The deployment of urban logistics solutions from research, development and pilot results. Lessons from the FREILOT Project

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Lessons from the FREILOT Project

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Abstract

The deployment of urban logistics solutions is one of the main pending questions in the field of urban goods transport research and practice. Indeed, although several solutions and projects have been tested in the last years, only few of them reach an operational phase and remain viable in time. Through the example of a recently finished demonstration project, this paper presents the main issues related to the deployment of urban logistics solutions form research and development results. More precisely, this paper aims to focus on how the conclusions of pilot actions can be used to forecast the possibilities of deployment for an urban logistics service. First, we present the main stages in deploying a technological or organizational solution, based on the FREILOT project's deployment research and analysis. Then, one of the analysed technologies in the project is presented: the delivery space booking service. After presenting the main business model elements, an example of cost-benefit analysis is proposed, defining the method and the main hypotheses, as well as the main conclusions from the analysis. Then, the main barriers to the deployment of delivery space boking devices are presented. Finally, the paper shows a set of guidelines for public authorities and transport practitioners to deploy urban logistics solutions.

Keywords: urban logistics services, deployment, cost-benefit analysis, barriers, business model.

1. Introduction

Urban commercial and goods transport is a necessary but disturbing activity. To deal with the main nuisances related to it (mainly congestion, noise, global warming and local pollution), public and private stakeholders have studied and developed methods and solutions of different nature and dimensions. We observe in transport research hundreds of works dealing with the subject of commercial and goods transport, but the number of operational urban logistics systems is very small. This is the case of urban consolidation centres (UCCs) but not only. Indeed, although several projects have been developed and tens of pilots and demonstrators have been seen in the last ten years, most of them end without a deployment of the developed technologies or organizational solutions. However, also a few projects have resulted on operational solutions nowadays implemented or in mature solutions able to be deployed. In the first group we observe the UCCs of Padova in Italy, the proximity delivery services of Chronopost, Colizen and La Petite Reine in France.

In the context of the above this paper aims to present the main issues related to the deployment of urban logistics solutions as suggested by research and development results, and tested in the context of real urban environment demonstration actions. First, we will present the main stages in deploying a technological or organizational solution, based the scientific and practice-related state-of-the art. Then, we present one example extracted from the FREILOT[1] project (the Delivery Space Booking service) and its main evaluation results. After presenting the main business model elements, the focus of this paper will be on cost benefit analysis and deployment barriers. Finally, we propose a set of guidelines for public authorities and transport practitioners to deploy urban logistics solutions.

2. Deployment issues in the FREILOT project

The FREILOT project has been carried out between March 2009 and September 2012. It is focused not on pure or applied research but in the phases of demonstration and deployment. For that reason, 5 technological solutions have been implemented and tested in four European cities, enabling services that are related to four service domains covering the entire delivery operation scope. The domains and service related to each of them are summarized in the following:

- **Traffic management domain**
    - <u>Service 1: Intersection Control Optimised for Energy Efficiency (EEIC)</u>: The FREILOT freight distribution vehicles get moderate priority when they approach the intersection, this increases non stopping and improves the traffic flow and energy consumption. At the same time, they get information about the traffic light phases (when it will be in red, green...) and therefore, drivers can adapt their speed. This facilitates an active collaboration and interaction

[1] Urban Freight Energy Efficiency Pilot, Information and Communications Technologies Policy Support Programme (ICT PSP). Information Society and Media Directorate. Grant agreement no.: 238930. Pilot type B.

between vehicles and traffic light management systems, as the drivers could adapt their speed and reduce stops, improving also city's road security.

- **Vehicle operation domain**
    - Service 2: Acceleration and Adaptive Speed Limiters (AL & ASL): The service solution proposed in FREILOT gives the possibility to define geographical zones to facilitate adaptive vehicle speed or acceleration limitation. This can be done by the fleet operator or by the city council in order to regulate the access and the accessibility conditions of certain areas of the cities, such as pedestrian streets or limited traffic zones, among others.
- **Driver behaviour domain**
    - Service 3: Enhanced "Eco Driving" Support (EDS): The solution adopted in FREILOT, promotes efficient driving, reduces emissions and noise pollution by reducing non-ecodriving behaviours like rapid acceleration, noise and fuel consumption, and thereby also emissions.
- **Fleet management domain**
    - Service 4: Delivery Space Booking (DSB): The service solution proposed in FREILOT gives the possibility to plan the deliveries, by reducing travel times, improving traffic flow conditions and therefore, reducing energy consumption and working time for delivery execution. This service will provide the basis for enhancing the use of city delivery facilities by the existing distribution demand and therefore will improve the service supplied by the city.

Different stakeholders can be interested on such services provisioning and exploitation. Two main goals have been identified (Zubillaga et al., 2012) for involving service provisioning:

- Public Goal: Administrations, like cities or other road authorities, are the Service Direct Users or customers, in the EEIC and DSB services.
- Private Goal: Depending on the FREILOT service analysed, the technology providers will be the Service Providers (VOLVO, RENAULT Trucks, PEEK, GERTEK) and the Fleet Operator will be the Service Direct Users in all 5 FREILOT services.

In order to study the deployment issues of such service enabling technologies, it is important to craft the necessary environment and context to bring these services to real life operation of the city. To do this, a business model is needed. A starting point for building the business model is the selection of target market segments. This model describes the value that is delivered to customers, how customers are being charged, and what business context and processes need to be built in order for the business to be successful. On the other hand the identification of all possible barriers for the deployment of the services will be listed and linked to potential solutions. For understanding the value to stakeholders it is necessary to understand what the individual benefits of each service are and what is needed to bring and keep them alive and profitable. It is then important to provide a consequent cost benefit analysis to support the business model and help decision makers find arguments and solutions to the identified barriers. Finally, an exploitation plan describes the induction of the business and how to sustain and expand the business. One pillar of the plan is the certification and regulatory actions that need to be performed.

This comes down to the following structure for the business model strategy, where overall process and specific work is listed (Zubillaga et al., 2012). In this paper, we will focus on cost benefit analysis and on deployment enablers and barriers for two systems, i.e. DSB and EEIC). For an in-depth description of the business model and the analysis of all systems, including the combination of two or more services, see Zubillaga et al. (2012), Jeftic et al. (2012), Aifandopoulou et al. (2012) and Gonzalez-Feliu et al. (2012).

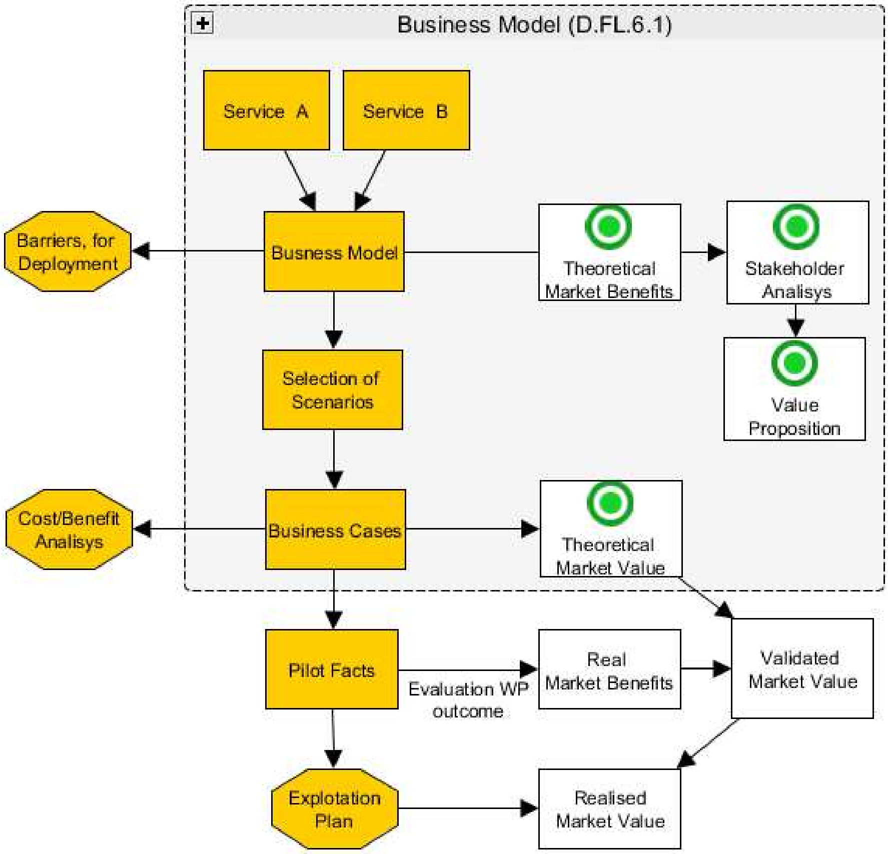

Figure 1: Pilot process and deployment strategy chart (Zubillaga et al., 2012)

3. The delivery space booking service

In the FREILOT pilot cases, two DSB applications have been tested, one in Bilbao and one in Lyon. In this section we introduce them, as well as the main conclusions of the evaluation results.

3.1. DSB device in the city of Bilbao

The Delivery Space Booking service application for Bilbao uses the Urban Merchandising Distribution Management (UMDM) system, which has been implemented by GERTEK, the company currently managing the parking system in Bilbao. UMDM is an innovative system for the real-time management of urban delivery spaces, built upon the Open Parking System (OPS) functionality. This is currently the only system that guarantees rotation in parking place usage through real-time control of maximum time limit parking slot occupation and time limit of return to the restricted zone. The UMDM system allows a real-time booking procedure if there is a free slot that no one is using. The system also allows fixed periodic bookings for a period of 3 months allowing in this way a medium time organization to fleet operators. The UMDM system is however neither able to provide an Estimated time of Arrival (ETA) nor to manage conflicts due to drivers not respecting the booking plan. The system allows the fleet manager to book in advance an urban delivery space specifying the time of the day required and the type of vehicle to be used. For the road operator, it provides the possibility to optimise the management of delivery spaces through better knowledge of the delivery time period and duration in order to improve the flow of vehicles, to reduce negative impacts due to double lane stops, to reduce consequent traffic congestion and to reduce negative environmental impacts in urban areas. Through real-time centralization with control by truck type identification, the UMDM system guarantees the fulfilling of the freight space city ordinance, i.e., maximum allowed parking time, scheduling of each delivery space usage, identifying vehicles that are not allowed to use the delivery space etc. The initial booking procedure is done via Internet by fleet operators. The system also supports bookings directly on the parking machine near the delivery bay. All data and real-time operations are stored/ updated in the main server, which will be supported by a maintenance office. UMDM is also prepared to interface with an additional identification system based on Detection loops and sensors which can identify vehicles that are not allowed in the delivery space as well as double parked cars.

Table 1. General requirements of the DSB service in Bilbao

For pilot purposes the loading/unloading timetable is from Monday to Friday from 8:00 am to 13:00 pm.
Public and private truck operators can participate in the pilots.
Loading/unloading operation time is fixed to 30 minutes. However due to some extra requirements the slot might vary in order to find the optimum time frame for the operations.
The same truck is able to book as many slots as required in one day.
However the same truck can never book two consecutive slots.
Real-time booking lasts for 30 minutes. However depending on the circumstances the system can supply more time. • If the bays are free for more than 30 minutes the user will have this extra time. E.g. 16 min + 30 min = 46 min. • If the time remaining to the use of the delivery space is less than 30 minutes the system won't be able to supply any loading/unloading slots. • If the loading/unloading activity finishes before the time is over, the remaining time will be available for the next real-time booking.
During the pilot even trucks over the permitted weight (9.5 tons) are allowed to use the delivery spaces in order to find the validity of the service for all types of trucks. These trucks must have a special permit.
The system assigns the bays in the order listed below: (in order to allow trucks to have 2 or 3 bays): • Bay 1 - in the right extreme. • Bay 3 - in the left extreme if there are 3 places. • Bay 2 - in the middle, always the last bay.
Each delivery space is equipped with a city parking toll system and it is painted for the pilot in a unique and easily recognizable way: • Each bay has a painted identification number, which will go from 1 to 3 • Each bay has 5 LEDs (Light Emitting Diodes) to operate it.
Drivers must identify themselves with a chip card when parking in the bay.

The delivery space booking application of Bilbao consists then of three subsystems: an in-vehicle application for handling delivery space reservations, a delivery space operator back-office system and a fleet operator back-office system. Two use cases of booking a loading and unloading space are supported:

1. Internet booking

A fleet manager uses a web-based back-office system connected to the delivery space operator back-office. Once the vehicle is at the delivery space it should identify to the delivery space operator back-office which grants or denies the access to the delivery space area. There are two different ways of booking through internet:

- Fixed booking: This option implies that the reservation will last up to 3 months. This system provides fleet operators with a medium term time horizon organization of delivery plan improving current fleet management functions.

- Daily booking: This option will be used if the fleet operator wants to book the delivery space for a concrete day for 30 minutes. This operation should be performed at the latest 1 hour in advance.

In both cases the time slot for booking is 30 minutes.

2. Real-time booking

Drivers are also allowed to book delivery spaces during the execution of their delivery schedule. This kind of reservation must be done through parking toll poles in real-time if the delivery space is not occupied and free of reservation and has not been reserved at this time. This function is quite important as it will discourage private cars to park at the delivery spaces.

3.2. DSB device in the city of Lyon

The Delivery Space Booking application for Lyon is based on the work done in the European project Cooperative Vehicle-Infrastructure System, CVIS. The goal of this application is to support the driver, fleet manager and road operator (including parking zone operator) in the booking, monitoring and management of the urban parking zones for freight driver activities. The system allows the fleet manager to book in advance an urban parking zone specifying the time of day required, the duration required, the type of vehicle to be used, and possible dangerous goods transported. For the road operator, it describes the possibility to optimise the management of parking zones through better knowledge of the delivery time period and duration in order to: improve the flow of vehicles, reduce all negative impacts due to double lane stops, reduce consequent traffic congestion and reduce urban environmental impacts. The application is based on dynamic delivery space booking algorithms, taking advantage from the experience being made on the CVIS Parking Zone application development. As the objective of the pilot is to implement economically sustainable solutions which can be kept running even after the end of the FREILOT timeline. The application is scalable (starting from a 1st level configuration with the possibility to include additional functionalities and components by means of open interfaces). The proposed solution is based on Application Service Provider (ASP) software (derived from the CVIS Parking Zone Booking system developed by Thetis). The main stakeholders (Fleet operators, Municipality, Enforcement personnel) can access the application functionalities through the Internet with PCs and/or portable devices.

Table 2. General requirements of the DSB service in Lyon

The Fleet Operator can make requests for "delivery space slots", specifying the time of day required, the duration required and the parking area.
The Vehicle System is able to accept a request from the Driver for a delivery space at a specific location, at a specific time, with a given duration for a specific type of vehicle.
Regarding the parking area, time of day and duration, the Delivery Space Booking application is able to identify the nearest parking slot available.
If necessary the Delivery Space Booking application will generate a response which proposes an alternative time slot and communicate this to the Vehicle.
If necessary the Delivery Space Booking application will generate a response which proposes an alternative parking zone (with a parking slot associated) and communicate it to the Vehicle.
The Vehicle provides the possibility to accept updates to the delivery space slot and the possibility for the Driver to accept or reject an updated slot.
The vehicle provides updates of its Estimated Time of Arrival (ETA) to the parking system as the vehicle approaches the delivery space.
The Vehicle identifies itself when it is within a defined distance of the delivery space and it informs the Delivery Space Booking application.
The Delivery Space Booking application processes the ETA and responds to the Vehicle with an indication of the availability of the requested delivery space.
The Delivery Space Booking application manages every event raised by the possible parking infrastructure (if any) and knows the status of the Parking area.
On receiving a Vehicle ETA, the Delivery Space Booking application determines if the delivery space is free at the given time.
The Vehicle processes updated delivery space or holding zone bookings from the Delivery Space Booking application and presents the information to the Driver.
The Parking System processes updated ETAs from vehicles and proposes alternate delivery space slots.
The vehicle identifies the arrival at the delivery space and then notifies the Delivery Space Booking application
The Delivery Space Booking application has the ability to detect that a Vehicle has exceeded the requested length of time at the delivery space.
If a vehicle that currently occupies the delivery space is exceeding its booked time, the Delivery Space Booking application will send an alert to the enforcement personnel.
When leaving the delivery space, the vehicle informs the Delivery Space Booking application that the delivery space is now free.

The delivery space booking application consists of two subsystems: an in-vehicle application for handling parking zone reservations and a parking zone operator back-office system. To reserve parking slots, a fleet manager uses the web-interface of the parking operator back-office. During the vehicle trip, the estimated time of arrival is estimated to detect late or early arrival at the parking. At the parking entrance, the vehicle notifies the parking operator back-office which grants or denies the access to the parking area.

3.3. Pilot operations and evaluation results.

Each system has been tested in its corresponding city. Bilbao's demonstration started in June 2010 and finished in December 2011, involving 45 companies and 95 vehicles. Lyon's action started in January 2011 and finished in June 2012, involving 4 companies and 6 vehicles. The pilots'details as well as the data collection issues and operational problems are seen in Blanco et al. (2012) and Koenders et al. (2012). Since the aim of the paper is to present deployment issues, we present only the main results of the evaluation that are used for the deployment analyses. However, the evaluation was larger and included the collection and analysis of various data :

- Records from the reservation systems (of different nature and with different information for each city).
- GPS data collection for the analysis of instantaneous fuel consumption and CO_2 emissions (for a detailed description of this method, see Pluvinet etal, 2012).
- Infraction counting campaign (3-4 weeks baseline and 2-4 weeks pilot).
- Traffic counting (manual for Lyon, manual and authomatic for Bilbao).
- Qualitative analysis via questionnaire (mainly in Bilbao).

The main results of the evaluation are synthesised in below. First, we show in the following table the direct gains for a truck on each DSB, in a deployment situation. To obtain the gains shown below, we need to ensure a minimum capacity, without what it is not possible to deduce any gain due to the saturation of parking place, even when cars are not on delivery bays. For an in-depth DSB evaluation, see Blanco et al., 2012.

Table 3. Gains on a single DSB (on a 120 m area, Gonzalez-Feliu et al., 2012)

Indicator	Without DSB	With DSB	Gap in Freilot areas	Gap in the entire route
Travel distance (m)	147	108	-27%	-0.00%
Travel and stop time(min)	15.25	16.92	+11%	+0.60%
Fuel consumption (g)	101.4	71.5	-29%	-0.08%
CO2 emissions (g)	336	235	-30%	-0.01%
NOx emissions (g)	4.1	2.7	-34%	-0.01%

Travel time is intended on the DSB's influence area (the loss is due to the security and the tranquillity drivers feel when legally parking their vehicle with respect to double line parking and other practices). However, another impact of DSB's less easy to quantify (at least directly from evaluation results) is that of traffic improvement due to the usage of a coherent network of delivery bays. That effect will be further quantified, from evaluation data and a simulation with a network of DSB's in a given city.

4. Cost benefit analysis

The cost benefit analysis (CBA) is the most used economic calculus tool for assessing the deployment of strategies in different fields (Boardman et al., 2006). CBA provides a protocol for assessing the efficiency impacts of proposed policies. The patterns for the CBA are derived from standard CBA methodologies (for a review and CBA patterns, see DG REGIO, 2008). Cost-benefit analysis are practical ways of assessing the desirability of projects, where it is important to take a long view (looking at repercussions in the further, as well as the nearer, future) and a wide view (allowing for side-effects of many kinds on many stakeholders and/or areas). In other words, it implies the enumeration and evaluation of all the relevant costs and benefits. This involves drawing on a variety of traditional sections of economic study – welfare economics, public finance, resource economics – and trying to weld these components into a coherent whole. For those reasons, we will develop a cost-benefit analysis derived from the method proposed by DG REGIO (2008).

4.1. Methodology and hypotheses

A CBA method consists in listing on one side all investment and operational costs, year after year, for a given time horizon (in general 30-40 years for infrastructure projects, i.e. DG REGIO, 2008). Then benefits are also listed in the same time horizon. Then, year by year, benefits are confronted to costs and their difference is discounted (in France, by 4% for public bodies) in order to take into account the availability of money at different years.. Finally, the sum of these discounted amounts lets calculate the Net Present Value on a pre-determined period of time, from which can be derived the Internal Rate of Return (IRR). Although each technology has different settings and is associated to specific assumptions and hypotheses, we need to define a set of common assumptions to all scenarios in order to compare and assess them. The general hypotheses are associated to the way the money is obtained to invest and to the stakeholder that is making investments.

First, we assume a hypothetic city, making abstraction of the country. We assume a VAT of 20% and, for each system personnel costs equal to those of employees working during the pilot implementation, operation and evaluation phases (in case of pilots in different cities, the retained costs will be precised in the corresponding section). We assume the investor is a public authority, mainly a city, and the money to invest is available. If the public authority needed to loan it, interest rates should be added to the CBA, but as a first approach the assumption of money availability let the various readers have a first idea of profitability without complicating the analyses. Another important assumption concerns the time period where investments are made. Oppositely to public transport infrastructures (tramways, subways, urban-suburban trains), investments are not supposed to be made before the first year of operation, but the systems are introduced gradually. This assumption enforces that of money availability.

The CBA will be made on a 10-year horizon, which is enough long to ensure a return of investment and enough short to not need a strong technology change or replacement during the operation period. We also assume the level of operating costs and revenues as constant over this period. The discount rate is assumed to be the French public one, i.e. 4%. This rate varies from one country to another, and can be updated (as well as personnel costs and VAT) when adapting the scenario assessment to cities of one precise country. Last but not least, we suppose that the target IRR (internal rate of return, i.e. the level of profitability requested by the investor) is that of the French public sector, i.e. 4%.

All simulations are based on the same city, a virtual 2.000.000 inhabitant urban area created from real data (MODUM, 2011). Using the tools of evaluation in this context, i.e. generalising local effects to a city point of view, we estimate the costs and the benefits for the two main stakeholders: the city (or public authorities) and the transport carriers (or individuals).

4.2. Scenario characteristics and assumptions

When assessing a scenario, for a CBA or other forecasting analyses, it is important to explain well the context and the input variables by defining all the parameters and setting the various assumptions that allow building the scenario. In this section we present the main characteristics of the scenario that will simulate the deployment of a DSB service in the virtual city as well as the assumptions that have been made. To build a deployment scenario under realistic commercial, tactical and operational conditions, we suppose that the solution tested in Bilbao has been further developed and can be applied to existing parking machines in order to allow the possibility to make private car parking payment (for private parking places around the DSB) and booking operations for the DSB systems on the same machine. In that way, existing machines can be used for both private parking and DSB services. We suppose that all delivery bays with the DSB technology are deployed in a central area (about 3.5 km²). A total number of 100 DSB will be operational in 5 years, and we assume a total number of users (per year) of 1200 vehicles. We assume that one user corresponds to one vehicle and then one vehicle uses only one card. Because the cards can be lost, broken or stolen, we estimate that 15% of the users will need to replace their cards each year. The deployment trends of the system and the number of vehicles consequently using it are reported on the following table:

Table 4. Deployment trends for the chosen scenario

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6+
Number of installed DSBs	16	40	60	80	100	100	100
Number of vehicles using the system	0	150	450	850	1150	1250	1250
Percentage of replaced cards	15%	15%	15%	15%	15%	15%	15%

4.3. Economic cost-benefit analysis

First, an only economic cost-benefit analysis is made. To do this, we take the viewpoint of the service manager, on an economic perspective. We assume then that investment funds are available and that the installed devices are fully operational the year after they are deployed and the number of new carriers are operating and benefiting from the system the same year they become customers of the system, paying a yearly fee independently on the year period they start using it. The cost structure is the following:

Table 5. Cost structure

DSB – INVESTMENT COSTS						
Cost type	**Year 0**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Back office investment	27,000 €	0 €	0 €	0 €	0 €	0 €
Infrastructure and civil works	40,246 €	60,369 €	50,308 €	50,308 €	50,308 €	0 €
Other investment costs	10,000 €	10,475 €	16,000 €	11,000 €	10,500 €	10,460 €
Total investment costs	77,246 €	70,844 €	66,308 €	61,308 €	60,808 €	10,460 €

DSB – OPERATIONAL COSTS						
Cost type	**Year 0**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Functional costs	0 €	0 €	0 €	0 €	0 €	0 €
Police enforcement	0 €	40,000,€	40,000,€	40,000,€	40,000,€	40,000,€
Maintenance	0 €	57,904,€	80,560,€	99,440,€	118,320,€	137,200,€
Other operational costs	0 €	113,€	338,€	638,€	863,€	938,€
Total operational costs	0 €	98,017,€	120,898,€	140,078,€	159,183,€	178,138,€

To finance the system and also to make it more efficient, it is necessary to ask a fee to the users, in order to both contribute to its development and be more involved in using it as well as in defending its good usage. Via an iterative CBA, an unitary benefit of 250€/year is found to lead to an internal return rate (IRR) of near 9%, larger than the requested 4%. Taken into account the sensitivity of the cost model, this IRR is enough to guarantee a return on investment and a correct operational follow-up of the system (in both functional and maintenance aspects). Assuming a VAT value of 20%, the unitary fee for the service is set to 300 € per vehicle and year.

Table 6. Benefit structure and yearly balances

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Over year 6
Number of vehicles	0	150	450	850	1150	1250	1250
Investment COST	77,246 €	70,844 €	66,308 €	61,308 €	60,808 €	10,460 €	10,460
operational COST	0,00 €	98,016 €	120,897 €	140,077 €	159,182 €	178,137 €	178,137 €
Total COST	77,246 €	168,861 €	187,205 €	201,385 €	219,990 €	188,597 €	188,597 €
Individual economic benefit	250 €	250 €	250,00 €	250 €	250 €	250 €	250 €
Total economic benefit	0 €	37,500 €	112,500 €	212,500 €	287,500 €	312,500 €	312,500 €
Balance of total costs	-77,246 €	-131,361 €	-74,705 €	11,114 €	67,510 €	123,902 €	123,902 €
Balance of operational costs	0 €	-60,516 €	-8,397 €	72,422 €	128,317 €	134,362 €	134,362 €

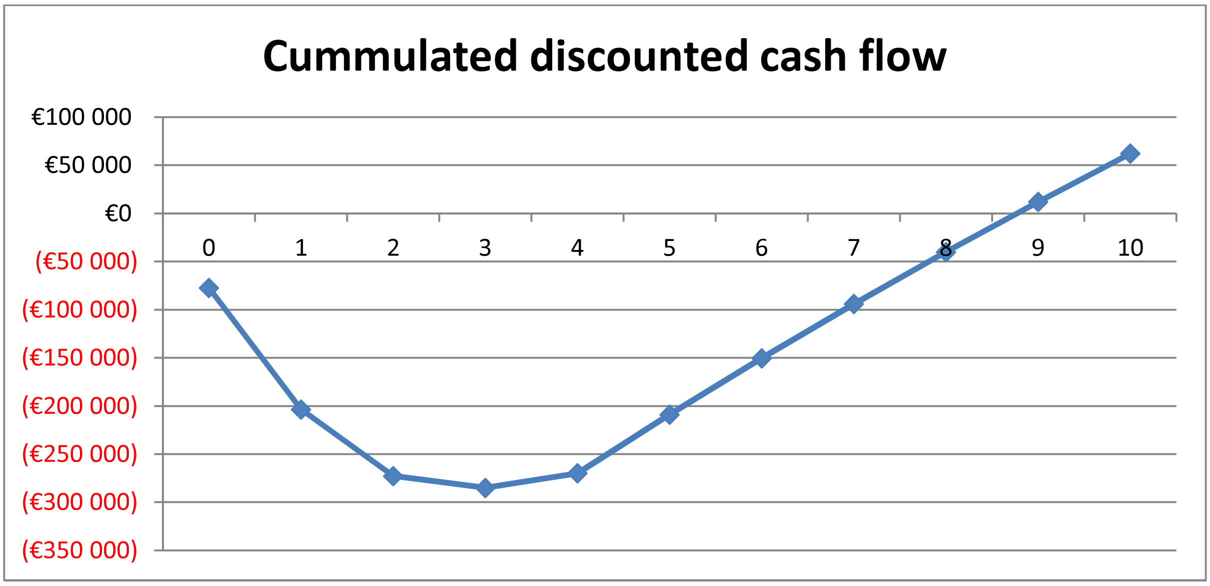

Figure 2. Updated cost-benefit differential trend

After setting the minimum fee, a second analysis is made to include the environmental and social benefits, which are quantified into a monetary value. In this analysis, two viewpoints are studied : first, that of transport carriers (to see the interest of using the DBS service or not), then that of public authorities (to define the public utility rates and eventually reduce the fee by the amount that it is considered to be derived from the advantages the DSB service gives to the city in a collective way). From the evaluation, we observe that environmental and social costs for transport carriers are negligible, since the DSB are few and it is difficult to find a synergy. However, for the city, when positioning the DSB in a limited traffic zone (LTZ), the usage of these systems can be in synergy to the access conditions to the LTZ, and then the traffic nuisance reduction is possible to be taken into account.

4.4. User's socio-economic cost benefit analysis

After making an economic analysis for the service manager, it is important to study the service impacts on users and their cost-benefit differential to state on the feasibility of the system's deployment. To do this it seems important to first quantify the benefits of a DSB for a transport company. In this case, we can identify four direct benefits for a carrier:

- Fuel savings, directly translated into economic gains (money savings related to fuel consumption).
- Time savings, also directly translated into economic gains (money savings related to timetabling and working hours).
- Distance savings, indirectly translated into economic gains (money savings related to vehicle usage).
- CO2 savings, which can be related to economic gains if a Carbon Tax is assumed.

Distance savings are small compared to each route total distance and the vehicle's life, so the impacts on vehicle usage (wheels, brakes) are assumed as negligible. Time savings directly related to the delivery stops are also negligible (less than 2 minutes per stop, less than the data collection incertitude threshold, although the trend is to increase slightly times, but not enough to result in significant changes on daily working hours). However, DSB leads to a decrease of parking infractions (Blanco et al., 2012) which is directly related to traffic improvements that have a positive impact on running time. So the only two variables that result in cost savings are fuel consumption and CO2 emissions, and time savings related to traffic improvement due to DSB usage.

We assume that the DSB areas will be created in order to consent the loading and unloading operations for carriers that are not DSB customers, i.e., to be developed in a non-congested situation. For this reason we assume a development of 100 DSB systems, with a daily time range of 14 hours (from 6:00 a.m. to 8:00 p.m), in order to allow a re-equilibration of the system and maximize the usage of each delivery bay. We extrapolate the results of Bilbao's DSB evaluation with a small calibration concerning small vehicles, the category the less concerned by the system (their characteristics and delivery behaviour show the need of stopping even when no place is available and the possibility to make double parking lines without significantly perturbing the traffic and the environment). In this context, we assume a unitary fuel and CO_2 savings per vehicle per DSB stop as follows:

Table 7. Fuel and CO_2 savings for DSB in a deployment situation

Vehicle type	Fuel savings (ml)	CO_2 savings (g)
Van	0	0
Small truck	32	82
Big truck	40	101

We make the following assumptions:

- The deployment of the DSB allows an average usage of the system, per vehicle, as follows:
  - First year (16 DSB): 5 stops/route at DSB.
  - Second year (40 DSB): 8 stops/route at DSB.
  - Third year and more: 11 stops/route at DSB.
- Savings related to double line avoiding are negligible for drivers in terms of fuel consumption and CO2 emissions. Moreover, time savings are negligible on parking but not when running. Indeed, a speed gain related to congestion decreasing has a direct impact on travel efficiency. The speed increase is estimated to be about 2 km/h in average in the considered area, i.e. an average gain in route of 20 min., corresponding to a time savings of 6% with respect to total travel time.
- Fuel savings are estimated in grams, then converted into litres using an average volumetric mass for fuel of 750 g/l. Moreover, a fuel cost of 1.3 €/l is assumed (this is the current value in France, according to CNR (2012), it can be updated to the current value for each country).

- Concerning CO2, we assume a carbon tax for each transport carrier. Although the current value is 17€/ton, we aim to set it to 100 €/ton[2], according to the last European Considerations (French Ministery of Land Use and Transport, 2005). In this configuration, a carrier having a standard route (see Pluvinet et al., 2012, for more information about routes using DSB in Bilbao) would pay about 1175 €/truck each year (for trucks making urban distribution as those of DSB pilot). On the another hand, the direct benefits are small since the gain of CO2 and the current carbon prices give an average gain of 16 €/truck each year.

The benefit table for the transport carrier is the following:

Table 8. Benefit monetary conversion, for each savings category

Type of gain	Stakeholder	Economic gain (€/year)
Vehicle usage	Transport operator	0 €/year
Time savings	Transport operator	350 €/year
Fuel savings	Transport operator	85 €/year
CO_2 reduction	Transport operator	15 €/year
Total savings	Transport operator	450 €/year

Assuming a fee of 300 €/vehicle each year, after year 5 and that each transport carrier would have an average benefit of 450 €/vehicle each year leads to a potential gain of 150 € per vehicle and year, mainly due to the congestion reduction (= time savings). Remains then to evaluate the gains for the city but the impacts for carriers are positive mainly due to a global effect: illegal parking reduction and better distribution of parking due to urban goods transport and loading/unloading.

5. Deployment barriers

After the identification phase, the barriers were grouped for further discussion with the involved stakeholders. This grouping can be expressed in the following questions:

1. Who will run the back office?
2. How to improve the drivers and fleet operators' acceptance?
3. How to improve the technology providers' acceptance?
4. How to improve the politicians' acceptance?
5. How to solve the policy problems?

[2] That assumption is the estimated cost of CO_2 in 2020-2030, according to French Ministery of Land Use and Transport (2005) .

Technology providers' acceptance

In order to ensure the large-scale development of the technologies, the FREILOT business models must convince technology providers that there is a big market for these products. In the case of the in-vehicle systems the solution proposed by the partners is to adapt the technologies to long haul trucks, thus accelerating service enabling technologies components introduction to freight vehicles.

Who will run the back office after the pilot and who will pay for it?

During the pilot each system developer run the back office of the tested system, but after the pilot there is the need for a unique body in each city running the back office. For the in-vehicle systems the back office will define the zones and the speed limitations, but the other architecture issues will be managed by each truck manufacturer in cooperation with the fleet operators. For the DSB there is a need for a back office managing the parking places. The interoperability of the systems must be provided by a standardized platform and system, where the use of standards will give to everyone the possibility to connect. There is also the necessity for enforcement, control methods are needed, such as policy control, third parties or automatic control (cameras).

The economic viability of a private back office must be proved because the cities are not willing to run the back office. They want to decide zones, speed limits, DSB places and other staff, but the back office must be run by a private company. The city is not willing to pay for the back office, since the direct benefits apply only to fleet operators, not to the cities. The cities can pay the initial investment (short term), but not the maintenance (long term). The European Commission must provide rules on how to manage the back offices, in a pan-European back office systems definition.

Different schemes were provided by the partners for the back office:

- If each back office of the whole country is managed by one company, scale economies for a private company managing the DSB of all the cities will apply (always avoiding monopoly).
- Another solution for funding is to give the back offices to already existing services paid by the cities (parking places management), scale of economy for the cities.

In order to assist in the management of the DSB places taking advantage of the experience created in the pilot, there is the necessity of developing a guidebook on how to manage the DSB places with the Spanish and French experiences. The booking (DSB) procedure (long term booking, FIFO[3] booking) makes it difficult to manage the places. A priority ranking based on the real use of the places and the environmental characteristics of the truck should be implemented.

Another important issue is that of maintenance and service guarantee. If a problem appears, a solving service must be provided. During the pilot, a parking management company (Gertek)

[3] First In First Out, i.e., the first to book is the first to have the right to park at the chosen time period.

in Bilbao and a technical consulting company (Interface Transport) in France were ensuring this problem solving service. However, when technical (related to mechanics or electronics) or information system (related to communication and data exchange) problems appear, both technical and information science staff must be available, at least during the hours the service is active. When a specialised parking management company is involved (i.e. it becomes the service provider and management operator) this possibility is feasible. When a municipal service is assumed, it is important to subcontract technical assistance, with a defined intervention contract, to avoid dysfunctions and difficulties to ensure the service quality.

Drivers and fleet operators' acceptance

In order to increase the market penetration the obtained results must convince small companies and self-employers for using the DSB service. A drivers' point of view (rather than a fleet operators' point of view) can make this task easier, by taking into account the extra work for fleet operators and drivers. Since sharing the machine with car users may cause them time important losses, other technologies such as Bluetooth or WIFI technologies should avoid extra work and save time.

Fleet operators did not interested in actively using the DSB service, as it is reflected by the use of the systems during the pilot (Blanco et al., 2012). In Lyon this was due to technical problems and difficulty to make the system technically operational, whereas in Bilbao it was because the capacity of delivery bays was underused. However, the city of Bilbao has continued the system after finishing the pilot because the transport carriers made pressure to continue it. In order to convince both carriers and public authorities about the benefits, fuel saving and CO_2 reduction indicators must be proved, but also a tax reduction could be applied to them by the cities (also environmental zones commented above). Moreover, a network of DSB must be provided to make the advantages be visible, mainly in terms of traffic positive impact and time savings.

We have also to note that for drivers the service does not imply major changes if delivery spaces are reserved before the delivery route takes place, but have an impact on their flexibility. Therefore, a Smartphone application (as contemplated in the CVIS framework) should help drivers to cancel or change their reservations online if major issues at one stop or during the driving time create an impossibility to reach a reserved delivery space on the reserved period. Furthermore, only a coordinated network of delivery spaces should result on an easily identified positive system, accepted by carriers, but will lead to organizational changes not always seen by drivers as acceptable.

Politicians' acceptance

The role of the politicians is very important in the large-scale implementation of the FREILOT technologies, from the back office management to the promotion of new policies for favouring trucks equipped with FREILOT technologies. Different ideas were proposed by the partners:

- Added value of the system (ambulances, fire brigade…) will favour the support of politicians to the implementation of the technologies.

- Due to the low usage of the system at off peak periods, DSB places could be used for other purposes during off peak hours, enforcing the business model.

The cost of the systems implementation is a key issue for the politicians:

- Civil works for the installation of DSB places are very expensive, also the adaptation of the current machines for hybrid possibilities (parking and delivery) is very expensive (30,000 €). Other technologies (wireless) should be considered, integrating these services within a more complex solution, but reducing costs.
- The DSB is only justified in large cities. Its maintenance can be paid by large commercial stores (they are already paying in France and Spain for private parking places), or by grouping smaller stores. An alternative is to ask the city to invest in the DSB places and then rent them. Economic studies (payback period, IRR…) will justify the investment and the renting prices.

<u>Policy</u>

Policy issues are very important for convincing users. Providing FREILOT technology users with advantages will improve the penetration rate and assure the increment in the usage of the technologies. There are some questions related to this issue:

- How to book public places for private users or to private entities or individuals?
- How can the cities ban trucks that are not equipped with these technologies?
- Who can state priority rules to non-public vehicles since it is not allowed in some countries due to unfair competition (public authority giving priority to some fleet operators)?
- Which urban stakeholders can be involved into the system by expressing the benefits of national distribution to their business development?

For solving the above questions the partners proposed the following:

- Positive results of the project should prove the benefits for modifying the legal framework.
- Consider freight as public service.
- Allow the booking of spaces for specific private activities (car sharing had the same problem and was solved).
- Define environmentally friendly trucks and provide them with privileges.
- Show other advantages (e. g. safety, ambulances, fire brigades…)

6. Conclusion

This paper has presented the main issues in deploying urban logistics systems. From the example of the delivery space booking system described above, we presented the main questions related to making a business model from the evaluation results and the main implementation conclusions. Moreover, a cost-benefit analysis allowed us to fix the most suitable fees, and the main barriers to the deployment of a DSB service have been identified.

From those results, we can set a group of recommendations to both public and private authorities for the deployment of such systems. The first is that of consultation. As shown in Gonzalez-Feliu and Morana (2010), grouping all the potential stakeholders that can be involved on an urban logistics service can accelerate its implementation once the main tactical decisions are consensual, then make the system be operationally more stable. The FREILOT project, and more precisely, the DSB pilot, has shown the importance of consultation and the implication of all partners to make the service work. Indeed, the cohesion of stakeholders in Bilbao made that more than 50 carriers participating in the pilot, where only 4 in Lyon. Moreover, the city aimed to stop the system after the project, and the transport carriers, although not using actively the system, aimed to continue towards the adoption of an operational system and its deployment, which convinced the city to study other strategies to keep and develop the system. In this sense, the CBA should be a valuable decision support, giving both public and private stakeholders the elements to decide which deployment strategy is the best. Moreover, although several barriers have been identified, the communication and the consensus helped to break some of them.

Finally, it is important to lead to a robust business model, with a mature technology and a solid cost-benefit balancing schema, in order to support deployment. To do this, the pilot results will be used to develop a hybrid system allowing existing machines to make also DSB reservations, and the expensive movement captors that identify vehicles on the delivery bays can be replaced now by an alternative solution which is less expensive and ready to deploy. In conclusion, to deploy an urban logistics solution, it is important to first ensure the maturity of the proposed services, its operational status, its technical robustness and its capacity to become an economically viable project (with or without public subvention, and the conditions of this support), then to make a high work on standardization and to make a collaborative work among all the partners.

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