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# Feasibility Study of a Network of Consolidation Centres in Luxembourg

Jacques Leonardi, University of Westminster, United Kingdom

Laetitia Dablanc, IFSTTAR, France

Patrick van Egmond, Luxmobility, Luxembourg

Cindy Guerlain, LIST, Luxembourg

**KEYWORDS:** Urban Consolidation Centre; Clean Vehicle; City Logistics Management Models; Feasibility Study; Ex-ante Impact Assessment

## ABSTRACT

The concept of a multi-actor network of Urban Consolidation Centres (UCCs) was tested in Luxembourg. The authors of this paper developed a feasibility study together with the Luxembourg's Ministry of Transport. The methods used are encompassing data collection and data analysis, ex-ante scenario development and impact assessment of different options, interviews, workshops, and consultation with key operators in the public and private sectors. The market size appears to be sufficient. Clean technology is available and the willingness to use it is given. The management structure can rely upon constructive partnerships, a draft Charter for Urban Logistics and regulatory changes.

# 1. INTRODUCTION

Recently, many different configurations and logistics systems have emerged around the topic of freight consolidation, and several city logistics policies in Europe are considering the establishment and set-up of an Urban Consolidation Centre (UCC) together with the use of clean trucks and vans for central area deliveries (Triantafylou et al. 2014). This is done because a high potential for climate change impact reduction is estimated to be available in the freight transport system (McKinnon 2007). To reach this objective, it is required to find and provide suitable buildings and clean vehicles, then to set up the delivery service. Many different additional activities are also needed, such as regulation change, data collection and processing, and innovative city logistics management, such as stakeholder engagement and consultation methods. All these activities were developed during this feasibility study of an Urban Consolidation Centre in Luxembourg.

In Luxembourg, a relatively small country of about 550,000 inhabitants in Western Europe, in which there are no public city logistics policies in place so far, a new initiative was started by the Ministry of Sustainable Development and Infrastructure (MDDI) and the large logistics operator CFL Multimodal. The objective of this initiative is to coordinate the management of a city logistics policy focusing on a new Urban Consolidation Centre. Far from being limited to a pure theoretical exercise of writing down the different potential solutions available, business needs and transport requirements, success factors and rules to be followed by the operators, the study participants were engaged into a policy process aiming at the successful set-up of an Urban Consolidation Centre.

Therefore, from the very beginning, the feasibility study was embedded in a much larger activity framework, aiming at developing an innovative and result oriented urban freight policy in Luxembourg.

More precisely, the feasibility, governance model, business model and critical market size would have to be demonstrated, before the project of starting a new UCC could be considered viable.

Due to the very high number of failed projects of (often subsidized) consolidation centres in the past, notably in Europe (Allen et al., 2012, Ville et al., 2013), it was important to define clearly the risks and opportunities of such an initiative, and to test an approach that could become replicable in other contexts, especially in cities which have not implemented any city logistics strategy so far. Luxembourg cities are such newcomers from the point of view of urban logistics and thus this feasibility study is facing multiple challenges.

As a first very broad working definition, the Consolidation Centre was considered to be a classical logistics storage and transshipment depot, from which clean vehicles would start to deliver goods to the central areas of different cities in Southern Luxembourg. The exact number of logistics activities was not pre-defined but central functions of the new depot would be cross-docking and consolidation, while stockholding and replenishment, returns management, packaging or other B2B or B2C logistics services were not considered essential at this stage.

Besides this central area of cross-docking and consolidation action, several other policy domains required attention:

- Legislation change,
- Street design,
- Consultation with multiple stakeholders,
- Consensus building,
- Data collection and processing,
- Scenario development and impact modeling.

All these elements were to be included into the study.

The paper presents the main outcomes of these topics, which are all integrated and logically connected in the analysis of the feasibility study. In the following Section 2, we present the general approach chosen and the methods applied. In Section 3, we review different existing or past solutions and provide a benchmark. In Section 4, we identify key results of our modelling efforts for the Luxemburg situation. Section 5 provides concluding remarks.

## **2. METHODS, APPROACH AND ASSUMPTIONS**

The modeling approach is qualitative for the business and policy-oriented part, and quantitative for the impact evaluation part of the feasibility analysis. The central element is an ex-ante evaluation using an adapted mix of scenario modelling, data collection and before-after approach.

It was not the purpose of this feasibility study to develop any new, innovative method but to prepare a tangible result; therefore a mix of existing, well-validated methods was selected, applied and replicated.

The methodological basis of approaches to urban freight evaluation is presented in multiple studies. For example Macharis et al (2009) use Multi Actor, Multi Criteria Analysis, which is very inspirational for this study. For an overview, clear explanations and a review of different concepts and evaluation methods on consolidation, see Allen et al (2012).

For the past 20 years, economics literature on consolidation centres has developed a way of doing studies which includes two basic elements, a theoretical one and a case study oriented one. While in the theoretical works all elements of definitions, methods and modelling imply a rather top-down approach, in the case studies, the bottom-up approach, learning by doing and learning from examples and tests prevail. Case studies are in high number, and the on going key projects in Europe have been a source of inspiration for this study. The publications of many dozens of case studies and lessons learnt can be found at the respective online documentation of BESTFACT, SMARTFUSION, STRAIGHTSOL, LAMILO, and SUGAR projects (see the reference Section below). One of the main challenges faced by these projects is to streamline a structured approach to case studies so that all the different initiatives can be compared to each other. Using a standard grid and a fixed structure of analysis (process, success factors, barriers, costs, impacts, etc.) provides this.

The most popular information for decision makers is to understand how a solution was applied successfully. Once this has been made clear through the information provided, the case study can be considered as 'ready for use'

The main difficulty of all case studies is to demonstrate the economic feasibility and this is due to a lack of good costs data. Therefore one focus of this feasibility study was to collect cost data in as many relevant fields as possible and in the highest possible quality. Of course, there are very good reasons why good costs data are very difficult to obtain, for example confidentiality, too much effort involved, separated datasets, etc. (Thompson, 2014). These technical barriers to the collection of costs metrics could not be entirely removed but much time was employed to overcome this difficulty. Costs data were obtained through interviews with current operators of successful UCC schemes (see below).

The main methodology of the before-after assessment used in this feasibility study was developed in previous studies (Leonardi et al., 2012). Of course there is a very substantial literature, on which the authors could heavily rely upon, on how to best evaluate the potential application of an innovative solution in the frame of a well-managed city logistics policy (Taniguchi and Thompson 2014). To simplify the whole impact evaluation methodology to a

maximum: The first step for the Luxembourg UCC feasibility study is an ex-ante impact assessment that consists in collecting key data on the before situation and the second step aims at developing plausible scenarios with key actors in order to quantify the future impacts on different elements.

To read more about the calculation methods and equation used here, please see Leonardi et al. (2012). The main difference with this reference work from the year 2012 is that there are no after data collected. The after situation was the product of assumptions and estimates developed with the main businesses operating in urban delivery in Luxembourg.

The relevant impacts are measured with key urban freight impact indicators defined as follow:

*The number of parcels delivered daily:* the volume, expressed in parcels or pallets, is a key urban logistics indicator. One pallet in these calculations corresponds to 50 parcels.

*The distance driven per parcel:* measured in km/parcel, the distance is a key indicator of the presence of delivery vehicles in urban traffic. Our assumption is that any reduction in the distance per parcel results in the same reduction in a similar percentage of external costs of traffic accidents, noise, emissions, congestion. This is the main measure of the beneficial impacts of a solution.

*CO<sub>2</sub> emissions per parcel,* measured in kg CO<sub>2</sub>e / parcels, is a key efficiency indicator for estimating the environmental impact of logistics solutions. Fuel is expressed in l/100km and then in litres per day. The result is divided by the number of packages per day to achieve litres per package. The DEFRA (2012) equivalent of 3.1kg CO<sub>2</sub> factor for one litre of diesel is applied to get the result in kg CO<sub>2</sub>e / parcel. The choice of electric vans and the purchase of electricity from regenerative sources allow to sharply reduce the total freight transport emissions measured with this indicator. Hybrid trucks lower emissions by about 20% compared with standard diesel trucks.

*The number of staff:* It is an employment indicator. Generally, UCCs allow a re-organization, an increase in the number of parcels per stop and therefore increased productivity and fewer staff. But here, the approach chosen is to maintain the same parcel / staff ratio before and after the creation of the UCC. This is a conservative assumption that would need to be checked during the monitoring of the tests.

*The total cost per parcel:* This is an economic benefit indicator, calculated in € / parcel delivered. This includes personnel costs, fuel, fixed vehicle and building costs and other variable costs. These data are first collected per km or per day, then in combination with parcels per day to obtain costs per parcel.

### **3. REVIEW OF SOLUTIONS: CASE STUDIES AND BENCHMARKING OF UCCs IN 2014**

According to Triantafyllou et al (2014), two types of UCCs are mainly in use:

- 1) Large operators and logistics service providers develop privately their own regional depot in order to consolidate the flow to and from a large metropolitan area.
- 2) Cities or public authorities set up and manage multi-user logistics centres.

While the first type of UCC is mainly owned and run by a single operator, the second type is used by multiple logistics providers and is the product of cooperation. For the feasibility study, the original focus was more on how to set up the second type of UCC. But, because of the established presence of the first type of UCC in Luxembourg, one of the hypotheses was to try to include all existing types of UCCs into a single broad concept that

would encompass many different solutions and lead to a more consolidated urban freight delivery system overall. This type will be called in the following a network of UCCs. According to this objective, the first requirement is to analyse potential solutions in terms of their practicalities and adaptability to the Luxembourg situation. A review of solutions was included in the full report, and is summarised here.

From all aspects of Consolidation Centres, the most relevant criteria that were chosen for the review were those that are essential to understand how it has come to a market success and how not to replicate failures. Therefore, particular attention was directed to the successful configuration and preparation process, to the high impacts on costs and on CO2 reduction, and to the managerial and technological solutions leading to logistics efficiency gains such as a better load factor, or a lower distance per delivery.

Fundamental studies were performed on the demand side, in order to test the viability of different types of potential solutions. Marcucci and Danielis (2007) found out in a stated preference survey in Italy that UCC service cost, delivery time, annual cost of the access permits to the LTZ (Low Traffic Zone), and parking distance from the shop are the key decision influencing factors for the future user. Other elements such as Track and Trace and Warehousing have much less or no influence.

A high number of publications were issued on the best possible management solution for the set-up of consolidation centres, and the current debate seems to focus more on the analysis of success stories, in order to better understand how to avoid past mistakes and risks (van Duin et al. 2012, Ville et al. 2013, Gonzales-Feliu et al. 2014).

One of the most recurrent items in the literature is about the lessons learned from past failures. Many UCCs were established as a result of private initiatives, partly because their promoters anticipated increased access difficulties for transport companies due to a strengthening of regulations or an increase in congestion in dense urban areas. But, in Europe, it is the opposite effect that has been observed. Because municipal policies have been targeting (and achieving in many cases) a reduction in car traffic in central areas, they have paradoxically left more roadspace to commercial transport. "Anti truck" regulations were expected by the road transport industry and promoters of UCCs, but these tough rules did not materialize, until the arrival of environmental zones by the late 2000s (Dablanc, Montonen, 2015). It is in this way that the manager of UCC Basel, opened in 1993 and closed eight years later, explained his lack of success: incentives to use the UCC gradually disappeared (as easing of congestion resulted from car traffic reduction in the city centre), while the price of using his depot did not diminish. Panero et al. (2011) indicate another side-effect of transport policies in Fukuoka in Japan that hampers the development of UCCs. A recent municipal policy to increase the supply of public parking space in the city centre has reduced the market advantage of UCCs, which was to provide parking for transport operators to deliver businesses and retail stores in the downtown area.

Learning from these lessons, the main strategy is to avoid the pitfalls or escaping the barriers. To this aim, new UCC models are developed, that are both more robust and better targeted. The local authorities incentivise, organise or set up UCC schemes, using a qualitative development strategy (advertising), targeted subsidies, or specific regulations giving priority to carriers using the UCC. This solution is at risk on a legal level, but as demonstrated by the case of Vicenza in Italy, the courts may ultimately give their blessing to the regulatory action of a municipality (Ville et al., 2013).

Many projects have been completed through public-private partnerships, in which cases governments often financed at least parts of the initial investments, preparatory studies and evaluation studies. Sometimes the municipality, or an association of store owners in the case of Motomachi, near Tokyo, is up to finance partly the operation of the service. The UCC in La Rochelle is included in a public service concession, and its managers are receiving subsidies for each parcel delivered.

Some examples show that a purely privately owned service can be profitable without subsidies, for example Binnenstadservice in the Netherlands, although the economic model is still fragile. The organization of a number of UCCs has become more professional (appearance of major players such as DHL or Transdev), and the legal framework used for setting up a delivery consolidation activity is getting more robust. A law from January 2014 in France actually mentions that a municipality can set up a UCC as a public service 'if the private supply of urban delivery services is ill-adapted.'<sup>1</sup> In some cases, such as Lille in France, UCC operations are assigned to a new service provider that was previously external to the local distribution market, facilitating the acceptance of the new organization by the other carriers.

A recent trend in Europe is the emergence of parcels and freight networks and the increased concentration of the urban logistics industry. A very recent trend is the appearance of systematic approaches to urban delivery services. Until today, for innovative urban freight solutions, the most frequently used approach for one innovator was just to start bottom-up with a trial or a case study, then expand it in case of commercial and technical success; but this approach was using isolated experiments made in single cities. Instead, the new approach is more systematic and targets cross-city, sometimes cross-country networks. Examples are the following:

Large logistics groups like UPS, DHL or Fedex today commonly engage contractors for operations in the most central areas of many large cities, which are using electric or innovative vehicles (such as electrically assisted cargocycles). They use service providers that can provide this type of cleaner operation, which requires the use of logistics distribution centres nearby. These companies or their subcontractors are in search of land opportunities close to cities or within cities in order to develop these networks of logistics centres.

The Geodis Group announced the development of Distripolis, a network of urban consolidation centres. Distripolis aims at consolidating the urban distribution of three parcel express transport subsidiaries of Geodis within the same national urban distribution network, using clean delivery vehicles for the final segments of distribution. The network takes longer than expected to deploy, notably because, among others, a lack of available urban spaces to accommodate the urban cross-docking operations, and other land use problems. However, this example is worthy of attention as it systematizes a network approach.

Star's Service is a delivery company that has become dominant in France as the main home delivery partner of marketplaces and urban retail chains. It now operates more than 1200 delivery vehicles from logistics centres that are located near major urban centers to minimize the stem mileage and time, and maximize the reactivity and quality of service.

Across Europe, powerful e-commerce parcel delivery networks are now organized at a national or a European level (Kiala/UPS, Pickup services, ByBox, Packstations, etc.). The concept is to use local stores or automatic locker boxes at certain central points to offer consumers the possibility to pick-up a parcel at their convenience, while reducing the need for transport operators to reach the home of each single consumer. Their spatial deployment is now outstanding (Morganti et al. 2014).

Innovative start-ups are gradually taken over by large groups: in France, Star's Service bought La Petite Reine (one of the first urban delivery operators using cargocycles in the early 2000s) in 2011, Kiala was acquired by UPS in 2012.

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<sup>1</sup> Translated from article L1231-1 of the current French Transport Code.

## **4. RESULTS**

### **Market analysis**

Our market analysis has focused on the current state of urban logistics activities in Luxembourg. The main result is that market potential for a UCC has been verified, due to an estimated total number of deliveries per day of about 20,000 in the cantons of the Ville de Luxembourg and Esch-sur-Alzette, the two main cities in the Southern part of the country.

The few business leaders that are currently running successfully profitable UCC schemes in Europe, and were willing to share their experience, stated in interviews that the minimum conditions for a profitable UCC business would be to deliver a volume of 1000 parcels per day, to sell the service at 2.5 Euro per drop, and to rely upon a very good client relationship. Logistics operators in Luxembourg were asked and stated that these volume, price and relationship targets seemed achievable.

According to the same business leaders currently running UCCs, electric vans and CNG trucks are available on the market at prices that are comparable with diesel options. Even if the purchase price is slightly higher, operating costs are lower and the total costs of ownership are similar for electric vans and natural gas powered trucks. For clean vehicles, there is also the question of the autonomy range for battery powered vans. The geographical catchment area of a potential UCC seem to be limited by the short range of clean vehicles. If only electric freight vans are considered, the delivery area would have to be within a 45-50 km radius of the Centre. This is corresponding to a round trip distance of about 120-160km per day. The boundaries of the two cantons of Luxembourg and Esch-sur-Alzette are well within these limits and therefore the autonomy range is not considered as a limitation for the choice of vehicle fuel technology. Consequently, there is also demonstrated market feasibility in terms of using clean vehicles.

The feasibility studies regarding actual facilities and logistics buildings showed that there are at least two running logistics facilities and depots located within Luxembourg city centre. There are also several municipality-owned parking facilities that could potentially accommodate a small cross-docking area. The two operators of these depots showed willingness to start using those locations for the UCC. The surface estimated to be needed for distributing 1000 parcels a day in a cross-docking activity is about 300-400 m<sup>2</sup>; under the condition that no other logistics service activity would take place. This surface is available in at least two depots, and could be used in the short term for a kick-off of the consolidation system. Therefore, the market feasibility is also demonstrated in terms of available building space.

### **Network of UCCs, options and identification of scenarios**

A consultation process with the industry, commerce and key stakeholders took place, and a governance model for the future consolidation centre was developed.

Our business case analysis suggests that different options for consolidation activities seem to be suitable for an initial start-up phase. Notably, an option with one single logistics depot and another option with a network of existing logistics hubs. In both cases, the operator of a UCC would be allowed to deliver to a restricted area in the city centre, provided they use clean vehicles. Especially the network option, if retained, would be a managerial, policy and governance innovation in city logistics. To our knowledge, there is currently no network of multiple urban consolidation centres in operation. The set-up of a network would have the advantage to preserve the business of every current logistics operator in Luxembourg, modifying only each operator's city centre deliveries. For an established operator, the only



condition to fulfil to be considered a UCC, would be to use clean vehicles and deliver to the central area in a consolidated manner. In this scenario, access rules in the central area would become more restrictive, notably for diesel trucks. Under these new regulations, operators using diesel vehicles could not access the restricted zone, and would have to drop their shipments at the UCC instead. The UCC would then see its market volume increase, permitting further consolidation of its delivery activities.

The advantage of a network of UCCs, compared with a single UCC, is that it provides an impulse for many more logistics providers to operate with clean vehicles and in a more optimized manner.

The regulation changes are a crucial element of the feasibility of a successful UCC scheme. Access rules to specific areas, such as pedestrian zones, would need to be changed in favour of clean vehicles and specific time windows allowed for deliveries from the UCC.

To decide on the final configuration for the future UCC concept, it is important to identify the potential effects of different options, developing several scenarios, and quantifying their impacts on the indicators above.

To this aim, each scenario has been sketched and defined so that it has only one major difference option compared with other scenarios.

The basic requirement of an option is that it is not supposed to reproduce all the elements that will become effective in the final establishment of the UCC.

To illustrate the options available and the potential changes induced by a UCC introduction in Luxembourg, see Figure 1.

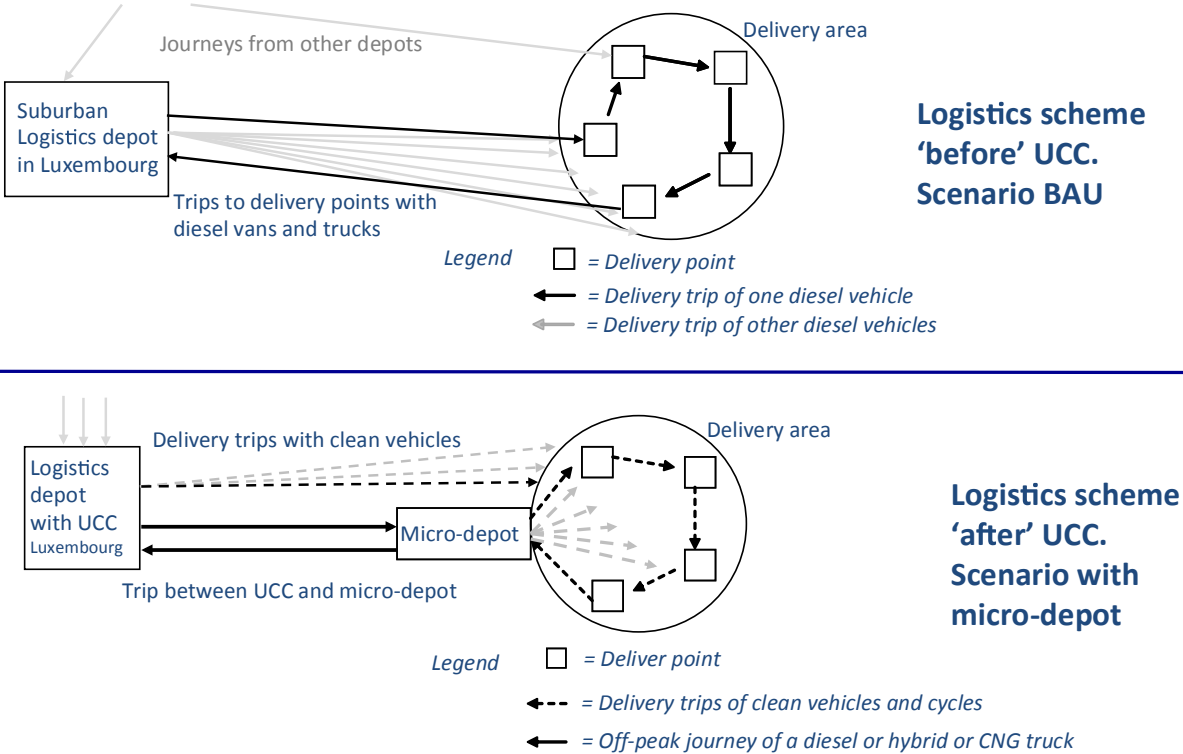


Figure 1: Logistics scheme of the Luxembourg delivery area with and without a UCC

Each scenario presents realistic options and is calculated from figures obtained from existing UCCs in Europe. Six scenarios are compared with scenario 0, without UCC.

Scenarios can be summarized by the following points:

- ÉScenario 0: BAU = Business as Usual 'Before' UCC
- ÉScenario 1: BAU + use of clean vehicles

ÉScenario 2: one UCC + 10% market share increase through capture of international flows + clean vehicles

ÉScenario 3: one UCC + Micro-depot + 10% international flows + clean vehicles

ÉScenario 4: Scenario 3 + Group of retailers from the same street

ÉScenario 5: Alliance of one large + many small businesses

ÉScenario 6: Alliance of two large companies: one specialist in logistics, the other in trade

Many descriptions and assumptions are needed to calculate the impact of generic scenarios. UCC business solutions are based on qualitative and quantitative assumptions used in the scenarios. These assumptions are the following:

**BEFORE Scenario 0 (BAU):** 1200 parcels per day are delivered to the centre of Luxembourg city and Esch-Alzette, including 400 (equivalent of 8 pallets) with 1 diesel truck (HGV) and 800 by 8 diesel vans (LGVs). 100 parcels are delivered daily per HGV or LGV.

**AFTER Scenario 1:** Using 8 electric vans and a clean hybrid truck. All vans are 100% electric, distributing 800 parcels / day, and the hybrid truck delivers the equivalent of 400 parcels or 8 pallets / day. No CO<sub>2</sub> emission occurring from electric vans, due to renewable sources of electricity. Clean truck is a hybrid electric 7.5t diesel with a capacity of 400 parcels or 8 pallets.

**AFTER Scenario 2:** Scenario 1 + 10% of total volume (120 parcels) is added from international routes. One electric van and one van delivery driver are added, distributing 10% more volume. The total volume delivered is 1320 parcels / day.

**AFTER Scenario 3:** one diesel truck of 40 tonnes carries 400 parcels to the micro-depot at night or off-peak hours before continuing its round. After a transshipment at micro-depot, the 400 parcels are delivered by four electrically assisted tricycles. Among the remaining volumes, 520 parcels are delivered by six electric vans and 8 pallets (equivalent of 400 parcels) are delivered by one hybrid truck. The micro-hub is large enough to handle the transfer of 400 parcels and provide parking for 4 tricycles or small electric vans, or 200 m<sup>2</sup>. This surface, according to the working hypothesis is in a public car park or at an existing depot and is made available to the operator without a charge. The organization of the tests will determine whether it is possible to arrange the delivery through an existing micro-depot without necessarily making an additional break in the supply chain or setting up a completely new logistics facility. At night, the micro-hub must provide parking for electric vehicles and thus be equipped with charging stations. No logistics activity or service is provided on the micro-hub. No staff is present except the drivers.

**AFTER Scenario 4:** + 10% (120) of the total parcels are added to the total volume of parcels of scenario 3, with the retailers group in a single destination. This group could be a single street in the pedestrian area of Luxembourg city. The total volume delivered is equivalent to 1440 parcels / day. One more van and one delivery driver are added to carry the 10% additional volume.

**AFTER Scenario 5:** same conditions apply as in Scenario 3, but there are 20% of revenues and staff more through an alliance of a logistics company with several small logistics providers.

**AFTER Scenario 6:** Alliance of two large companies. Same conditions apply as Scenario 1, but with doubled initial volume (2400 parcels per day before) and no volume increase AFTER (2400 parcels per day after). Use of micro-hub and tricycles, as for scenario 3, for 400 parcels per day after. Other trips are made by electric vans from the suburban depot.

Before and After: one driver per vehicle. The truck driver who delivers the micro-depot does not end their round trip after delivering there, but continues the journey to other destinations. Half a working day is allocated for that driver to calculate labour costs in the options that include the micro-depot.

Before and After: 100 parcels per day per vehicle for the van or the tricycle, 400 parcels equivalent of 8 pallets per day for the truck.

The additional quantitative assumptions are:

ÉDistance from UCC to city center is 15 km

ÉDistance from UCC to micro-depot is 15 km

ÉDistance / day within the city center, for trucks or vans or tricycles is 20 km

ÉNumber of parcels per day delivered per truck, van or tricycle driver is 100

ÉLarge 40 tonne truck fuel use in urban conditions is 40 l / 100km

ÉDiesel van fuel use is 22l / 100km

ÉClean hybrid truck fuel use is 28l / 100km

ÉEmission factor is 3.1 kg CO<sub>2</sub> / l diesel

ÉCost of personnel per working day is €135

ÉNumber of staff per vehicle is 1.25

ÉDiesel price is 1,2 € / l

ÉFixed costs except personnel and fuel are €3,5 / km

ÉElectricity prices are € 0.20 / kWh

ÉElectricity consumption for an electric van is 10 kWh / day

ÉElectricity consumption for a tricycle is 6 kWh / day

### Impacts of scenarios

The impacts of scenarios 1 to 5 are presented in Figure 2. The impacts for scenario 6 are presented in Figure 3.

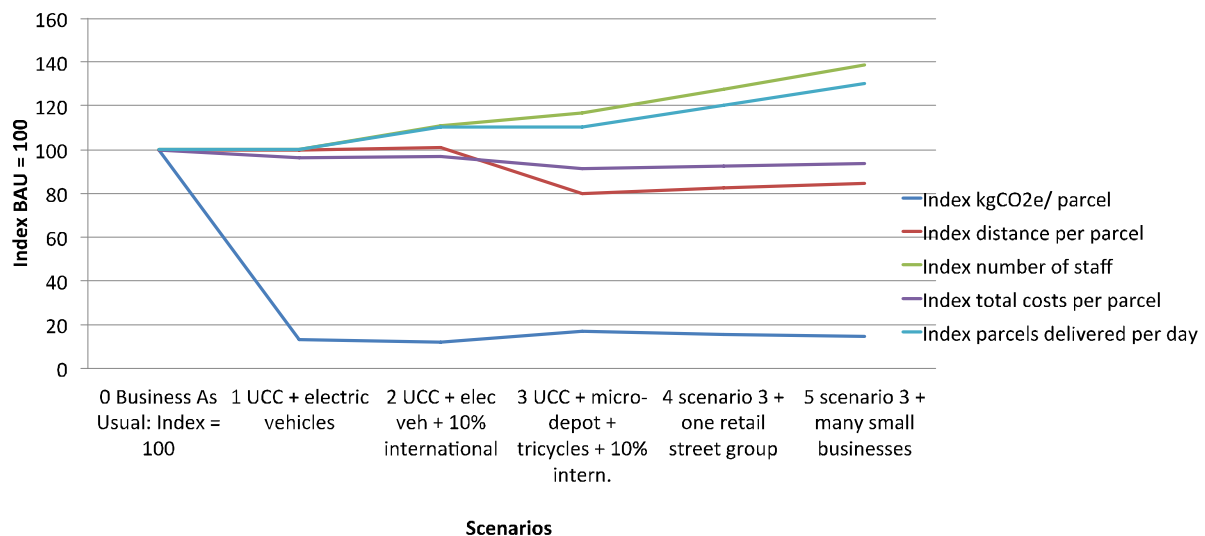


Figure 2: Impacts on key indicators of UCC scenarios 1 to 5

Scenario 1 has two effects: a strong reduction in emissions and a much smaller reduction in costs due to the low price of electricity. Because all other logistics indicators remain stable in the assumptions, including staff and distance, the main business indicators remain the same, and only the fuel consumption and vehicle fuel costs are going down. Fuel cost represents a small percentage of the overall costs and its reduction is too small to cause a substantial overall decrease in costs per parcel.

Scenario 2 shows an increase by 10% in the volume of packages. Keeping a ratio of 100 packages/ vehicle leads to the findings that the key indicators also remain fairly stable,

except for emissions that are going strongly down. A better result would be obtained if we assume that a driver could deliver 10% more parcels due to the close proximity of the clients' destinations. In that case the consolidation of the vehicles would be higher, which would lower further the distance per parcel and the costs per parcel.

Scenario 3 introduces two simultaneous changes: the use of a micro-depot or mini-hub in the city centre and the use of power-assisted tricycles for the final delivery. To supply the micro-depot, a diesel truck delivers 400 packages early in the morning or during a night shift, coming from the UCC, before continuing its tour. This route generates more emissions than the equivalent of four electric vans, but lowers the distance per van between the UCC and the city centre. The final distribution with four tricycles has the same ratio of parcel delivered / staff than the parcels delivered by truck. The decline in the total distance leads to a reduction of fixed costs and variable costs, as these costs are also calculated on a km basis. Thus, the effect on logistics total distance of four cycle delivery trips results in lower costs per package.

This applies in the event that the micro-depot does not create additional real estate costs, or any costs that would have to arise in case an additional breaking point is introduced for the load in the supply chain (see description of the scenario 3 above).

For scenarios 4 and 5, volume growth increases the number of drivers and the number of parcels, and this effect could potentially result in reduced profitability; but the calculation shows that is not the case, with an index of the total cost per package that remains in all scenarios lower than the costs of BAU. The beneficial effect of a micro-depot on total mileage remains constant in absolute value in scenarios 4 and 5. This explains the good profitability of these two solutions. As the number of packages that pass through the micro-depot does not increase above 400 in all these scenarios, the relative share of micro-depot use decreases. Thus the total distance per package and therefore costs per package do not diminish further.

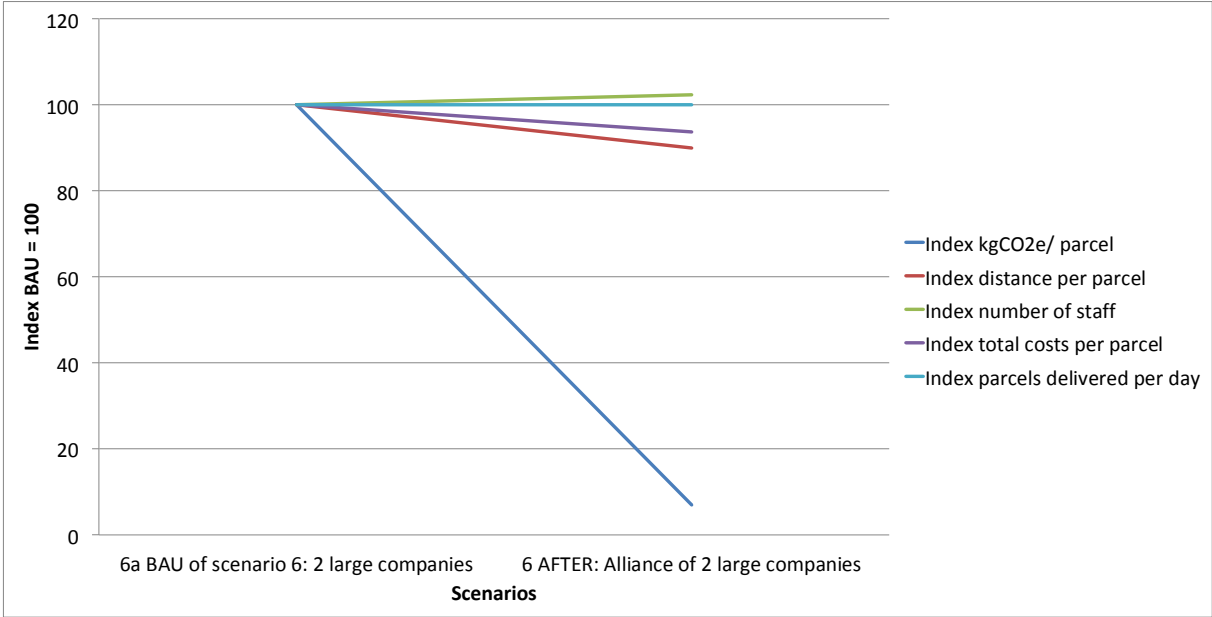


Figure 3: Impacts of an alliance of two large companies in scenario 6

In all scenarios, the main effect for a total distance reduction is the replacement of four vans by one truck on the trips between the UCC and the micro-depot. It would be fairly possible to increase the capacity of the micro-depot and start using electric vans from there but this has not been taken into consideration at this very early stage. Of course it would be possible to assume that more load would be transiting through the micro-depot without additional breaking point in the supply chain, for example through re-arrangement of existing

depot operations and reallocation of space use in city centre depots. In that case the impacts on distance and on costs reduction would be even more beneficial.

For Scenario 6 (cooperation of two large companies), the reduction of key indicators is substantial because the estimated consolidation is strong. The total distance is reduced by about 10% per package, because the distance driven by a tricycle from the minihub is significantly lower than the distance of a round trip in a van from the UCC. Thus, distance, costs and emissions are going down significantly in this scenario. This conservative scenario is assuming that the final distribution through a micro-hub is remaining for volumetric amount identical to scenario 3 (400 packages) delivered with four tricycles. If the number of packages that pass through the micro depot doubles, and if the number of tricycles doubles, the reduction in distance travelled per parcel would reach 20% instead of 10%.

It is therefore advisable to think big and consider an alliance between two large companies, because this option has a higher operational impact potential for a network of UCCs in Luxembourg.

## 5. CONCLUSION

The feasibility study was completed at the end of January 2015 with an overall positive outcome, as the market, technology, building and business conditions seem favourable for the creation of a UCC network.

The expected planning of the consolidation centre has already started and business consultations are taking place.

The policy changes are becoming more specific and therefore the targets of establishing a clearer and more rationale basis for the planning, preparation and set-up of a UCC, or of a network of UCCs, have been reached.

Knowledge about the urban logistics sector in Luxembourg has improved and the data made available through observation surveys have demonstrated that the day to day practice is very similar to other cities in Europe.

Therefore it seems reasonable to expect that the technologies, concepts and business solutions applied elsewhere for UCCs could potentially be transferred to many different logistics and retail businesses in Luxembourg.

The development of each current logistics business established in Luxembourg and providing deliveries to city centres will probably evolve in short terms towards a more sustainable urban freight system. If the solutions presented in this study are fully applied by a high number of operators, this system will be based on a network of UCC serving the central area with consolidated and clean vehicles. The expected overall impacts are lower costs for businesses and reduced negative externalities for local communities.

The feasibility study itself was certainly not a methodological innovation, in so far as it did not invent any additional equation of impact assessment. But the review of existing solutions and the dialogue with different actors were leading to the development of an innovative practical solution, the network of UCCs. This solution could be further facilitated through a mix of practical tests, participative stakeholder involvement and consultation, market research and impact assessment, data collection and evaluation, and regulatory changes.

In all these fields, activities have already started to be implemented beyond the duration of the project, and consequently, the feasibility study can be seen as a validated research and managerial tool facilitating public policy action and business decisions in city logistics.

The next steps will show if the solution of a Network of UCCs can be successfully tested in small experimentations and later implemented at a larger scale.

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