicing. Fuel usage, services and repairs are also documented by Fleet Services.

Analysis performed within CITYLAB Southampton electric fleet implementation has indicated that Nissan eNV-200 and Renault Kangoo ZE would be two best suited options to replace 16 pre-selected vehicles. This is due to:

- The high cost-effectiveness to reduce the fleet's emissions.
- The low cost of purchase compared to other alternatives.
- Their similar GVW to the current vehicles used in the current fleet.

- Extensive use by many entities, e.g. North Somerset Council, University of Southampton, Ghent City Council, etc.

9.3.2 Role of stakeholders

If SCC decide to switch to electric vehicles, this will require involvement of a wide range of stakeholders (Table 35).

Table 35. Participating stakeholders in Southampton electric vehicle implementation

Stakeholder	Role	Participation in solution	Interest
SCC	Community services provider	Replacing diesel vehicles with electric vehicles	Less air pollution “Greener” image of municipality
OEMs	Electric vehicle manufacturers	Providing with suitable vehicles	Profit and market share
Charging infrastructure providers	Supplying with charging infrastructure	Supplying with charging infrastructure	Profit and market share
Maintenance services	Assist the smooth operation of the vehicle	By request providing maintenance of the vehicle and charging infrastructure	Profit and market share
Drivers	Switching from diesel vehicle to electric	Driving electric vehicles	Improved feeling of comfort, less noise
Clients	Their service have to be delivered	No active participation	Less air pollution

9.3.3 Effects from CITYLAB Southampton electric vehicles implementations

Service areas within SCC act as operators and procurers of the vehicles and will experience the major impact from switching of 16 vehicles from diesel to electric. Relationships with new partners have to be established: vehicle manufactures, charging infrastructure dealers, vehicle and infrastructure maintenance network, etc. There are no major changes in key activities of the SCC service areas, as 99% of the daily distances travelled by the vehicles are less than 60 miles, which makes them suited to be replaced by EV.

Table 36. Summary of vehicle performance as estimated from the GPS tracking activity. GPS data was only available for 14 of the 16 vehicles.

Service Area	No. of Vehicles	Combined Mileage (mi)	No. of working vehicle-days sampled	Average distance per working vehicle-day (mi)
Animal Welfare	1	908.9	29	31.3
Clinical Waste, Hygiene & Pest Control	3	1490.2	58	25.7
Emergency Planning	1	84.3	6	14.1
Library Services	1	253.7	24	10.6
Parking Operations	6	1326.9	74	17.9

Service Area	No. of Vehicles	Combined Mileage (mi)	No. of working vehicle-days sampled	Average distance per working vehicle-day (mi)
Waste & Recycling	2	736.7	33	22.3
Total	14	4800.8	224	21.4

The new key activities will include training of drivers to operate a new vehicle, but also installation of charging infrastructure and getting charging process into the vehicle routine. It was suggested that at least 8 single phase 16A 7kW charging points should be installed in 5 different locations. In case if charging at home is considered, there is a need to establish a framework for the Council to provide such facilities where possible, including the possibility of communal charging stations for drivers with no driveway.

Electric vehicles are still more expensive than conventional ones and demand higher initial investments. Experiences show that operational and maintenance costs (in case of no major break-down of the vehicle) are considerably lower. Nowadays for the small electric freight vehicles (above 3.5 tons) the TCO breaks even at 8-10 years, depending on existing additional financial or operational benefits (subsidies or privileges). If medium and large vehicles are to be replaced, financial and operational burden is much higher. Not directly related to it, but CITYLAB Southampton implementation has identified that it is highly useful for SCC to invest in a unified IT system to manage its vehicle fleet, which includes the use of telematics and real-time monitoring. This data can be used to optimise the routes and schedules of the Service Areas.

The key benefits for the municipality and the changes of value proposition are related to the improved externalities from the service provided by SCC: less noise, less air pollution and CO2 emission contribute to the “greener” image of the SCC. Drivers benefit from more comfortable driving conditions. Dealing with electric fleet also helps municipality to get a better overall knowledge over electric fleet and makes it easier for it to develop sustainable and green public procurement criteria.

<table>
<tr>
<td rowspan="2">Key partners
EFVs OEMs
Charging infrastructure dealers
Maintenance network</td>
<td>Key activities
Training of drivers
Installation of charging infrastructure
Vehicle charging</td>
<td>Value proposition
Improved sustainability of SCC operation
Own example to other transport companies</td>
<td>Customer relationship</td>
<td rowspan="2">Customer segments</td>
</tr>
<tr>
<td>Key resources
Purchase/leasing of the EFV
Purchase of the charging infrastructure</td>
<td>Externalities
Less air and CO2 emissions
Less noise</td>
<td>Channels</td>
</tr>
<tr>
<td colspan="2">Cost structure
Purchase/leasing of the EFVs
Purchase/leasing of charging infrastructure
Training of drivers</td>
<td colspan="3">Revenue streams
Reduced operational costs
Reduced maintenance costs</td>
</tr>
</table>

Figure 38. Business model canvas from business as usual to CITYLAB implementation for SCC Service areas

Costs and benefits for society of CITYLAB solution

CO_2 emissions estimates were based on the distance travelled by each vehicle taken from 2016 data provided by Fleet Services and on fuel consumption data for the same time period (Table 37). The average is taken to factor in the data provided by the vehicle manufacturers as tested in official tests, and raw CO_2 output of diesel to simulate the emissions from older engines. The result is a balance of the best case and worst case scenarios. The estimates indicate that if the 16 selected vehicles were replaced with EVs, CO_2 savings would be between 17 and 98 tonnes of per year, with the most likely value being 58 tonnes.

Table 37. Annual CO2 emissions from the replacement of 16 vehicles

Vehicle	CO2 emissions (official, kg)	CO2 emissions (based on fuel burnt, kg)	Average (kg)
Ford Transit Connect 220 SWB	1,867	1,872	1,900
Ford Transit Connect 230 LWB	700	827	800
Ford Transit Connect 230 LWB	1,651	2,193	1,900
Ford Transit Connect 230 LWB	1,174	1,727	1,500
Ford Transit Connect Tourneo	542	927	700

Vehicle	CO2 emissions (official, kg)	CO2 emissions (based on fuel burnt, kg)	Average (kg)
Vauxhall Combo	185	299	200
Fiat Doblo	1,039	10,904	6,000
Volkswagen Caddy Maxi Life	1,449	15,311	8,400
Ford Transit Connect 230 LWB	228	360	300
Ford Fiesta Van 1.4 TDCi	619	8,354	4,500
Ford Transit Connect 200 SWB	2,244	22,249	12,200
Ford Transit Connect 200 SWB	1,967	19,505	10,700
Ford Transit Connect 230 LWB	1,072	10,632	5,900
Volkswagen Transporter BlueMotion	835	949	900
Ford Transit Connect 230 LWB	735	1,062	900
Ford Fiesta Van 1.4 TDCi	897	986	900
	17,204	**98,159**	**57,700**

Financial viability of CITYLAB solution

CITYLAB Southampton electric vehicle implementation assessed in detail OPEX and CAPEX for the replacement of the 16 diesel vehicles, comparing the options of eNV-200, Kangoo and Transit Connect, as well as looking into the options of leasing, gradual and "at once" replacement of the vehicles as well as most beneficial loan conditions for the purchase.

The base case for comparison would be the financial data as reported in the data obtained from Fleet Services for the period 1 Jan 2016 to 31 Dec 2016, as reported in a table below.

Table 38. OPEX and the individual cost drivers of the current vehicles for the period 1 Jan 2016 to 31 Dec 2016.

Vehicle Number	Fuel cost	Maintenance Cost	Insurance	Road Tax	Total Annual Cost (2016)	Cost per mile
F 1456	£715.29	£620.23	£534.28	£185.00	£2,054.80	£0.29
F 2411	£319.75	£537.19	£534.28	£185.00	£1,576.22	£0.59
F 2415	£827.26	£617.94	£534.28	£185.00	£2,164.48	£0.34
F 2416	£666.62	£408.43	£534.28	£185.00	£1,794.33	£0.40
F 2430	£354.08	£236.76	£534.28	£130.00	£1,255.12	£0.49

Vehicle Number	Fuel cost	Maintenance Cost	Insurance	Road Tax	Total Annual Cost (2016)	Cost per mile
F 1907	£116.83	£200.32	£267.14	£130.00	£714.29	£0.84
F 0317	£427.92	£979.68	£534.28	£185.00	£2,126.88	£0.50
F 0812	£600.88	£896.83	£801.42	£185.00	£2,484.13	£0.42
F 1438	£149.31	£476.03	£534.28	£185.00	£1,344.62	£1.54
F 1909	£261.05	£821.49	£267.14	£20.00	£1,369.68	£0.42
F 2410	£1,025.27	£1,195.64	£534.28	£185.00	£2,940.19	£0.34
F 2414	£985.50	£1,123.35	£534.28	£185.00	£2,828.13	£0.37
F 1402	£608.59	£1,521.44	£534.28	£185.00	£2,849.31	£0.69
F 1437	£362.74	£2,368.29	£534.28	£295.00	£3,560.31	£1.26
F 1458	£405.41	£1,587.14	£534.28	£185.00	£2,711.83	£0.96
F 1901	£378.48	£532.60	£267.14	£20.00	£1,198.22	£0.26
Total	**£8,204.98**	**£14,123.36**	**£8,014.20**	**£2,630.00**	**£32,972.54**	**£0.48**

Compared to above, the estimated cost of operating a fleet of 16 Electric freight vehicles is shown in table below.

Table 39. Comparison for estimated OPEX for the current fleet, a fleet replaced with Nissan eNV-200s and Renault Kangoo ZEs

Price of electricity	Current fleet	Nissan eNV-200	Renault Kangoo ZE
16 p/kWh	£32,972.54	£14,284.54	£13,917.02
12 p/kWh		£13,181.97	£12,906.32
8 p/kWh		£12,079.39	£11,895.63
6 p/kWh		£11,528.10	£11,390.28

Considering the total cost of 16 vehicles, the Nissan is 57% to 65% cheaper to operate than the current SCC fleet vehicles for electricity prices ranging from 6p to 16p per kWh. The Renault is 58% to 65% cheaper to operate than the current SCC fleet vehicles over the same electricity prices. Overall, EVs are significantly cheaper to operate than current fleet vehicles, even at high electricity prices. The savings offered by the Nissan and Renault are very similar, with differences only becoming pronounced at higher electricity prices.

9.4 Upscaling scenario: 50% of municipality fleet is switched to electric vehicles

Scenario description

16 vehicles represent roughly 3% of the Council's fleet size. The upscaling scenario is looking at the benefits of a large-scale conversion of the fleet into electric fleet. The assumption is that 50% of the vehicles would be suitable for replacement.

Effects and consequences scenario

If we extrapolate the data received from the CITYLAB Southampton electric vehicle implementation to the rest of the fleet, the following assumptions have to be done:

- The average amount of CO_2 produced per vehicle per year remains constant (3,606 kg, based on middle ground estimate).
- The total number of vehicles owned by the Council remains constant at 472 (Jan 2015 numbers).

The resulting cumulative CO_2 emitted as a function of percentage of the fleet that is replaced by zero-emission vehicles is shown in the figure below. For the base case, where no vehicles are replaced, the fleet is expected to produce a cumulative 18,723 tonnes of CO_2 by Year 10. For the case where all the vehicles within the scope are replaced (3% of the fleet) are replaced, there would be a 3% reduction in cumulative CO_2 produced, at 18,089 tonnes by Year 10. In the optimistic case of a 50% replacement, the figure drops to 9,362 tonnes of CO_2 by Year 10.

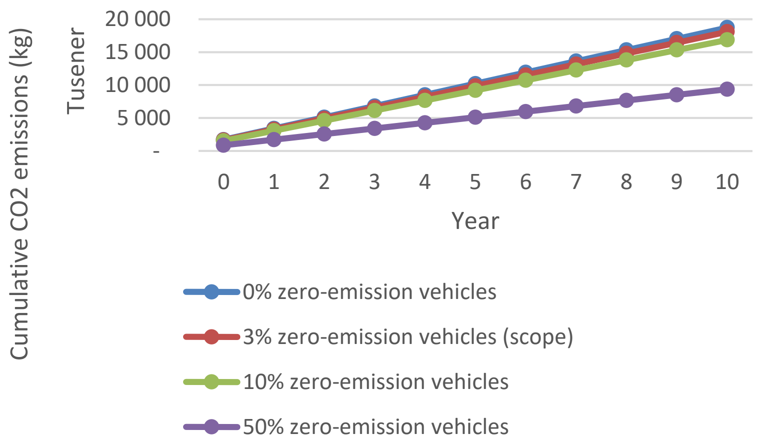

Figure 39. Projected cumulative carbon dioxide emissions as a percentage of fleet vehicles replaced with zero-emission vehicles.

These would derive from replacing a substantial number of SCC's existing van/car fleet, using diesel or unleaded fuel, with electric vehicles. Key assumption is that larger vehicles (SCC own 112) are currently not suited to a switch to electric. As vehicles are used to provide a wide range of different services across Southampton, the benefits would be distributed across the whole city.

For the SCC the larger upscaling will mean that it is necessary to install sufficient number of charging points at strategic locations, including the possibility of installing them at or near the residences of the drivers.

On the financial side, the expected 10-year total cost of ownership for 16 EVs would be £575,000, purchased at an interest of 4% p.a. This gives a CO_2 reduction effectiveness of roughly 30 kg per £ spent. The 16 EVs are expected to save on total cost of ownership, as compared to the current vehicles, for the life of the vehicle so long as interest rates stay below 8% p.a. If only old vehicles are replaced with EVs, the savings are immediate; for a full-scale replacement, savings would be realized in 7 to 15 years, depending on the prevailing interest rates. Though, that is only advised to replace the vehicles on an 'as-needed basis': replace with EVs only when the current vehicle needs to be replaced. Otherwise, if vehicles are replaced immediately, the financial returns on the investment may not be realized until around 10 years later.

10 Conclusions

In this document the effects of large-scale implementation of the CITYLAB solutions were investigated. It was performed based on the set of steps, bringing together all the information collected during development of various CITYLAB solutions, as well as additional data necessary for upscaling. Where possible and available, benefits and costs to society, financial viability of solutions were estimated. Integration of all stakeholders' opinion in the process was considered with the help of the preliminary MAMCA analysis. Overall, the upscaling methodology for each city first looked at the business as usual scenario, prior to implementation, and into changes that were brought in the operations of different stakeholders with CITYLAB implementation. That was performed using a Business Model Canvas approach. Next, MAMCA analyses helped to identify where the solutions should be improved, according to the opinions of different stakeholders. Finally, in discussion with involved research partners, two upscaling scenarios were developed per city/CITYLAB solution. Estimation of the upscaling effects in terms of costs and benefits to society and financial impact on the key stakeholders differs a lot per solution, depending on the baseline upscaling data available. Below we present key results of analysis per each CITYLAB city involved.

In Amsterdam, the implementation action aims to improve last mile logistics making better use of available infrastructure. Upscaling is performed for the third concept of the implementation, where PostNL planned to use locations like unused stores as a shared logistical micro-hub with other logistic service providers. From these micro-hubs, located in the city centre, electric freight bicycles are used to empty public mailboxes and to collect and deliver mail to business clients. This concept has been implemented since a beginning of 2017, when 7 shared micro-hubs have been opened which were already being used as for example post office or public mail delivery. The key stakeholders involved in the implementation are: Post NL, City of Amsterdam, shippers and customers and cycle manufactures. Implementation brings key changes for Post NL, for which Business Model Canvas is developed. Concerning the effects, compared to the BAU situation, it was estimated that implementation in Amsterdam has significantly reduced the amount of trips made by vans (3900 van kilometres), saving about 220 kg of CO_2 and 2 KEuro per day in leasing, salary and diesel. Results of MAMCA analysis for Amsterdam show that the CITYLAB solution clearly contributes better to the criteria of the stakeholders than business as usual, except for shippers. For shippers, the alternative solutions score slightly better: BAU scores better on the criterion of high quality deliveries which is very important for shippers. Sensitivity analysis reveals that the slightly higher score for BAU for this stakeholder is not very robust. Overall, it should be possible to adjust the solution in a way that it would be supported by all stakeholders when attention is paid to the quality of the deliveries. Analysis shows that society clearly supports the new solution compared to the BAU situation: it highly values road safety and air quality. Therefore, two upscaling scenarios were developed: when all delivery for this implementation is performed by electric freight bicycles, increasing the number of orders handled by the clean way of transport from 2200 to 3500 per day. This scenario shows positive financial and societal benefits. In a second upscaling scenario we looked at its application to another Dutch city (Utrecht), which also appears to have overall positive impacts and financial viability.

In Brussels, urban freight transport both suffers from and contributes to severe road traffic congestion, with an average time loss of 38% compared to free-flow traffic. The CITYLAB implementation in Brussels focuses on synergies between different types of freight transport currently transported in vehicles with suboptimal vehicle fill rates. Procter & Gamble, as an owner of the implementation, introduced a new online sales channel to reach the nanostores. Products are delivered by utilizing the spare transportation capacity of vans of existing service-providers. The goal is to reduce or eliminate inefficient storeowner pick-ups, and substitute them by utilizing the free capacity of service-driven companies, whereby load factors of these vehicles are increased. The implementation changes the operational activities and business models of the following stakeholders: P&G; service driven companies and nanostores. The changes for all these actors are described with a Business Model Canvas. Financial sustainability of this solution should be further investigated. As concern costs and benefits for society, the key is that deliveries did not lead to additional vehicles kilometres. Instead of the old vehicles typically used by the storeowners, a Euro 5 fleet of the participating service company was deployed, which potentially lead to the decrease of emissions. MAMCA results for Brussels show that the BAU scenario is beneficial for both P&G and nanostores owners but, for society, the CITYLAB solution is better. The biggest difference between BAU and the new solution is measured for P&G: there are two of their criteria for which BAU scores high: low cost for transport and high quality deliveries. These two aspects need to be addressed to make the solution interesting for P&G. Upscaling of the Brussels solution looked into the impact when the solution is accepted and implemented on a larger scale. For this various business/bundling logic scenarios were simulated with a SYMBIT model, being 8 in total (including BAU scenario). For all of the scenarios the total number of kilometres driven was assessed, which can be further translated into the impact to society. Key conclusions are that the location of the DC might be one of the considerations for choosing a company. At the same time, a company needs a dense network (like Febelco); many delivery addresses in a relatively small area, many trucks and different milk runs per day. This is important to provide a reliable service with a short lead-time. If this cannot be provided, willingness to place replenishment orders online might decrease. In other words, no reliable service is offered to the nanostores. After all, it can be expected that lead-time increases when another service-driven company has fewer delivery rounds and/or fewer vehicles. Most importantly, a service-driven company has a core business, which is not delivering to nanostores. Too many shop orders might hamper the core business with the risk of losing clients (reflected in lead-time). It is therefore interesting to consider using multiple service-driven companies to spread the shop orders. Additionally, the location of the store vis-à-vis the location of the service-driven company determines the choice for the company delivering to a particular nanostore. This can tackle the problem of vehicle kms and lead-time.

The London CITYLAB implementation is investigating how to scale-up sustainable solutions, and what would be the most promising business case and growth conditions for deliveries with electric vehicles and tricycles. In the BAU situation several suppliers of goods are individually delivering to their clients in the city centre. In the CITYLAB London implementation, TNT, from both national and international depots, deliver their goods to Gnewt Cargo's inner London depot out of rush hours. From there, Gnewt Cargo performs the last mile delivery to final clients with electric freight vehicles. In that case, instead of many vans, fewer bigger and better loaded trucks are used to transport the goods from the TNT depots to the Gnewt Cargo depot. CITYLAB implementation provides clear societal benefits, that results from the distance reduction of TNT conventional fuel trucks. However, the trial is too small for London to have any substantial impact on the air pollutant concentration overall. Due to reduced amounts of diesel trips, there is also energy consumption reduction per parcel delivered. Decrease in empty distance is also observed. In order to assess stakeholder support for London solution, multiple alternative scenarios were tested. MAMCA results show, that there is no one preferred solution/alternative for various participating actors. Two upscaling scenarios were considered for London: scenario A aiming to increase the volumes through Gnewt Cargo by at least 20% per year in the next 5 years and more general scenario B, looking into when more companies start using electric vehicle for the last mile. Looking at the upscaling effects of scenarios, all beneficial effects of the trials are expected to be occurring in a very similar way in scenario A: 60% reduction in total distance driven in London for last mile deliveries, 100% CO_2 reduction at the tailpipe, more than 80% reduction in PM10 and NOx, and a strong reduction for all the other proven air pollutants associated with diesel combustion. Additionally, upscaling of this solution will increase efficiency of the carriers operation, increase load factors of the vehicles, reduce time the vehicle spend in the city (including loading and unloading operation) and contribute to further retiming and rerouting of logistics activities.

Improvement of accessibility stands as one of the main goals of the New Rome Mobility Masterplan, as approved in 2014 by the City Council and in 2015 by the Municipal Assembly. Optimization and reduction of the freight vehicle movements directly contributes to this goal. CITYLAB Rome implementation is looking into how to efficiently integrate recycling logistics flows into existing vehicle movements. The main idea is to test how to organise the transport for some categories of recyclable waste, collected at large attractors (such as universities, hospitals, public authorities), by non-dedicated trips, making use of an IT alerting system. The main impacts from CITYLAB implementation are experienced by UR3 and Mobility Manager as part of it, that have, on one side, to develop relationships with new actors (e.g. Meware, Concierge service company) and, on another side, perform fewer duties for the plastic caps collection. Poste Italiane is also the main actor influenced by the solution. Business Model Canvas is therefore developed for these two stakeholders. Other stakeholders are not directly involved in implementation of this new solution, even though are experiencing indirect benefits from it (municipality of Rome and citizens). Analysis of effects from CITYLAB solution shows that currently it is not financially sustainable for Poste Italiane, the main operator of the solution. Though, there are clear benefits for the society from this implementation, which are: reduction of the effort agents have to perform when recycling (e.g. no specific trips would be required to visit recycling facilities); reduction of number of trips collection firms need to perform to increase the amount of materials recycled; minimization of illegal discharging of toxic/dangerous materials; load factor optimization. In terms of emissions, per collection are saved: 2.75g of NO2; 0.29g of PM2.5 and PM10; 677g of CO2; 0.004g of SO2. Results of MAMCA analysis show that the CITYLAB solution is, by far, the preferred solution by all stakeholders. For all stakeholders, the new way of working scores better or at least just as good on all their criteria. Two upscaling scenarios were identified for Rome solution: scenario A is looking into upscaling of Rome solution to the whole Rome territory and scenario B into applying CITYLAB solution to different recycling materials. Effects of scenario A will lead to the overall growth of benefits for the City of Rome and its citizens, as a cumulative number of trips avoided will considerably contribute into reduction of congestion and reduction of emissions. It was estimated that upscaling can result in the following emission savings per month: 53.31 Kg of NO2; 5.60 Kg of PM2.5 and PM10; 13,128 Kg of CO2; 0.08 Kg of SO2. Key financial and organisational impacts will be on Poste Italiane, who will need to integrate much higher volume of flows in its operational structure. For the scenario B both feasibility of solution, financial possibilities as well as organisation of solution will depend on the type of material used. Regulations dictate that certain types of waste cannot be combined in a truck, which, of course, has an impact on the number of vehicles involved, number of trips produced and overall on the CO_2 emission of the service. Currently different companies come to recycle these materials. Economies of scale can be achieved if all materials can be recycled by one company. The overall positive impact from the upscaling of the CITYLAB solution (with Poste Italiane) to other recycling materials are in terms of elimination or reduction of some negative externalities for society, like traffic jam (car crash risk, time to reach places, acoustic and air pollution), illegal disposal places, cost (fuel, maintenance).

CITYLAB Oslo implementation action aims to reduce the negative impacts from urban freight movements in a city. It is focused on making more efficient deliveries, looking into the improvement of logistics processes at multi-tenant shopping centres. The implementation assists the planning process of a new shopping centre at Økern, Oslo, looking into regulatory, technical, design, organisation and financing challenges, when constructing the shopping centre infrastructure with common logistics functions. The business models of several actors will be changed once common logistics function is implemented in the shopping mall: logistics service providers, shopping mall and retailer. The key difference is whether logistics function will be obligatory for all the tenants or will be offered on the voluntary basis, which is not yet known for Økern shopping mall. Introduction of the common logistics function show positive potential impacts for society. However, experiences of other malls illustrate that the costs of the solution seem to be a major obstacle for further up-take of the solution: potential value creation resulting in the direct monetarized gains benefit one stakeholder, while all the direct costs for the development of the service are bared by another stakeholder. So cost-benefit redistribution is necessary in order to make implementation of this solution feasible for the shop owners. Stakeholder support of the solution indicates that no common logistics function is worse for all stakeholders. However, some of them prefer the scenario with voluntary use: the retailer and the transport operator delivering to the shopping centre. Shippers, society and the shopping centre owner prefer compulsory use. Upscaling scenarios for Oslo solution both looked into application of the solution to a larger number of shopping centres in Oslo and Akershus (in scenario A to all the large malls with turnover more than 1000 million NOK, and scenario B to the malls with turnover of more than 500 million NOK). Having common logistics functions within all biggest clients helps the most to the logistics service providers, for which cumulative time savings on delivering the pallets. Being less related to the specific time windows also helps LSPs to plan their routes more efficiently during the day. Potentially this can also lead to the improvement of the load factor per truck and decrease in the number of trucks used to serve specific amount of shopping malls. With regard to financial viability of the solution, the costs/benefits for the shopping mall remain the same no matter if other centres have the same solution. However, if the operation of common logistics functions becomes widespread, the services will probably become more skilled and efficient, thus reducing the costs for each shopping centre. As benefits for the LSP are getting higher due to the fact that more shops are involved and time savings are higher, there is also a higher chance that LSPs will be willing to participate in the costs for this optimization solution.

The CITYLAB Paris implementation action aims to address the negative consequences of "logistics sprawl". It looks into the effects of the reintroduction of logistics terminals in the dense urban areas. CITYLAB Paris implementation assists with the evaluation of two different terminals located in Paris: Chapelle logistics hotel and Beaugrenelle urban consolidation centre. The Chapelle International project is being built as a key element of the City of Paris' strategy to reintroduce logistics activity in the dense urban area. That is a "logistics hotel": a multi-user multi-story freight facility incorporating cross-docking and warehousing facilities as well as multimodal rail road terminal. The Chapelle logistics hotel is currently nearly finished. The building will be delivered in Sept 2017 and the first tests for the train services will run after that, while the logistics incubator settles in. It is planned that in January 2018 the wholesalers will settle in and the logistics hotel will start its full operation. As Chapelle logistics hotel is not yet operational, that is not yet possible to have a straightforward quantitative evaluation of its activities, which was also not the goal of the CITYLAB implementation. The effects of this implementation, are therefore evaluated from the perspective of the regulatory, technical and economic process for different involved parties. When upscaling of Chapelle logistics hotel functions at full capacity it is estimated that logistics hotel will contribute to the reduction of reduce 700 daily truck flows, 7 120 km travelled per day, 460 tons of CO2 emission and 99% of NOx and PM pollution in Paris region. The second CITYLAB Paris implementation is Beaugrenelle, an urban delivery centre situated in the 15th borough of Paris and operated by Chronopost. Before operating from Beaugrenelle, Chronopost was running a regular service from a suburban cross dock terminal located 10 kms from Paris. The location of the depot has made a huge difference in operations because consolidated shipments arrive all the way to

Beaugrenelle (with Chronopost trucks), then contractors take over. The assessment study, released in January 2017, shows an important decrease in freight veh-kms and emissions due to the new location of the depot (from suburban to urban). 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. Compared to the distribution without consolidation, it contributed to the reduction of 50.4% of CO_2 emission, 52.4% of PM, 47.8% of SO_2, 34.3% of CO and 34.7% of HO emission, and 52% veh km savings. In 2016, it contributed to the 8% reduction of noise with the deployment of electric vans. In Beaugrenelle, consolidation increases load factors for final deliveries and provides improved flexibility and quality of service for final deliveries, as well as substitution of diesel vans by clean vehicles (electric or CNG). One of the potential upscaling scenario for Beaugrenelle urban delivery centre would be introducing clean vehicles (electric or natural gas vehicles) for all inner Paris distribution trips performed from it.

Improvement of air quality is a fundamental policy objective of the City of Southampton. Other city objectives include to reduce the HGV movements in urban areas and to facilitate a structure that will enable economic growth to continue unhindered by issues of congestion and, in particular, to maintain effective operation of the Port of Southampton. Within the Citylab project, the aims of the Southampton implementation actions are to support the policy objective acting on reduction of freight vehicle movements and increasing the number of less-polluting vehicles. It was chosen to focus on the freight transport generated by large municipal organisations (LMOs), such as local authorities, hospitals, universities. The CITYLAB Southampton implementation considers two different strands to reduce the environmental impact: use of the Southampton Sustainable Distribution Centre by LMOs and use of electric vehicles by Southampton City Council for their in-house operated services. In the first case, consolidation opportunities for University of Southampton (UoS) and Southampton Solent University (SSU) student halls of residence via the Southampton Sustainable Distribution Centre (SSDC), operated by Meachers Global Logistics (MGL) from their premises on the outskirts of Southampton, were assessed in detail. In the BAU situation, university employees working at halls of residence spend a large proportion of their time receiving and transferring packages ordered by students. In the solution assessed by CITYLAB, this function would be transferred to the SSDC, that will than provide a single delivery each day of the whole, pre-sorted volumes of packages per day to each hall of residence. Overall society benefits from the CITYLAB Southampton consolidation implementation are: increased average vehicle loads; reduced vehicle kms driven by couriers and centralized logistics providers and associated reduction in vehicle emissions. For the time being, there is not yet a financial business model that can make this solution sustainable for all involved parties. MGL estimated the annual cost of a consolidation delivery service to all SSU halls of residences (2294 students) to be £47710, equivalent to £20.80 per student per year. However, at the present time, SSU 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. It was checked whether financial viability of the solution improved if upscaling to all the residence halls of Southampton Solent University and the University of Southampton will take place. Indeed, in that case, the cost per student per year drops to £18 pounds. Time savings for the hall reception staff remain the main benefit for the university. The usefulness of the time savings would depend on whether that time could be used effectively elsewhere or whether staffing hours could be reduced.

The second type of implementation performed within CITYLAB in Southampton was looking into the effects of converting parts of the Southampton City Council (SCC) fleets into electric fleet. CITYLAB Southampton electric vehicle implementation audited six different vehicle fleets within SCC, studying their working activity and assessing the feasibility of their replacement with electric vehicles (EVs). Analysis have shown clear societal benefits in the implementation of this solution as well as long-term financial benefits related to fleet operation.

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ANNEX 1

BRIEF DESCRIPTION OF THE IMPLEMENTATION (< Excel Dashboard)

B2B mail and parcel pick-ups and deliveries by PostNL in Amsterdam are shifted from vans to bicycles using micro-hubs to allow bicycle deliveries

SCENARIO'S (< Excel Dashboard and D5.3)

BAU	Mail and parcel pick-ups and deliveries in Amsterdam (city-centre) by means of vans. Vans travel between city-centre and distribution centre located outside city-centre.
ALTERNATIVE 1	Mail and parcel pick-ups and deliveries in Amsterdam (city-centre) by means of e-freight bikes through centrally located micro-hubs. Parcels are carried between micro-hubs and distribution centre outside city-centre by means of a truck.

STAKEHOLDERS (< Excel Dashboard and D5.3)

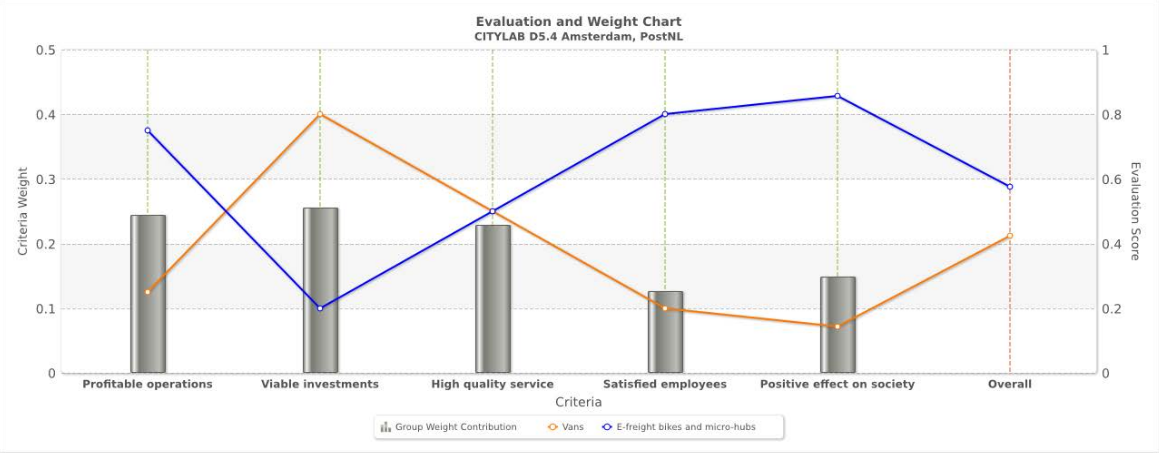
	Stakeholder category
Businesses sending mail	Shipper
PostNL	Transport operator
Businesses receiving mail	Receiver
Society	Society

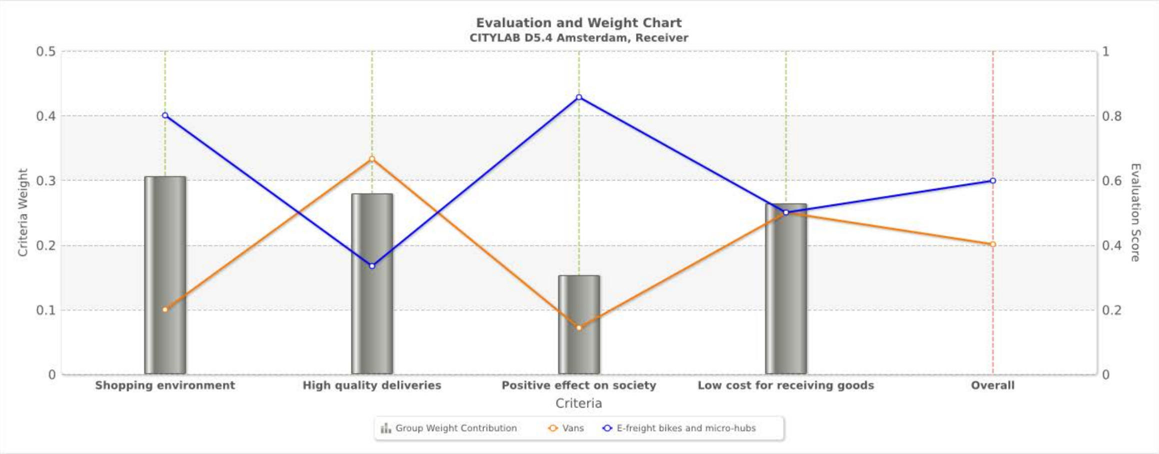
AHP EVAULUATIONS

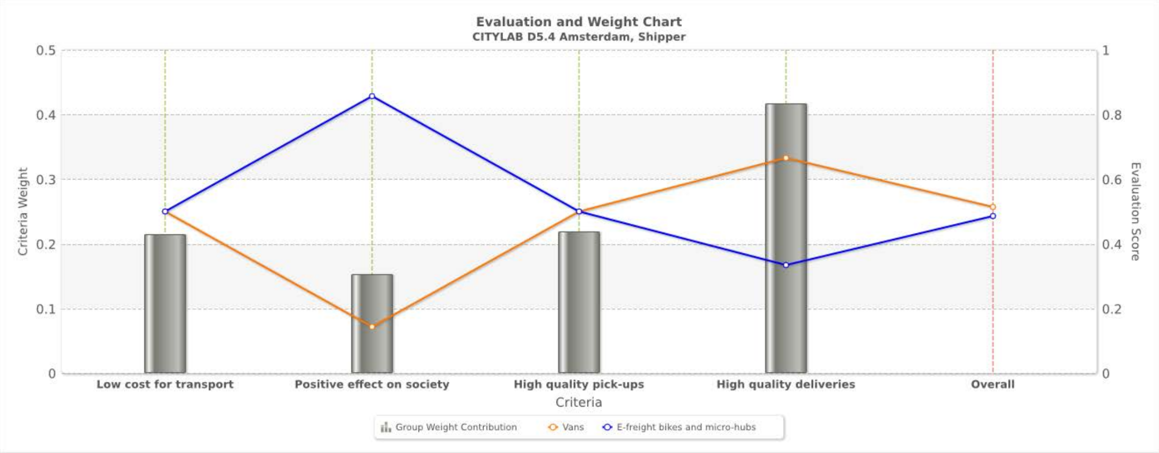
		BAU or alternative?	Value?	Justification
Shipper				
	High quality pick-ups	Same score	1	Excel template (Impact - row 26) - No impact on customer satisfaction.
	Low cost for transport	Same score	1	Excel template (Impact - row 45) - The price that is paid does not change and is based on fixed contracts.
	High quality deliveries	BAU	2	Excel template (Impact - row 26) - No impact on customer satisfaction. D5.3, p. 22: one of the challenges ahead is to find safe locations.
	Positive effect on society	Alternative	6	Combined effect: road safety, air quality, fluent traffic and noise
Transport operator				
	Profitable operations	Alternative	3	Excel template (Impact - row 27) - Operating costs decrease but this includes the van network outside the city-centre. The revenues were not influenced by the solution.
	Viable investments	BAU	4	D5.3, p. 22 - Most hubs are expensive or not at the right logistical location. One of the challenges is to find the best e-freight bike for the ob. Also, finding a suitable planning system for e-freight bikes is challenging. The market for that is not that developed yet.
	High quality service	Same score	1	Excel template (Impact - row 26) - No impact on customer satisfaction.

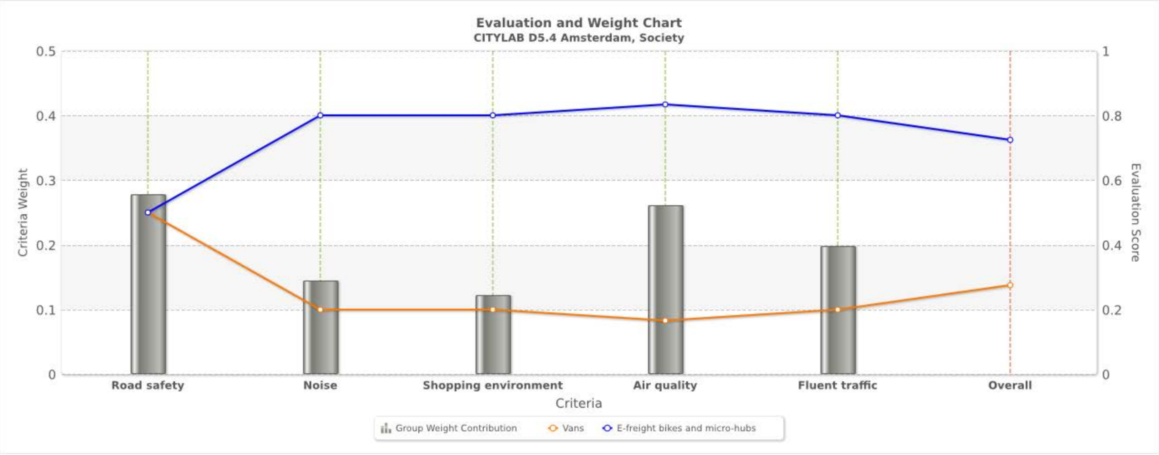
	Satisfied employees	Alternative	4	Excel template (Impact - row 40) - Employees are satisfied and happy. D5.3, p. 22 - After some doubts at the beginning, the drivers are happy with the shift to the bike because it makes their daily job easier and more pleasant. To be updated later (survey will be done on 14th of July)
	Positive effect on society	Alternative	6	Combined effect: road safety, air quality, fluent traffic and noise
Receiver				
	Low cost for receiving goods	Same score	1	Excel template (Impact - row 45) - Data in template does not reflect the cost for the receiver. Experience from other projects: Courier, Express and Parcel businesses do not charge the receiver, but their client (the shipper). The shipper can include the delivery cost in his prize or can charge a delivery cost. Since PostNL only charges one rate to their clients (which does not depend on how they pick-up the goods), the shipper also will not make a distinction based on how deliveries are done.
	High quality deliveries	BAU	2	Excel template (Impact - row 26) - No impact on customer satisfaction. D5.3, p. 22: one of the challenges ahead is to find safe locations.
	Positive effect on society	Alternative	6	Combined effect: road safety, air quality, fluent traffic and noise
	Shopping environment	Alternative	4	No justification in D5.3 or Excel template. Goods availability remains the same. The Amsterdam city-centre will become more pleasant because of the decrease of vans (87 bikes instead of 90 vans, Excel template (Impact - row 28)
Society				
	Shopping environment	Alternative	4	No justification in D5.3 or Excel template. Goods availability remains the same. The Amsterdam city-centre will become more pleasant because of the decrease of vans (87 bikes instead of 90 vans, Excel template (Impact - row 28)
	Road safety	Same score	1	No justification in D5.3 or Excel template. No justification in scientific literature (comparing vans with e-freight bikes). That is why we consider both alternatives

				to have the same impact on road safety.
	Air quality	Alternative	5	No justification in D5.3 or Excel template. We know that in BAU trips are done by (diesel) vans compared to e-freight bikes in the alternative situation which means there is a high decrease in local pollutants and a considerable decrease in CO2-emissions.
	Fluent traffic	Alternative	4	No justification in D5.3 or Excel template. We know that in BAU trips are done by vans and by bikes in the alternative situation. Positive impact on congestion.
	Noise	Alternative	4	No justification in D5.3 or Excel template. We know that in BAU trips are done by motorized vehicles and by silent bikes in the alternative situation. Positive impact on noise.


Evaluation and Weight Chart
CITYLAB D5.4 Amsterdam, PostNL
Criteria Weight
Evaluation Score
Profitable operations
Viable investments
High quality service
Satisfied employees
Positive effect on society
Overall
Criteria
Group Weight Contribution
Vans
E-freight bikes and micro-hubs


Evaluation and Weight Chart
CITYLAB D5.4 Amsterdam, Receiver
Criteria Weight
Evaluation Score
Shopping environment
High quality deliveries
Positive effect on society
Low cost for receiving goods
Overall
Criteria
Group Weight Contribution
Vans
E-freight bikes and micro-hubs


Evaluation and Weight Chart
CITYLAB D5.4 Amsterdam, Shipper
Criteria Weight
Evaluation Score
0
0.1
0.2
0.3
0.4
0.5
0
0.2
0.4
0.6
0.8
1
Low cost for transport
Positive effect on society
High quality pick-ups
High quality deliveries
Overall
Criteria
Group Weight Contribution
Vans
E-freight bikes and micro-hubs


Evaluation and Weight Chart
CITYLAB D5.4 Amsterdam, Society
Criteria Weight
Evaluation Score
0
0.1
0.2
0.3
0.4
0.5
0
0.2
0.4
0.6
0.8
1
Road safety
Noise
Shopping environment
Air quality
Fluent traffic
Overall
Criteria
Group Weight Contribution
Vans
E-freight bikes and micro-hubs

ANNEX 2

BRIEF DESCRIPTION OF THE IMPLEMENTATION (< Excel Dashboard)

P&G directly supplies urban high-frequency stores in Brussels. Store owners order online. Deliveries are done by transport service providers and by providers of business services.

SCENARIO'S (< Excel Dashboard and D5.3)

BAU	HFS owners go to a wholesaler/retailer and supply themselves with P&G products (and other products)
ALTERNATIVE 1	HFS owners order their P&G products online. Deliveries are done by transport service providers and by providers of business services with spare transport capacity. HSF owners still supply themselves with non-P&G products

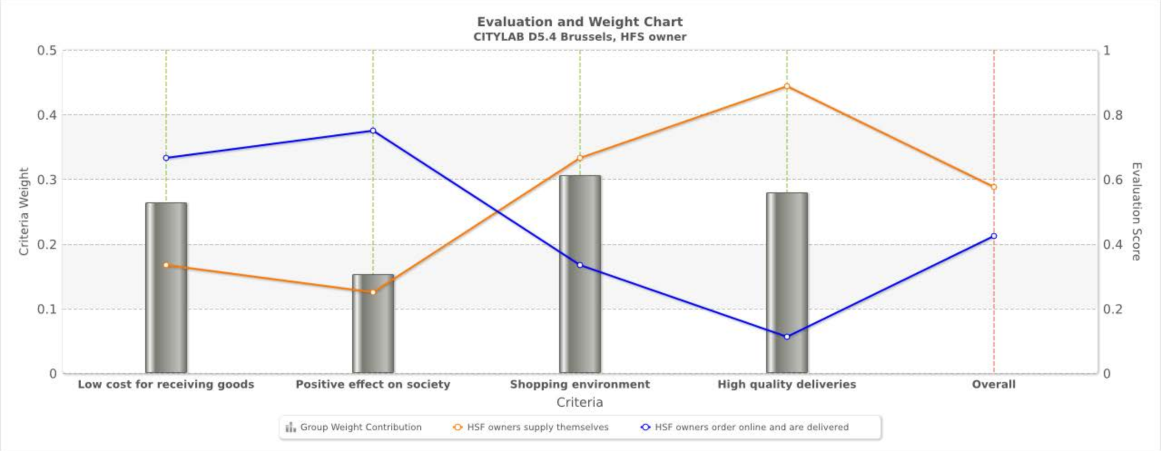
STAKEHOLDERS (< Excel Dashboard and D5.3)

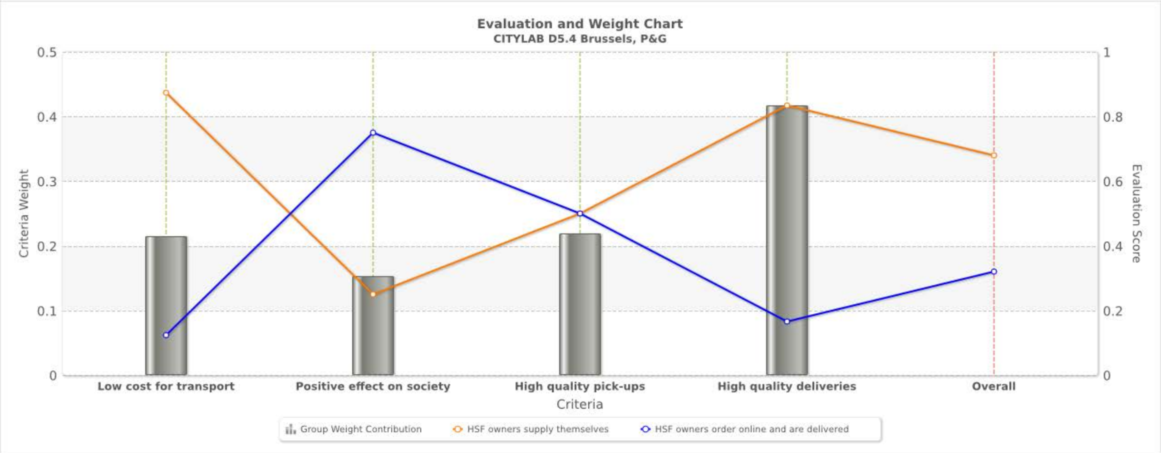
	Stakeholder category
Manufacturer (P&G)	Shipper
Owner of spare transportation capacity	Transport operator
HFS owner	Receiver
Society	Society

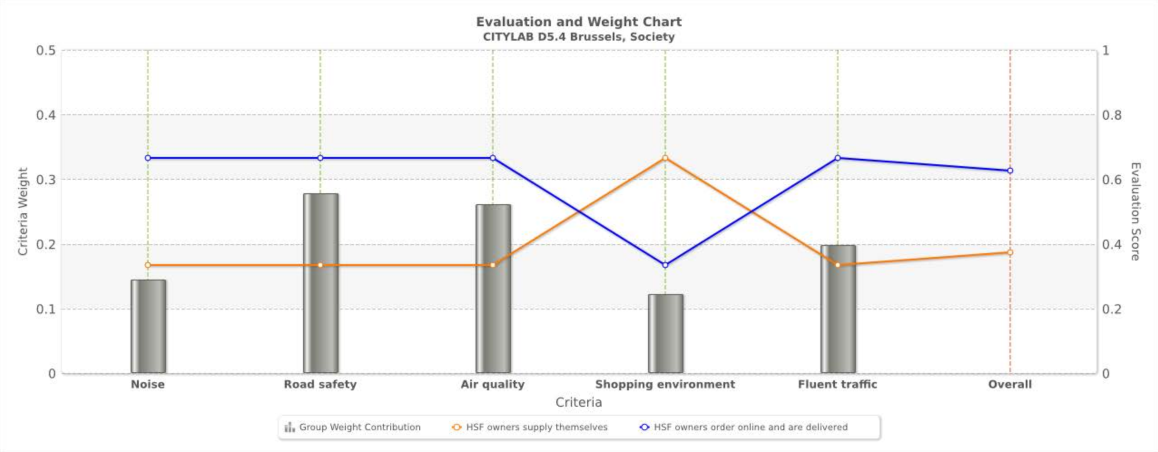
AHP EVAULUATIONS

		BAU or alternative?	Value?	Justification
Shipper				
	High quality pick-ups	Same score	1	Pick-ups are done from warehouse P&G. No change
	Low cost for transport	BAU	7	Excel template (Adoption - row 10): economic feasibility scores 2.5 on 1-7 Likert scale
	High quality deliveries	BAU	5	BAU: no deliveries, no service, HFS owner does his own pick-ups. Alternative: deliveries to the store, direct contact with HFS owner
	Positive effect on society	Alternative	3	Combined effect: road safety, air quality, fluent traffic and noise
Transport operator				
	Profitable operations	Alternative	4	No extra kilometres, extra revenues, no extra costs - to be confirmed by Febelco
	Viable investments	Same score	1	No investments needed - to be confirmed by Febelco
	High quality service	Alternative	3	Quality of service to pharmacies is the same as in BAU, quality of service to P&G is higher. Was P&G happy with the provided service?
	Satisfied employees	BAU	2	Complicated for drivers, less waiting time - to be confirmed by Febelco
	Positive effect on society	Alternative	3	Combined effect: road safety, air quality, fluent traffic and noise
Receiver				
	Low cost for receiving goods	Alternative	2	Spend less time in supermarket, ordering online during working hours in shop? D2.2: HFS owners expect that the solution will be more expensive, not confirmed by feedback P&G got from shop owners

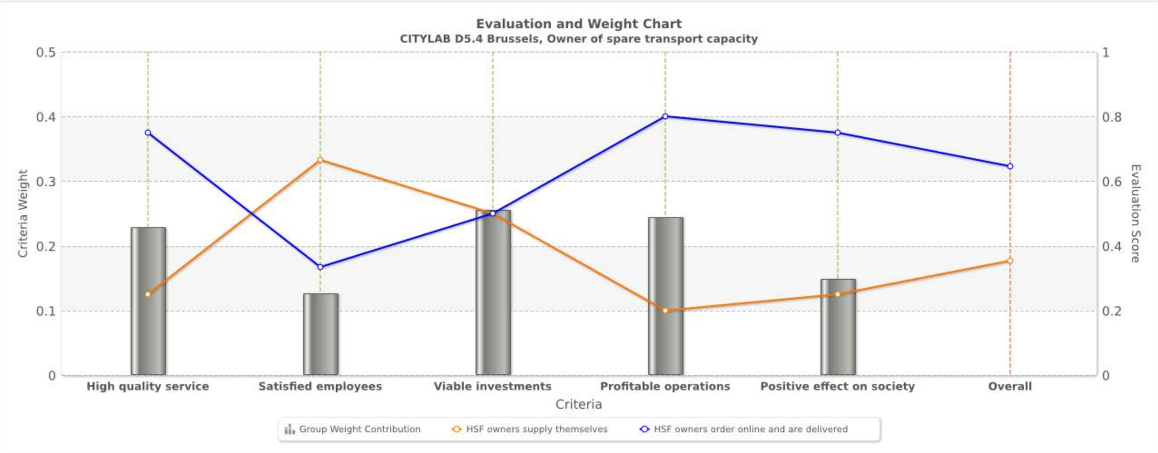
	High quality deliveries	BAU	8	Excel template (Adoption - row 6): adoption rate is very low. Input P&G: None of the participating store owners ordered a second time. Participating store owners indicated that deliveries are not convenient because of online ordering and online and upfront payment. D2.2: 15% of HFS owners interviewed ex-ante want to participate if purchased goods are cheaper, 15% of them do not want to pay prior to the delivery. 36% thinks the solution will be simple and efficient.
	Positive effect on society	Alternative	3	Combined effect: road safety, air quality, fluent traffic and noise
	Shopping environment	BAU	2	No justification in D5.3 or Excel template. More vehicles loading/unloading in front of shop (shop owner and Febelco)
Society				
	Shopping environment	BAU	2	No justification in D5.3 or Excel template. More vehicles loading/unloading in front of shop (shop owner and Febelco)
	Road safety	Alternative	2	No impact, same number of vehicles
	Air quality	Alternative	2	D5.3 (p. 28) and Excel template (Impact - row 9-20) - Reductions of 100%
	Fluent traffic	Alternative	2	Same number of vehicles: shop owners still go shopping in Colruyt and Febelco uses same number vehicles.
	Noise	Alternative	2	No impact, same number of vehicles


Evaluation and Weight Chart
CITYLAB D5.4 Brussels, HFS owner
Criteria Weight
Evaluation Score
Low cost for receiving goods
Positive effect on society
Shopping environment
High quality deliveries
Overall
Criteria
Group Weight Contribution
HSF owners supply themselves
HSF owners order online and are delivered


Evaluation and Weight Chart
CITYLAB D5.4 Brussels, P&G
Criteria Weight
Evaluation Score
Low cost for transport
Positive effect on society
High quality pick-ups
High quality deliveries
Overall
Criteria
Group Weight Contribution
HSF owners supply themselves
HSF owners order online and are delivered



Evaluation and Weight Chart
CITYLAB D5.4 Brussels, Society
Criteria Weight
Evaluation Score
0.5
0.4
0.3
0.2
0.1
0
1
0.8
0.6
0.4
0.2
0
Noise
Road safety
Air quality
Shopping environment
Fluent traffic
Overall
Criteria
Group Weight Contribution
HSF owners supply themselves
HSF owners order online and are delivered



Evaluation and Weight Chart
CITYLAB D5.4 Brussels, Owner of spare transport capacity
Criteria Weight
Evaluation Score
0.5
0.4
0.3
0.2
0.1
0
1
0.8
0.6
0.4
0.2
0
High quality service
Satisfied employees
Viable investments
Profitable operations
Positive effect on society
Overall
Criteria
Group Weight Contribution
HSF owners supply themselves
HSF owners order online and are delivered

ANNEX 3

BRIEF DESCRIPTION OF THE IMPLEMENTATION (< Excel Dashboard)

The main aim is to demonstrate and understand how to grow the business model of electric freight in urban logistics. The London implementation is run by a large parcel carrier specialised in B2B deliveries (TNT) and a small 'last-mile' carrier specialised in electric freight deliveries (Gnewt Cargo).

SCENARIO'S (< Excel Dashboard and D5.3)

BAU	20 routes of diesel van deliveries of TNT without Gnewt
ALTERNATIVE 1	Gnewt Electric van deliveries for 10 rounds international freight + 5 rounds for domestic freight deliveries
ALTERNATIVE 2	Allowing TNT deliveries to be consolidated with other deliveries in the same van route (20 routes)
ALTERNATIVE 3	Changing depot location, allowing all parcels from multiple clients to be served from a single depot (20 routes)

STAKEHOLDERS (< Excel Dashboard and D5.3)

	Stakeholder category
TNT UK	Shipper
Gnewt Cargo	Transport operator
Businesses receiving parcels	Receiver
Society	Society

AHP EVAULUATIONS

TRANSPORT OPERATOR - TNT

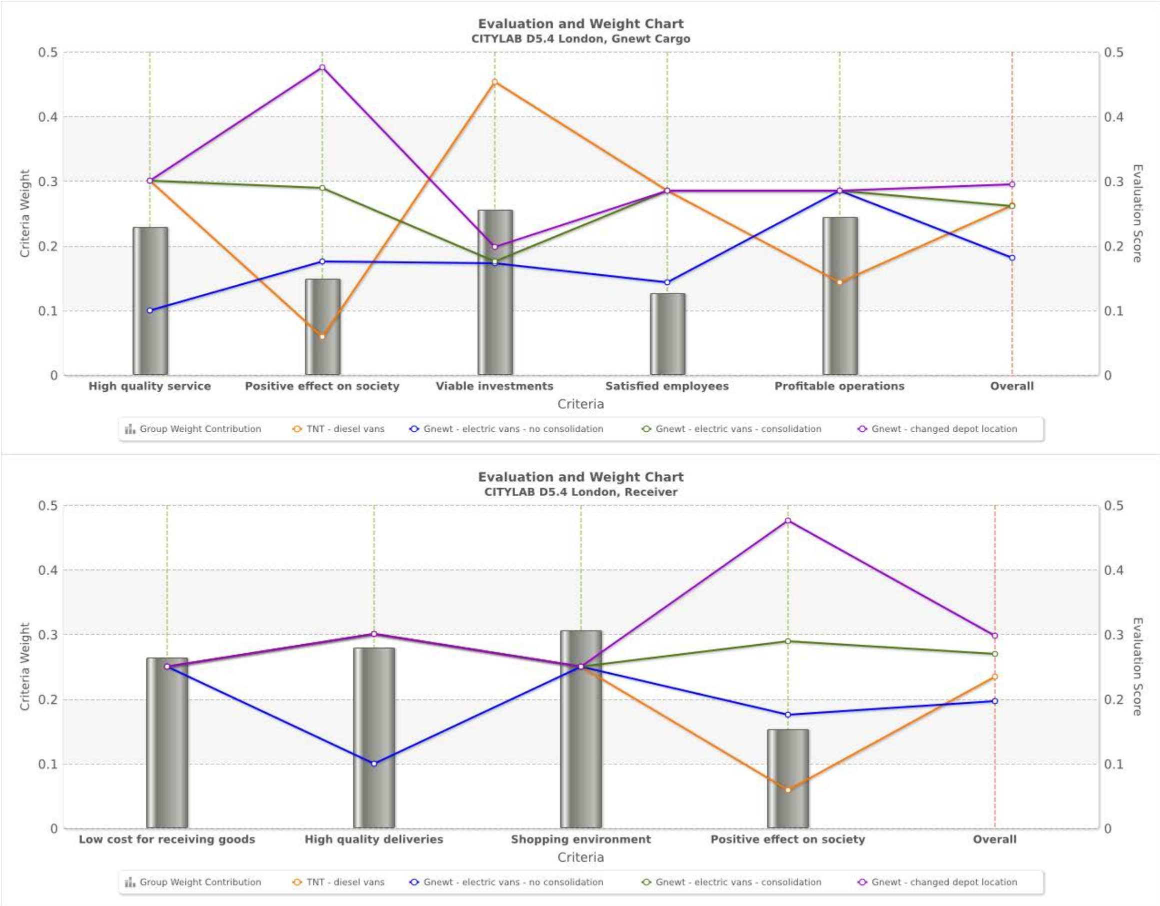
Profitable operations	BAU	Alternative 1	Alternative 2	Alternative 3	Justification
BAU		1	1	1	No impact. Excel template (Impact - row 22)
Alternative 1	1		1	1	
Alternative 2	1	1		1	
Alternative 3	1	1	1		
Viable investments	**BAU**	**Alternative 1**	**Alternative 2**	**Alternative 3**	No justification in D5.3. No justification in Excel template. Assumption that TNT's revenues remain the same, but their investment decreases in A1-A3.
BAU		1/4	1/4	1/4	
Alternative 1	4		1	1	
Alternative 2	4	1		1	
Alternative 3	4	1	1		
High quality service	**BAU**	**Alternative 1**	**Alternative 2**	**Alternative 3**	No justification in D5.3. Excel template (Impact - row 50): indication for satisfaction of clients TNT: worse in Alternative 1
BAU		3	1	1	
Alternative 1	1/3		1/3	1/3	
Alternative 2	1	3		1	
Alternative 3	1	3	1		
Satisfied employees	**BAU**	**Alternative 1**	**Alternative 2**	**Alternative 3**	No justification in D5.3. No justification in Excel template. Difficult to make an

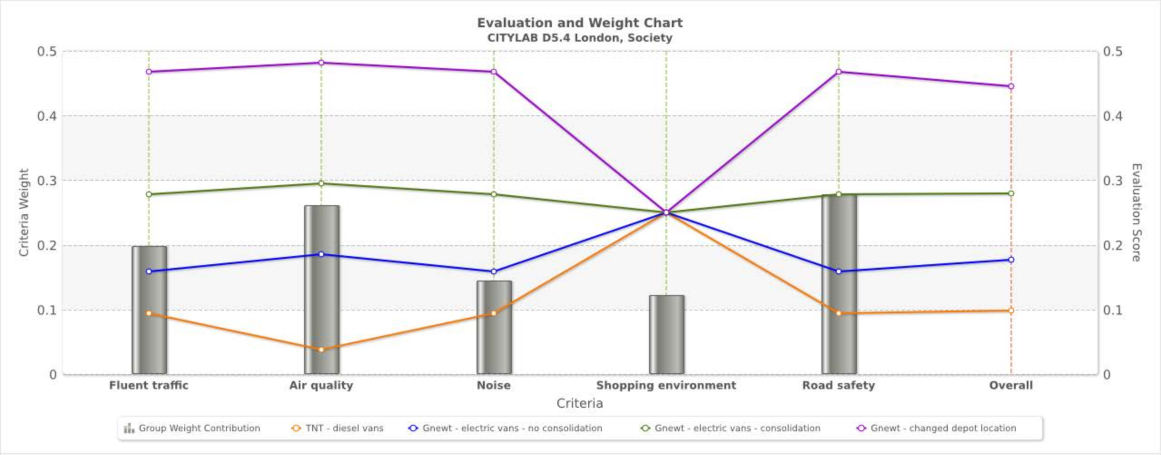
BAU		1	1	1	assumption which is why we will keep it equal. On the one hand, we could assume that TNT drivers will get another TNT delivery round. We could also assume that some of them will lose their job because TNT operations are outsourced. We could also assume that it gets better for them because they no longer have to drive into congested London.
Alternative 1	1		1	1	
Alternative 2	1	1		1	
Alternative 3	1	1	1		
Positive effect on society	BAU	Alternative 1	Alternative 2	Alternative 3	Combined effect: road safety, air quality, fluent traffic and noise
BAU		1/4	1/5	1/6	
Alternative 1	4		1/2	1/3	
Alternative 2	5	2		1/2	
Alternative 3	6	3	2		
TRANSPORT OPERATOR - GNEWT					
Profitable operations	BAU	Alternative 1	Alternative 2	Alternative 3	No justification in D.5.3. Excel template (Impact - row 23). Logistics operator is more profitable in alternative situations than in BAU since GNEWT did not have any business from TNT in BAU. Price paid by TNT suffices to cover the costs by GNEWT. Alternatives receive the same score.
BAU		1/2	1/2	1/2	
Alternative 1	2		1	1	
Alternative 2	2	1		1	
Alternative 3	2	1	1		
Viable investments	BAU	Alternative 1	Alternative 2	Alternative 3	No justification in D.5.3. Excel template (Impact - row 24). ROI is worse in A1 than in BAU (10%). No data for A2 and A3. We assume A2 is a bit better than A1 because of consolidation. A3 is a bit worse than A1 because of investment in new depot.
BAU		3	2	4	
Alternative 1	1/3		1/2	2	
Alternative 2	1/2	2		3	
Alternative 3	1/4	1/2	1/3		
High quality service	BAU	Alternative 1	Alternative 2	Alternative 3	No justification in D5.3. Excel template (Impact - row 50): indication for
BAU		3	1	1	
Alternative 1	1/3		1/3	1/3	

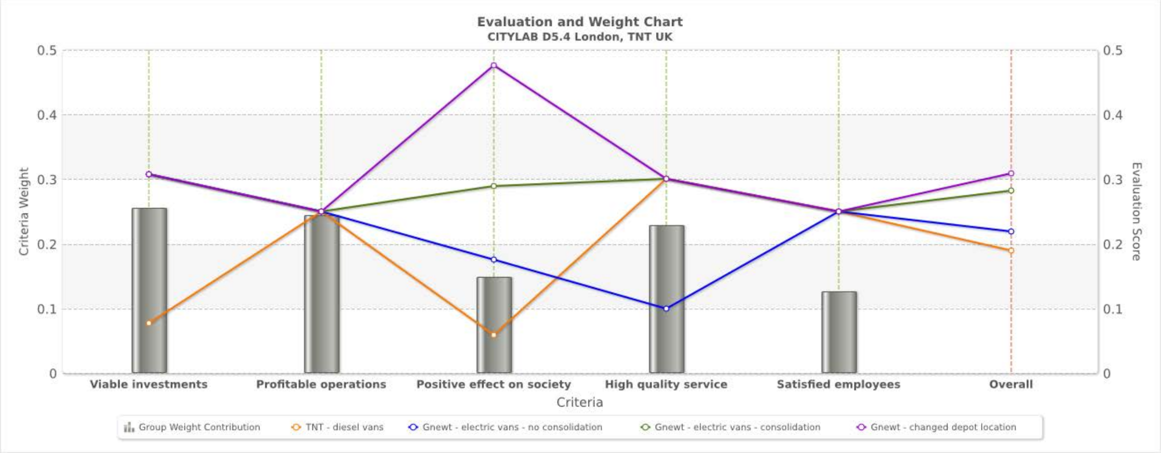
Alternative 2	1	3		1	satisfaction of clients TNT: worse in Alternative 1
Alternative 3	1	3	1		
Satisfied employees	BAU	Alternative 1	Alternative 2	Alternative 3	No justification in D5.3. Excel template (Impact - row 16): employee satisfaction is a bit worse in alternative 1 (score 4 on a scale of 1-5). BAU and other alternatives score 5. Scale 1 extermely disatisfied to 5 very satisfied. Drivers only
BAU		2	1	1	
Alternative 1	1/2		1/2	1/2	
Alternative 2	1	2		1	
Alternative 3	1	2	1		
Positive effect on society	BAU	Alternative 1	Alternative 2	Alternative 3	Combined effect: road safety, air quality, fluent traffic and noise
BAU		1/4	1/5	1/6	
Alternative 1	4		1/2	1/3	
Alternative 2	5	2		1/2	
Alternative 3	6	3	2		
RECEIVER					
Low cost for receiving goods	BAU	Alternative 1	Alternative 2	Alternative 3	Excel template (Impact - row 45) - The receiver does not pay Gnewt Cargo, TNT Express pays Gnewt. Clients of TNT Express won't charge their clients a different rate because deliveries are done through Gnewt Cargo.
BAU		1	1	1	
Alternative 1	1		1	1	
Alternative 2	1	1		1	
Alternative 3	1	1	1		
High quality deliveries	BAU	Alternative 1	Alternative 2	Alternative 3	No justification in D5.3. Excel template (Impact - row 50): indication for satisfaction of clients TNT: worse in Alternative 1
BAU		3	1	1	
Alternative 1	1/3		1/3	1/3	
Alternative 2	1	3		1	
Alternative 3	1	3	1		
Positive effect on society	BAU	Alternative 1	Alternative 2	Alternative 3	Combined effect: road safety, air quality, fluent traffic and noise
BAU		1/4	1/5	1/6	
Alternative 1	4		1/2	1/3	
Alternative 2	5	2		1/2	
Alternative 3	6	3	2		
Shopping environment	BAU	Alternative 1	Alternative 2	Alternative 3	No impact on physical shopping environment. No impact on goods availability.
BAU		1	1	1	
Alternative 1	1		1	1	
Alternative 2	1	1		1	
Alternative 3	1	1	1		
SOCIETY					

Shopping environment	BAU	Alternative 1	Alternative 2	Alternative 3	No impact on physical shopping environment. No impact on goods availability.
BAU		1	1	1	
Alternative 1	1		1	1	
Alternative 2	1	1		1	
Alternative 3	1	1	1		
Road safety	**BAU**	**Alternative 1**	**Alternative 2**	**Alternative 3**	Excel template (Impact - row 18) - No evidence of reduced accident rate when using smaller vehicles of 2.2t when compared to urban trucks of 7.5t. But decrease in number of kilometres per parcel (Impact - row 30) will improve traffic safety. Since alternatives 2 and 3 involve more consolidation, even fewer kms will be driven per parcel.
BAU		1/2	1/3	1/4	
Alternative 1	2		1/2	1/3	
Alternative 2	3	2		1/2	
Alternative 3	4	3	2		
Air quality	**BAU**	**Alternative 1**	**Alternative 2**	**Alternative 3**	D5.3 (p. 15) and Excel template (Impact - row 9-12) - Reductions of 100%. Diesel vans are entirely replaced by electric vans, and the TNT trucks are making no additional distance when delivering to Gnewt, compared to a delivery of the TNT depot. It is assumed the truck fuel use is therefore outside of the system of observations of Alternatives. Calculations in the Excel template state that alternatives 2 and 3 have the same impact on air quality as alternative 1. Calculations do not take into account energy savings through consolidation. That is why this analysis scores alternatives 2 and 3 better than 1.
BAU		1/7	1/8	1/9	
Alternative 1	7		1/2	1/3	
Alternative 2	8	2		1/2	
Alternative 3	9	3	2		

Fluent traffic	BAU	Alternative 1	Alternative 2	Alternative 3	Excel template (Impact - row 30) - In BAU, 0.82 kms are driven per shipment, in the alternatives, 0.267 kms are driven per shipment. Reduction in kms will have a positive impact on congestion. Same line of reasoning as for air quality. Since alternatives 2 and 3 involve more consolidation, even fewer kms will be driven per parcel.
BAU		1/2	1/3	1/4	
Alternative 1	2		1/2	1/3	
Alternative 2	3	2		1/2	
Alternative 3	4	3	2		
Noise	BAU	Alternative 1	Alternative 2	Alternative 3	Excel template (Impact - row 13) - 20 vehicle trial cannot change the noise level of traffic in London. Electric vehicle is only low noise for motor noise, not for onboard equipment or driver behaviour noise. To be in line with the other assessments: we will take into account a positive impact on noise because of the use of electric vehicles
BAU		1/2	1/3	1/4	
Alternative 1	2		1/2	1/3	
Alternative 2	3	2		1/2	
Alternative 3	4	3	2		


Evaluation and Weight Chart
CITYLAB D5.4 London, Gnewt Cargo
Criteria Weight
Evaluation Score
High quality service
Positive effect on society
Viable investments
Satisfied employees
Profitable operations
Overall
Criteria
Group Weight Contribution
TNT - diesel vans
Gnewt - electric vans - no consolidation
Gnewt - electric vans - consolidation
Gnewt - changed depot location
Evaluation and Weight Chart
CITYLAB D5.4 London, Receiver
Criteria Weight
Evaluation Score
Low cost for receiving goods
High quality deliveries
Shopping environment
Positive effect on society
Overall
Criteria
Group Weight Contribution
TNT - diesel vans
Gnewt - electric vans - no consolidation
Gnewt - electric vans - consolidation
Gnewt - changed depot location


Evaluation and Weight Chart
CITYLAB D5.4 London, Society
Criteria Weight
Evaluation Score
Fluent traffic
Air quality
Noise
Shopping environment
Road safety
Overall
Criteria
Group Weight Contribution
TNT - diesel vans
Gnewt - electric vans - no consolidation
Gnewt - electric vans - consolidation
Gnewt - changed depot location


Evaluation and Weight Chart
CITYLAB D5.4 London, TNT UK
Criteria Weight
Evaluation Score
Viable investments
Profitable operations
Positive effect on society
High quality service
Satisfied employees
Overall
Criteria
Group Weight Contribution
TNT - diesel vans
Gnewt - electric vans - no consolidation
Gnewt - electric vans - consolidation
Gnewt - changed depot location

ANNEX 4

BRIEF DESCRIPTION OF THE IMPLEMENTATION (< Excel Dashboard)

The aim is to identify consolidation opportunities for logistics service providers and off-hour deliveries when decoupling the transport leg and in-house transport leg. Steen & Strøm' seek common functions for in- and outbound freight flows to reduce truck stoppage times and increase in-house logistics efficiency at Økern shopping centre.

SCENARIO'S (< Excel Dashboard and D5.3)

BAU	No common logistics function (Strømen)
ALTERNATIVE 1	Staffed goods receipt - voluntary use - own pick-up from reception area or paid delivery to store (Strømen) - goods and waste are handled by the service provider
ALTERNATIVE 2	Staffed goods receipt - compulsory use - paying service - deliveries to store (Emporia) - goods and waste are handled by the service provider

STAKEHOLDERS (< Excel Dashboard and D5.3)

	Stakeholder category
Owner shopping centre	Shopping centre
Retailer (= tenant shopping centre)	Receiver
LSP (delivering to the shopping centre)	Transport operator
Society	Society
Sender of goods?	Shipper

AHP EVAULUATIONS

SHIPPER

High quality pick-ups	BAU	Alternative 1	Alternative 2	Justification
BAU		1	1	No impact - pick-ups are done by the LSP, common logistics functions in a shopping centre do not impact this
Alternative 1	1		1	
Alternative 2	1	1		

Low cost for transport	BAU	Alternative 1	Alternative 2	Justification
BAU		1	1	In both alternatives, LSPs do not have to pay for the common logistics function in the shopping centre. LSPs do experience considerable time gains which means there is a reduced cost per delivered item (D5.3, p. 46). That could reduce the price charged to the LSP in the future, but this was not the case in both alternatives.
Alternative 1	1		1	
Alternative 2	1	1		

High quality deliveries	BAU	Alternative 1	Alternative 2	Justification
BAU		1/5	1/5	Alternative 1: 70% of shop owners or shop employees are very satisfied with the solution. 15% are well satisfied and 15% are satisfied (Impact - row 16). 54% want to continue with the solution, 23% want to continue but to fear the cost once they would have to pay themselves (Impact row - 16). It means that 77% is satisfied with the deleveries. 15% wants to go back to how it was and 8% does not know

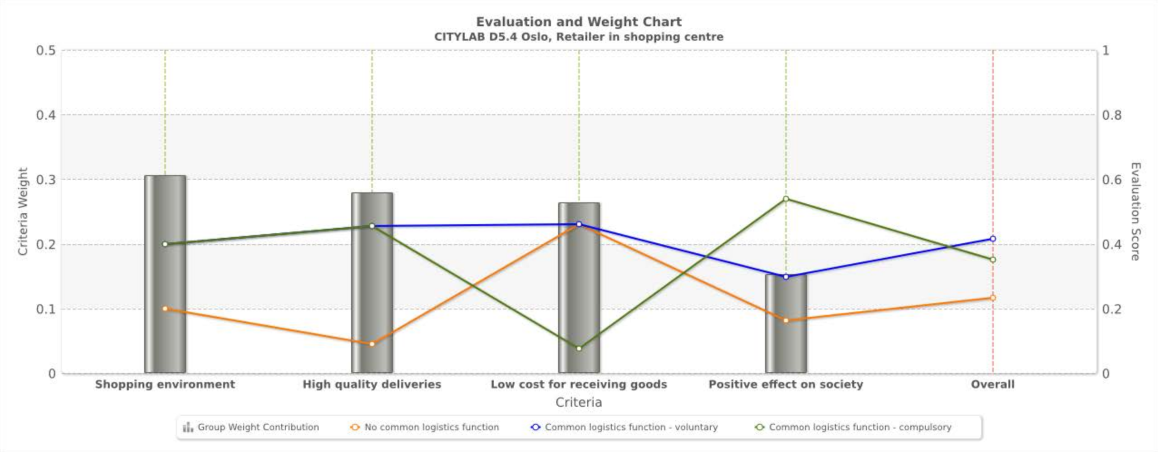
Alternative 1	5		1	(Impact - row 16). Alternative 1 is considerably better than BAU. Most goods are delivered to stores straight away and not stored in the storage facility => option to store goods is not used (D5.3, p. 44). Alternative 2: 7/9 stores interviewed are satisfied with the current solution (Impact - row 26 and p. 49 in D5.3). That is about 77% that is satisfied with the deliveries (comparable to alternative 1)
Alternative 2	5	1		
Positive effect on society	BAU	Alternative 1	Alternative 2	Combined effect: road safety, air quality, fluent traffic and noise
BAU		1/2	1/3	
Alternative 1	2		1/2	
Alternative 2	3	2		
TRANSPORT OPERATOR				
Profitable operations	BAU	Alternative 1	Alternative 2	BAU: deliveries from 10 am (D5.3, p. 50), on average 15 minutes per delivery (Impact - row 26) - performing last mile delivery to the customer (D5.3 - p. 46) - waiting time: mostly in peak hours (Impact - row 36) Alternative 1: on average 2 to 3 minutes per delivery (Impact - row 26 and 34) - revenue loss of not performing the last mile delivery to the customer (D5.3 - p. 46) - waiting time: a short wait (Impact - row 36) Alternative 2: on average 2 minutes per delivery (Impact - row 34) - revenue loss of not performing the last mile delivery to the customer (D5.3 - p. 46) - waiting time: can occur at busy times in the day and range from 15-30 minutes (Impact - row 36)
BAU		1/6	1/5	
Alternative 1	6		2	
Alternative 2	5	1/2		
Viable investments	BAU	Alternative 1	Alternative 2	Alternatives 1 and 2: transport operators do not have to invest in the solution, they only get the benefits. ROI is in line with the scores for profitable operations (see above).
BAU		1/6	1/5	
Alternative 1	6		2	
Alternative 2	5	1/2		
High quality service	BAU	Alternative 1	Alternative 2	Alternative 1: 70% of shop owners or shop employees are very satisfied with the solution. 15% are well satisfied and 15% are satisfied (Impact - row 16). 54% want to continue with the

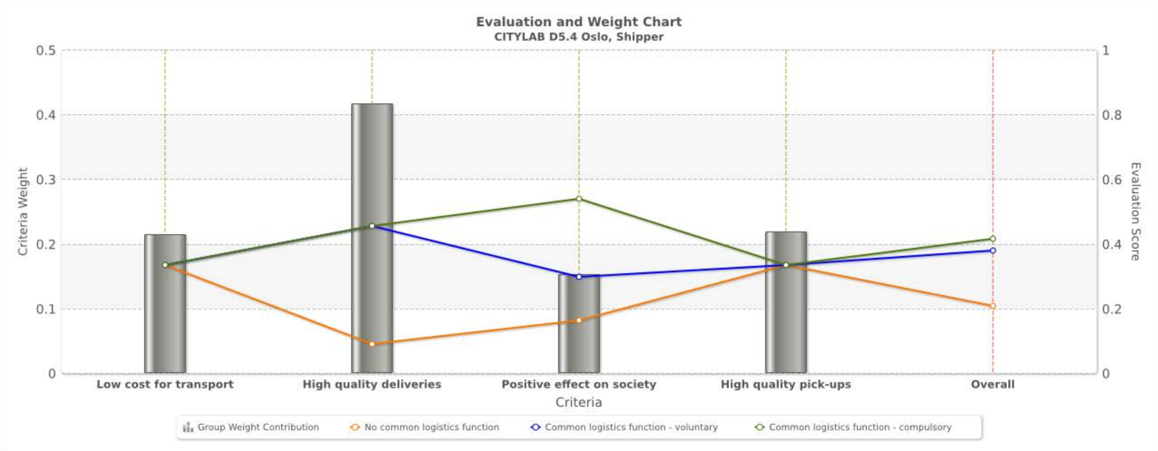
BAU		1/5	1/5	solution, 23% want to continue but to fear the cost once they would have to pay themselves (Impact row - 16). It means that 77% is satisfied with the delveries. 15% wants to go back to how it was and 8% does not know (Impact - row 16). Alternative 1 is considerably better than BAU. Most goods are delivered to stores straight away and not stored in the storage facility => option to store goods is not used (D5.3, p. 44). Alternative 2: 7/9 stores interviewed are satisfied with the current solution (Impact - row 26 and p. 49 in D5.3). That is about 77% that is satisfied with the deliveries (comparable to alternative 1)
Alternative 1	5		1	
Alternative 2	5	1		
Satisfied employees	BAU	Alternative 1	Alternative 2	No info on BAU, waiting time: mostly in peak hours (Impact - row 36) Alternative 1: 66% of drivers are very satisfied, 34% are well pleased (Impact - row 16), waiting time: a short wait (Impact - row 36) Alternative 2: drivers are satisfied with the solution (Impact - row 16), waiting time: can occur at busi times in the day and range from 15-30 minutes (Impact - row 36) Alternatives: some drivers are self-employed and are paid per delivery. To them, the alternative solution is much better than BAU (Impact - row 16), but we should not take that into account for criterion satisfied employees. We assume that employees of the transport operator prefer the alternatives, they do not have to go into the shopping centre (among shopping people) to do deliveries.
BAU		1/7	1/5	
Alternative 1	7		3	
Alternative 2	5	1/3		
Positive effect on society	BAU	Alternative 1	Alternative 2	Combined effect: road safety, air quality, fluent traffic and noise
BAU		1/2	1/3	
Alternative 1	2		1/2	
Alternative 2	3	2		
RECEIVER				
Low cost for receiving goods	BAU	Alternative 1	Alternative 2	BAU: costs for received items to the shops are included in the total logistics cost Alternative 1: Shopping centre
BAU		1	6	

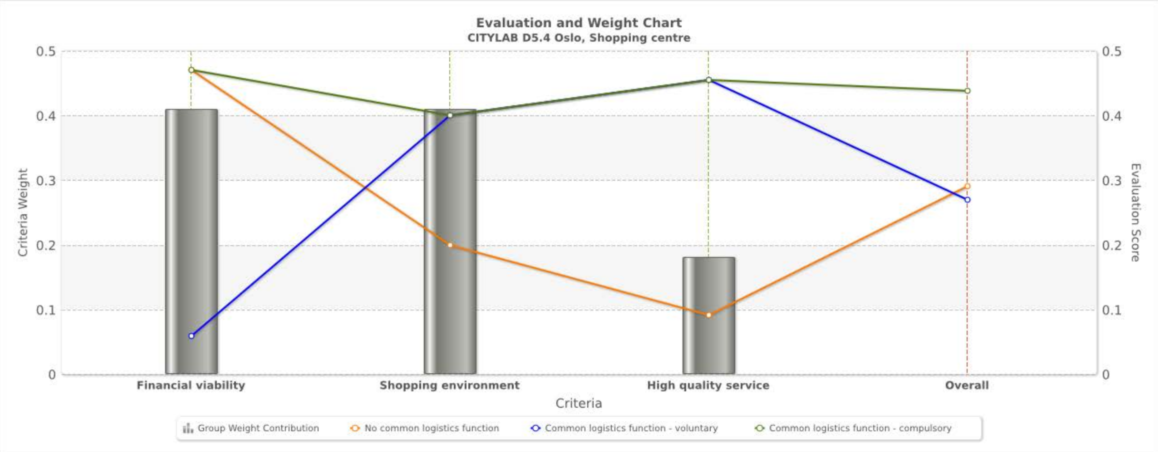
Alternative 1	1		6	management pays for the service (D5.3 - p. 47, Impact - row 21) Alternative 2: Retailer pays for the service - 5.15€ per item (D5.3 - p. 47, Impact - row 21)
Alternative 2	1/6	1/6		
High quality deliveries	BAU	Alternative 1	Alternative 2	Alternative 1: 70% of shop owners or shop employees are very satisfied with the solution. 15% are well satisfied and 15% are satisfied (Impact - row 16). 54% want to continue with the solution, 23% want to continue but to fear the cost once they would have to pay themselves (Impact row - 16). It means that 77% is satisfied with the deliveries. 15% wants to go back to how it was and 8% does not know (Impact - row 16). Alternative 1 is considerably better than BAU. Most goods are delivered to stores straight away and not stored in the storage facility => option to store goods is not used (D5.3, p. 44). Alternative 2: 7/9 stores interviewed are satisfied with the current solution (Impact - row 26 and p. 49 in D5.3). That is about 77% that is satisfied with the deliveries (comparable to alternative 1)
BAU		1/5	1/5	
Alternative 1	5		1	
Alternative 2	5	1		
Positive effect on society	BAU	Alternative 1	Alternative 2	Combined effect: road safety, air quality, fluent traffic and noise
BAU		1/2	1/3	
Alternative 1	2		1/2	
Alternative 2	3	2		
Shopping environment	BAU	Alternative 1	Alternative 2	BAU: drivers of various transport companies are carrying goods inside the shopping centre Alternatives: 1 service provider does the in-house logistics. Not mentioned as an impacted criterion in D5.3 (p. 48 - Figure 14 and Figure 16). D5.3, p. 51: many of the stores are satisfied with the service for the drivers and see no reason to change the current solution. D5.3, p. 46: saved costs on wear and tear of inventory => less damage to elevators etc. and 'satisfied shopping customers'
BAU		1/2	1/2	
Alternative 1	2		1	
Alternative 2	2	1		
SOCIETY				
Shopping environment	BAU	Alternative 1	Alternative 2	BAU: drivers of various transport companies are carrying goods inside the shopping centre

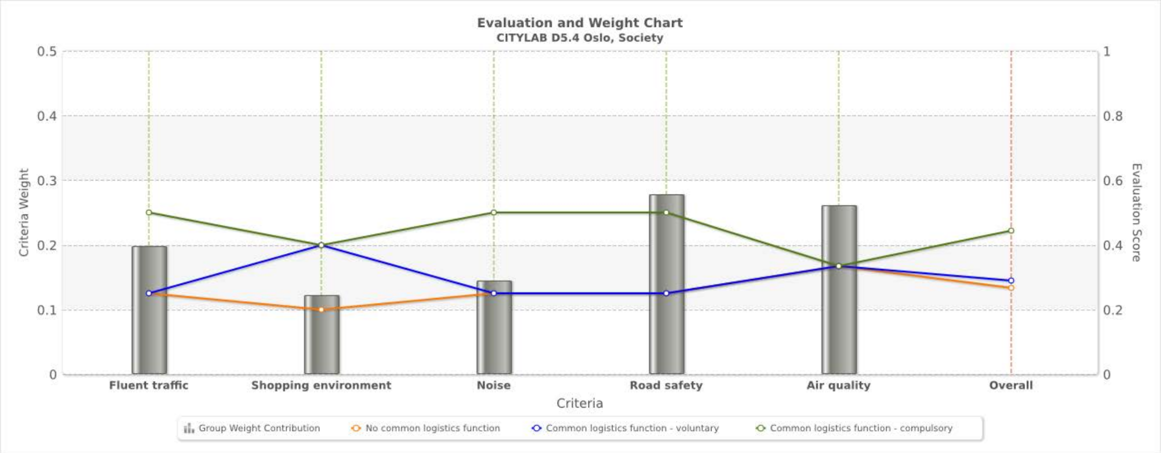
BAU		1/2	1/2	Alternatives: 1 service provider does the in-house logistics. Not mentioned as an impacted criterion in D5.3 (p. 48 - Figure 14 and Figure 16). D5.3, p. 51: many of the stores are satisfied with the service for the drivers and see no reason to change the current solution. D5.3, p. 46: saved costs on wear and tear of inventory => less damage to elevators etc. and 'satisfied shopping customers'
Alternative 1	2		1	
Alternative 2	2	1		
Road safety	BAU	Alternative 1	Alternative 2	Alternative 2: less kilometres because of centralised waste collection (Impact - row 9-12) => positive impact on traffic safety
BAU		1	1/2	
Alternative 1	1		1/2	
Alternative 2	2	2		
Air quality	BAU	Alternative 1	Alternative 2	Alternative 1: limited impact because freight vehicles do not start with a cold engine (Impact - row 9-12) Alternative 2: less kilometres because of centralised waste collection (Impact - row 9-12) and limited impact because freight vehicles do not start with a cold engine (Impact - row 9-12)
BAU		1/2	1/3	
Alternative 1	2		1/2	
Alternative 2	3	2		
Fluent traffic	BAU	Alternative 1	Alternative 2	Alternative 2: less kilometres because of centralised waste collection (Impact - row 9-12)
BAU		1	1/2	
Alternative 1	1		1/2	
Alternative 2	2	2		
Noise	BAU	Alternative 1	Alternative 2	Alternative 2: less kilometres because of centralised waste collection (Impact - row 9-12)
BAU		1	1/2	
Alternative 1	1		1/2	
Alternative 2	2	2		
SHOPPING CENTRE				
Financial viability	BAU	Alternative 1	Alternative 2	BAU: costs for received items to the shops are included in the total logistics cost, cost on wear and tear of inventory (D5.3 - p. 46) Alternative 1: Shopping centre management pays for the service (D5.3 - p. 47, Impact - row 21), they receive rent for buffer storage (Impact - row 22) but not enough to cover the cost for providing the service. Alternative 2: Retailer pays for the service - 5.15€ per item (D5.3 - p. 47, Impact - row 21). The invoice of the service provider is sent to the retailer
BAU		8	1	
Alternative 1	1/8		1/8	
Alternative 2	1	8		
Shopping environment	BAU	Alternative 1	Alternative 2	BAU: drivers of various transport companies are carrying goods inside the shopping centre

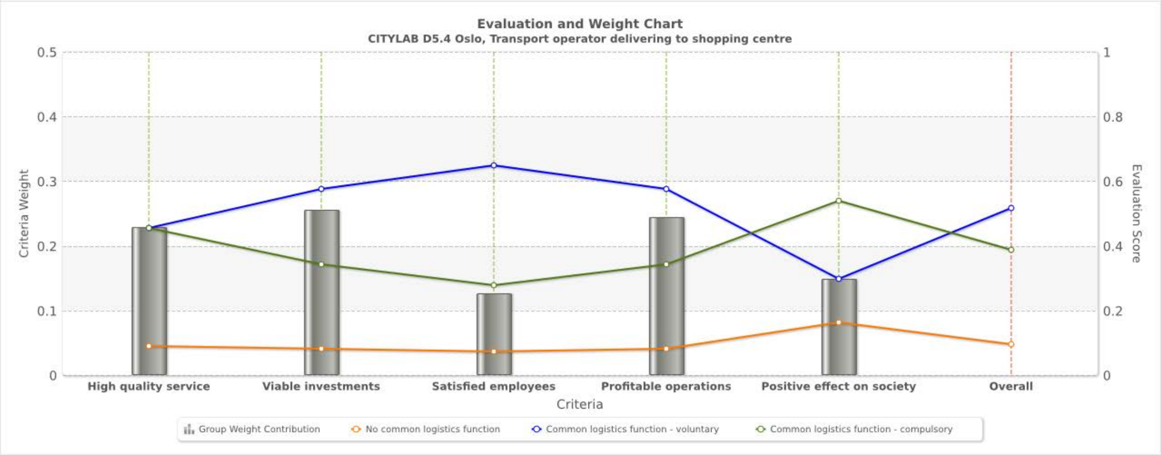
BAU		1/2	1/2	Alternatives: 1 service provider does the in-house logistics. Not mentioned as an impacted criterion in D5.3 (p. 48 - Figure 14 and Figure 16). D5.3, p. 51: many of the stores are satisfied with the service for the drivers and see no reason to change the current solution. D5.3, p. 46: saved costs on wear and tear of inventory => less damage to elevators etc. and 'satisfied shopping customers'
Alternative 1	2		1	
Alternative 2	2	1		
High quality deliveries	BAU	Alternative 1	Alternative 2	Alternative 1: 70% of shop owners or shop employees are very satisfied with the solution. 15% are well satisfied and 15% are satisfied (Impact - row 16). 54% want to continue with the solution, 23% want to continue but to fear the cost once they would have to pay themselves (Impact row - 16). It means that 77% is satisfied with the deliveries. 15% wants to go back to how it was and 8% does not know (Impact - row 16). Alternative 1 is considerably better than BAU. Most goods are delivered to stores straight away and not stored in the storage facility => option to store goods is not used (D5.3, p. 44). Alternative 2: 7/9 stores interviewed are satisfied with the current solution (Impact - row 26 and p. 49 in D5.3). That is about 77% that is satisfied with the deliveries (comparable to alternative 1)
BAU		1/5	1/5	
Alternative 1	5		1	
Alternative 2	5	1		


Evaluation and Weight Chart
CITYLAB D5.4 Oslo, Retailer in shopping centre
Criteria Weight
Evaluation Score
Shopping environment
High quality deliveries
Low cost for receiving goods
Positive effect on society
Overall
Criteria
Group Weight Contribution
No common logistics function
Common logistics function - voluntary
Common logistics function - compulsory


Evaluation and Weight Chart
CITYLAB D5.4 Oslo, Shipper
Criteria Weight
Evaluation Score
Low cost for transport
High quality deliveries
Positive effect on society
High quality pick-ups
Overall
Criteria
Group Weight Contribution
No common logistics function
Common logistics function - voluntary
Common logistics function - compulsory


Evaluation and Weight Chart
CITYLAB D5.4 Oslo, Shopping centre
Criteria Weight
Evaluation Score
Financial viability
Shopping environment
High quality service
Overall
Criteria
Group Weight Contribution
No common logistics function
Common logistics function - voluntary
Common logistics function - compulsory


Evaluation and Weight Chart
CITYLAB D5.4 Oslo, Society
Criteria Weight
Evaluation Score
Fluent traffic
Shopping environment
Noise
Road safety
Air quality
Overall
Criteria
Group Weight Contribution
No common logistics function
Common logistics function - voluntary
Common logistics function - compulsory


Evaluation and Weight Chart
CITYLAB D5.4 Oslo, Transport operator delivering to shopping centre
Criteria Weight
Evaluation Score
High quality service
Viable investments
Satisfied employees
Profitable operations
Positive effect on society
Overall
Criteria
Group Weight Contribution
No common logistics function
Common logistics function - voluntary
Common logistics function - compulsory

ANNEX 5

BRIEF DESCRIPTION OF THE IMPLEMENTATION (< Excel Dashboard)

"Logistics hotels" are a key element of the City of Paris' strategy to reintroduce logistics activity in the dense urban area. The Beaugrenelle Urban Districution Space was transformed from an old parking. It is operated by express parcel integrator Chronopost and handles 6.500 parcels per day.

SCENARIO'S (< Excel Dashboard and D5.3)

BAU	Chronopost deliveries and pick-ups in the 15th arrondissement of Paris are done from the Chronopost distribution centre of Chilly-Mazarin
ALTERNATIVE 1	Chronopost deliveries and pick-ups in the 15th arrondissement of Paris are done from the Beaugrenelle Urban Distribution Space. Fleet: 10 electric vans and 30 diesel vans. Transport between Chilly-Mazarin and Beaugrenelle is done by truck.

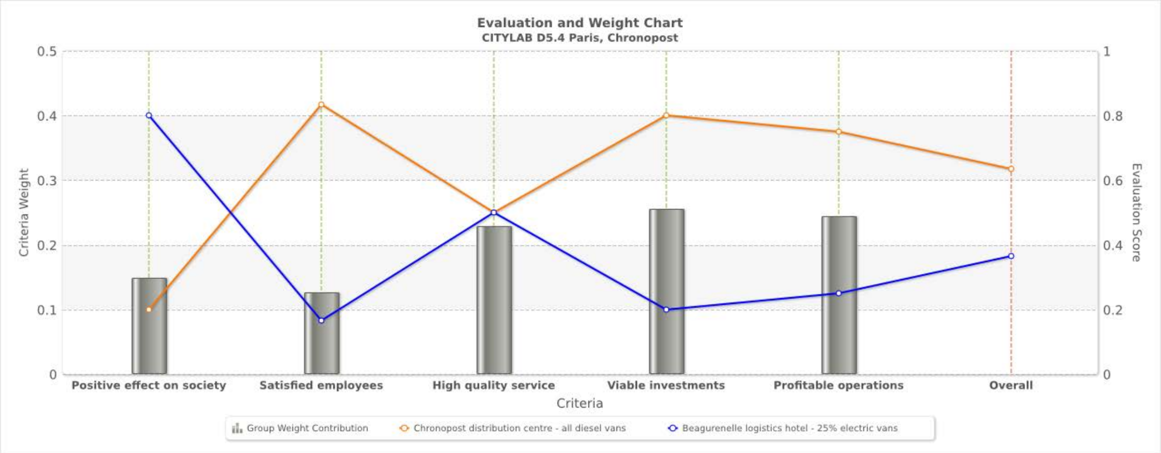
STAKEHOLDERS (< Excel Dashboard and D5.3)

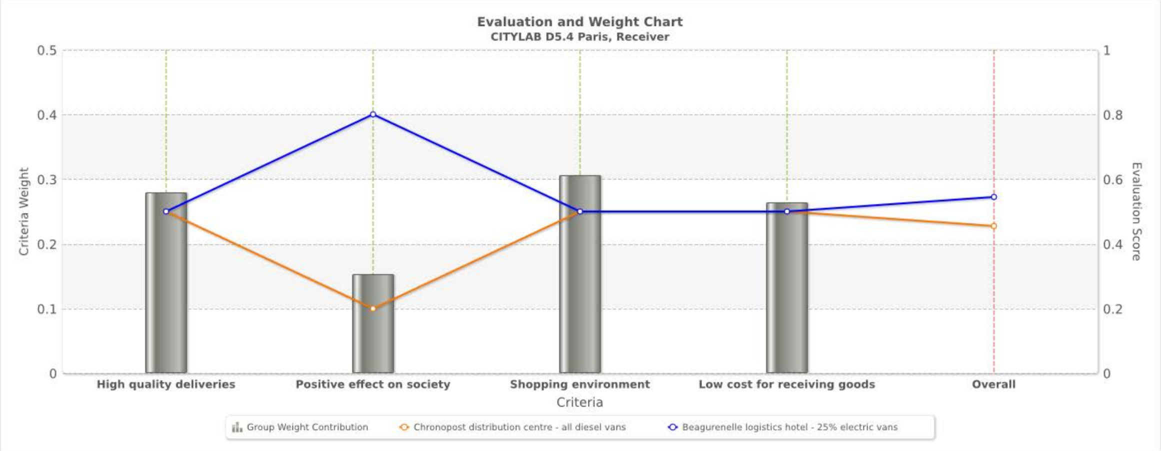
	Stakeholder category
Businesses sending parcels	Shipper
Chronopost	Transport operator
Businesses receiving parcels	Receiver
Society	Society

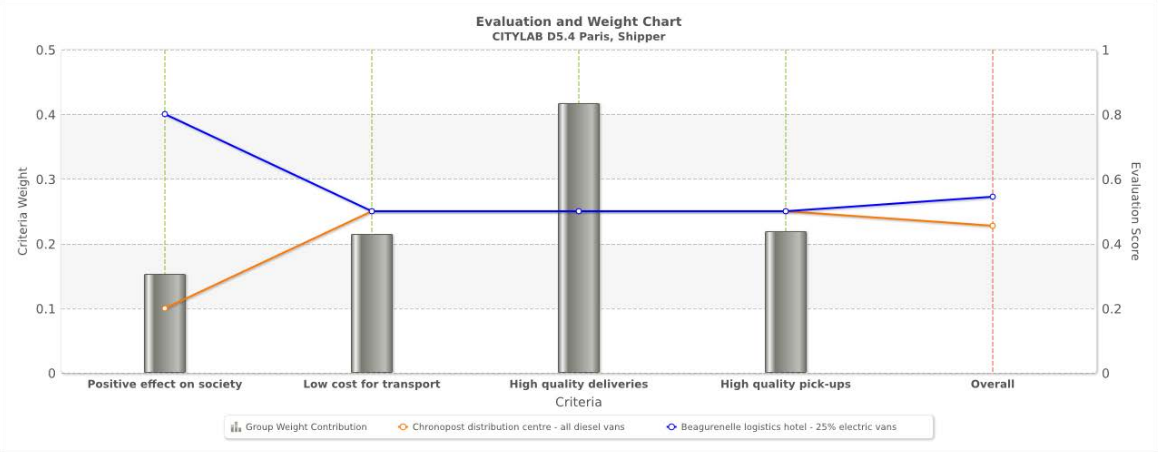
AHP EVAULUATIONS

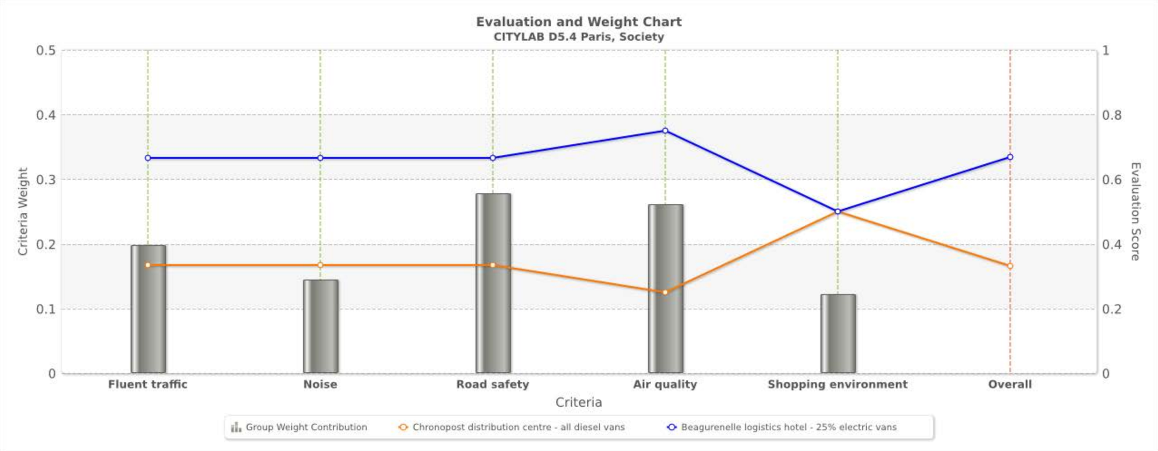
		BAU or alternative?	Value?	Justification
Shipper				
	High quality pick-ups	Same score	1	Excel template (Impact - row 26) - Evaluation shows a very low rate of failed delivery/pick-up. Similar to BAU.
	Low cost for transport	Same score	1	Excel template (Impact - row 46) - No data available. Experience from other projects: cost remains the same since Chronopost only charges one rate to their clients which does not depend on how they pick-up the goods
	High quality deliveries	Same score	1	Excel template (Impact - row 26) - Evaluation shows a very low rate of failed delivery/pick-up. Similar to BAU.
	Positive effect on society	Alternative	4	Combined effect: road safety, air quality, fluent traffic and noise
Transport operator				
	Profitable operations	BAU	3	No data available in Excel template. D5.3, p. 74: "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". On the other hand, they stick to the solution of using Beaugrenelle, so they assess that it would be profitable if they would use a different type of vehicle.
	Viable investments	BAU	4	No justification in D5.3. No justification in Excel template. Assumption that Chronoposts' revenues remain the same, but their investment cost is lower in BAU: they do not have to rent an additional warehouse and they do not have to invest in electric vehicles.
	High quality service	Same score	1	Excel template (Impact - row 26) - Evaluation shows a very low rate of failed delivery/pick-up. Similar to BAU.

	Satisfied employees	BAU	5	Excel template (Impact - row 16) - Employee satifsfaction socres 6, no value for BAU yet. Feedback from project partners: employees do not like the alternative because they cannot take the delivery vehicle home. After working hours, the vehicle goes back to the Beaugrenelle warehouse for recharging which means employees have to find another means of transport to commute.
	Positive effect on society	Alternative	4	Combined effect: road safety, air quality, fluent traffic and noise
Receiver				
	Low cost for receiving goods	Same score	1	Excel template (Impact - row 45) - No data available. Experience from other projects: Courier, Express and Parcel businesses do not charge the receiver, but their client (the shipper). The shipper can include the delivery cost in his prize or can charge a delivery cost. Since Chronopost only charges one rate to their clients (which does not depend on how they pick-up the goods), the shipper also will not make a distinction based on how deliveries are done.
	High quality deliveries	Same score	1	Excel template (Impact - row 26) - Evaluation shows a very low rate of failed delivery/pick-up. Similar to BAU.
	Positive effect on society	Alternative	4	Combined effect: road safety, air quality, fluent traffic and noise
	Shopping environment	Same score	1	No impact on physical shopping environment. No impact on goods availability.
Society				
	Shopping environment	Same score	1	No impact on physical shopping environment. No impact on goods availability.
	Road safety	Alternative	2	Excel template (Impact - row 42) - No data available. Assumption: decrease in the number of kilometres between Chilly-Mazarin and the 15th arrondissement => decrease in number of accidents.
	Air quality	Alternative	3	Excel template (Impact - row 10-12) - reductions around 50%
	Fluent traffic	Alternative	2	Excel template (Impact - row 42) - No data available. Assumption: decrease in the number of kilometres between Chilly-Mazarin and the 15th arrondissement => decrease in number of accidents.
	Noise	Alternative	2	Excel template (Impact - rows 13-14). 8% of the fleet is electric => 8% noise reduction


Evaluation and Weight Chart
CITYLAB D5.4 Paris, Chronopost
Criteria Weight
Evaluation Score
Positive effect on society
Satisfied employees
High quality service
Viable investments
Profitable operations
Overall
Criteria
Group Weight Contribution
Chronopost distribution centre - all diesel vans
Beagurenelle logistics hotel - 25% electric vans


Evaluation and Weight Chart
CITYLAB D5.4 Paris, Receiver
Criteria Weight
Evaluation Score
High quality deliveries
Positive effect on society
Shopping environment
Low cost for receiving goods
Overall
Criteria
Group Weight Contribution
Chronopost distribution centre - all diesel vans
Beagurenelle logistics hotel - 25% electric vans


Evaluation and Weight Chart
CITYLAB D5.4 Paris, Shipper
Criteria Weight
Evaluation Score
Positive effect on society
Low cost for transport
High quality deliveries
High quality pick-ups
Overall
Criteria
Group Weight Contribution
Chronopost distribution centre - all diesel vans
Beagurenelle logistics hotel - 25% electric vans


Evaluation and Weight Chart
CITYLAB D5.4 Paris, Society
Criteria Weight
Evaluation Score
Fluent traffic
Noise
Road safety
Air quality
Shopping environment
Overall
Criteria
Group Weight Contribution
Chronopost distribution centre - all diesel vans
Beagurenelle logistics hotel - 25% electric vans

ANNEX 6

BRIEF DESCRIPTION OF THE IMPLEMENTATION (< Excel Dashboard)

The solution foresees an innovative system for integrating direct and reverse logistic flows (i.e. clean waste) in the urban area thanks to the involvement of the national postal operator. The aim is to increase the amount of recycled materials (i.e. plastic caps collected at the University of Roma Tre) while also minimizing the amount of CO2 transport-related emissions.

SCENARIO'S (< Excel Dashboard and D5.3)

BAU	Ad-hoc trips for pick-up of plastic caps for recycling
ALTERNATIVE 1	Trips for pick-ups of plastic caps for recycling are integrated in delivery trips of Poste Italiane (by means of electric vehicles)

STAKEHOLDERS (< Excel Dashboard and D5.3)

City of Rome

Poste Italiane

MeWare: technology enabler. For them the new solution is always better, since they have new business. Technology enabler is therefore not considered as a stakeholder.

University of Roma Tre: shipper and receiver (caps are transported from other departments to the rectorate, transport from rectorate to recycling service remains the same)

CSU (company responsible for providing the concierge service at UR3: as stakeholder included in University of Roma Tre => also include whether the solution is feasible for him/her

UR3 mobility manager: as stakeholder included in University of Roma Tre

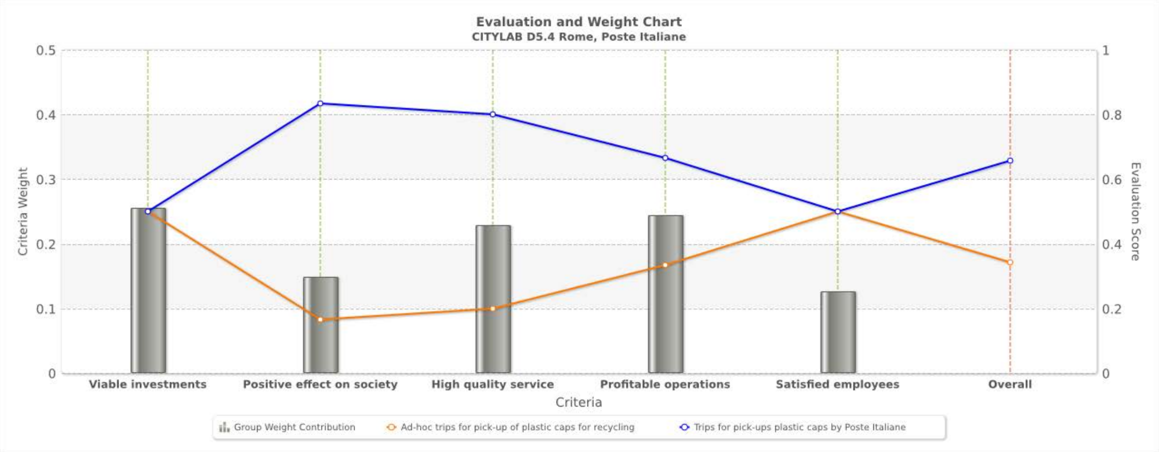
UR3 students, teaching and administrative staff: from D5.3: "STA is the actor responsible for the success of the recycling initiative. In fact, they have been consulted in the planning phase via specific surveys to acquire relevant information needed to define the most appropriate recycling system to foster their participation". It means that they are not a stakeholder in the logistics solution.

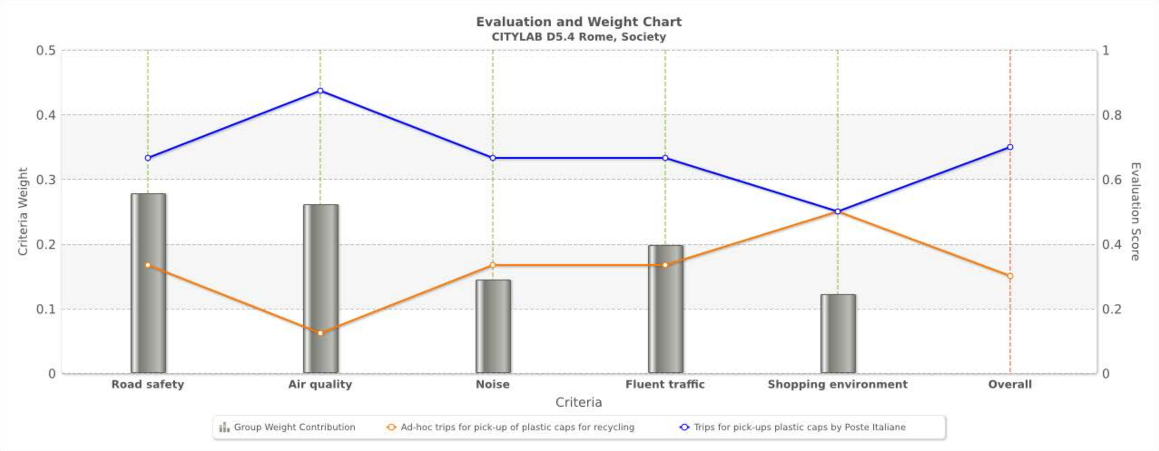
	Stakeholder category
Society	Society
University of Roma Tre (UR3)	Shipper and receiver (caps are transported from other departments to the rectorate, transport from rectorate to recycling service remains the same)
Poste Italiane	Transport operator

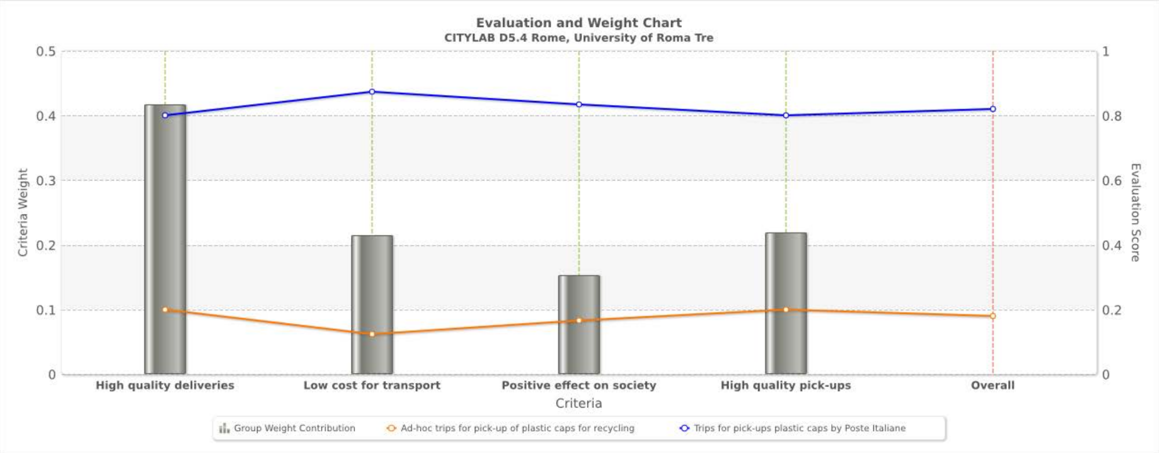
AHP EVAULUATIONS

		BAU or alternative?	Value?	Justification
Shipper/receiver				
	High quality pick-ups	Alternative	4	D5.3 (p. 56): BAU - "pick-ups are done by the UR3 Mobility Manager through dedicated trips". She does the trips when she has got time and thinks the collection bins need to be emptied. Alternative: Service is performed by a transport operator. When UR3 asks to do the pick-ups, the pick-ups are done the next day and delivered to the rectorate on the second day (D5.3, p. 60)
	Low cost for transport	Alternative	7	Excel template (Impact - row 23): Operating profit in BAU-9.74 and in alternative -2.6. Calculations in D5.3: Operating Cost for UR3 in BAU: 5.07€/kg and 1.50€/kg in alternative situation. BAU: UR3 Mobility Manager spends time and fuel to pick-up the caps. Alternative: Poste Italiane is paid more to do the pick-ups, but not that much since they already go there anyway. Concierge is paid anyway and can do the additional task as part of his current job. Cost of webplatform included?

	High quality deliveries	Alternative	4	D5.3 (p. 56): BAU - "pick-ups are done by the UR3 Mobility Manager through dedicated trips". She does the trips when she has got time and thinks the collection bins need to be emptied. Alternative: Service is performed by a transport operator. When UR3 asks to do the pick-ups, the pick-ups are done the next day and delivered to the rectorate on the second day (D5.3, p. 60)
	Positive effect on society	Alternative	5	Combined effect: road safety, air quality, fluent traffic and noise
Transport operator				
	Profitable operations	Alternative	2	No data available from perspective Poste Italiane. Alternative is slightly better than BAU: increased revenue (UR3 pays small fee for additional pick-up) and marginal increase in costs (no extra kilometres, postman already enters the building for post deliveries).
	Viable investments	Same score	1	No additional investments. Deliveries are already done by means of electric vehicles.
	High quality service	Alternative	4	Poste Italiane improves the service they provide to their already existing client UR3.
	Satisfied employees	Same score	1	Excel template (Impact - row 16) mentions improved employee satisfaction but it concerns UR3 employees and employees from the concierge service. For the postman, there is no difference compared to BAU.
	Positive effect on society	Alternative	5	Combined effect: road safety, air quality, fluent traffic and noise
Society				
	Shopping environment	Same score	1	No impact on physical shopping environment. No impact on goods availability.
	Road safety	Alternative	2	Marginal positive impact on road safety - dedicated trips to pick-up the caps are avoided
	Air quality	Alternative	7	Excel template (Impact - row 9-12) - Reductions of 100%
	Fluent traffic	Alternative	2	Marginal positive impact on traffic flows - dedicated trips to pick-up the caps are avoided
	Noise	Alternative	2	Marginal positive impact on noise impact - dedicated trips to pick-up the caps are avoided


Evaluation and Weight Chart
CITYLAB D5.4 Rome, Poste Italiane
Criteria Weight
Evaluation Score
Viable investments
Positive effect on society
High quality service
Profitable operations
Satisfied employees
Overall
Criteria
Group Weight Contribution
Ad-hoc trips for pick-up of plastic caps for recycling
Trips for pick-ups plastic caps by Poste Italiane


Evaluation and Weight Chart
CITYLAB D5.4 Rome, Society
Criteria Weight
Evaluation Score
Road safety
Air quality
Noise
Fluent traffic
Shopping environment
Overall
Criteria
Group Weight Contribution
Ad-hoc trips for pick-up of plastic caps for recycling
Trips for pick-ups plastic caps by Poste Italiane


Evaluation and Weight Chart
CITYLAB D5.4 Rome, University of Roma Tre
Criteria Weight
Evaluation Score
High quality deliveries
Low cost for transport
Positive effect on society
High quality pick-ups
Overall
Criteria
Group Weight Contribution
Ad-hoc trips for pick-up of plastic caps for recycling
Trips for pick-ups plastic caps by Poste Italiane