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Abstract

This paper presents the main issues related to the financing of urban logistics solutions, more precisely to the contribution of economic analysis on strategic decision support related for urban logistics financing, focusing on cost benefit analysis. First we present the main funding strategies in urban economics, mainly in the field of urban logistics. Second we address the contribution of cost benefit analysis by recalling the main methodology and adapting it to urban logistics. Third we apply the method to the example of deploying a delivery space booking network, and illustrate the application via a set of three examples containing different situations and scenarios, which are presented, assessed and discussed. From the different simulations, it is observed that the way the system is financed has strong impacts on both its individual cost (for potential users) and its attractiveness.

Keywords: urban logistics services, refunding strategies, cost-benefit analysis, scenario assessment.

1. Introduction

Urban goods transport is a necessary but disturbing activity. To deal with the main nuisances related to it, which are mainly congestion, noise, global warming and local pollution, public and private stakeholders have studied and developed methods and solutions of different nature and dimensions. In transport research, we observe hundreds of works dealing with the subject of urban freight, but the number of operational urban logistics systems is very small. One of the most popular systems is based on the notion of urban consolidation centre (UCC). 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 (Allen et al., 2012, Gonzalez-Feliu et al., 2013a). 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 (Gonzalez-Feliu

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and Morana, 2010) and Parma (Morganti, 2011) in Italy, the railway system of Samada Monoprix (Delaître and De Barbeyrac, 2012) in Paris, France, or the Postdamer Platz consolidation centre in Berlin, Germany (Oustin and Guihéry, 2012). Indeed, the successful stories are more an exception than a rule, and in other fields, like ICT, logistics pooling or home deliveries, most solutions have difficulties to become economically continuous, mainly due to a non-habit of examining their socio-economic suitability in a similar way that on transport infrastructure projects (Bonnafous and Faivre d'Arcier, 2013).

In literature, we observe several works dealing with transport project financing and socio-economic assessment, but most of them are related to transport infrastructures or public transport networks. Concerning urban logistics, Browne et al. (2004) investigate the collaboration fields among public and private stakeholders, comparing narrow Public-Private Partnerships (PPPs), mainly related to co-financing projects and sharing costs, risks and benefits, and wide PPPs, which are other forms of collaboration not always involving co-financing and risk sharing. Van Duin et al. (2008) propose a provocative vision of the trend that consist to promote UCCs and show via the identification of costs and benefits when and how an UCC can be viable. However, in both works, no socio-economic analyses are carried out in terms of generalised cost-benefit comparison over a time period, which would allow public and private decision makers to orient their choices. Such analyses, although often presented in literature (Nuzzolo et al., 2012; Wygnoki and Goodchild, 2012; Ambrosini et al., 2013) are more related to a global public authority's vision without investigating the financing issues but the impacts in terms of congestion and pollution. We think that it is important to give researchers and practitioners the ways to assess economics of deploying urban logistics projects since it is an emerging question and becomes a need for public and private stakeholders[1].

This paper aims to propose, via a case study, a methodology to assess the viability of urban logistics projects. Such methodology is adapted from that used in other transport fields to the specificities of urban logistics. First, a brief overview of financing mechanisms in urban economics is proposed, as well as its application to urban logistics. Then, the basis of a cost-benefit analysis is presented, focusing on how it can be used for city logistics projects. After that, an example of deploying a Delivery Space Booking (DSB) network on Lyon (France) is proposed based on the results of an evaluation carried out in Bilbao (Spain), a city which is similar to Lyon. Finally, three examples of use of a Cost Benefit Analysis for strategic decision support are proposed, having as basis the given example. Various scenarios are defined, assessed and discussed to show the interests of economic analysis for strategic decision support related to financing questions.

2. Refunding mechanisms in urban logistics

Financial structures and refunding mechanisms are wide subjects of research that have many direct applications and usages in urban transport, mainly in infrastructure and public transport planning. However, those subjects are much less usual in urban

[1] During the SUT conference in Goteborg, in April 10-12, 2013 (http://lindholmen.se/sv/node/28149), such issues were addressed and a big interest of both scientific and practice communities was made on assessing the capacity of projects to become economically viable.

logistics. According to Gonzalez-Feliu et al. (2013b), this can be explained by the cohabitation and usually the conflicts between two main viewpoints: that of public planners and that of private operators. Public planners' aims are directly related to policy assessment, deployment and evaluation (Ambrosini et al., 2008; Gonzalez-Feliu et al., 2013c). Private operators goals deal mainly with on carrier-based planning tactics and strategies (Crainic and Laporte, 1997). In any case, it is necessary to provide the necessary funds to make the investments needed, and this for both public and private entities. We find three families of refunding approaches: that of collective utility, that of users' refunding, and a wide variety of mixed approaches, Although traditionally the two first families have been seen as being in direct conflict, the development of approaches from the third family show that they can co-habit and combining them in a synergic way can improve the economic viability of a project (Browne et al., 2004; Bonnafous et al., 2006). In this section we examine the three families of approaches.

2.1 Collective utility and user's refunding

Collective utility can be defined as the socio-economic interest that a project can bring to a society (see for example Mills, 1994, O'Sullivan, 2007). In collective utility viewpoints, the initial investments and operational costs are paid by public authorities (O'Sullivan, 2007). Following this logic, funds must come from the public taxes (either local or national) without any requested monetary return to refund them. Collective utility is associated to the construction of free infrastructures, like national and regional public roads, public parking areas and delivery bays or electronic accesses to limited traffic areas. To justify public utility, a system must be proven socio-economically viable (Gonzalez-Feliu et al., 2013b). To prove that viability Cost Benefit Analysis is often used, as seen in infrastructure investment (Hayashi and Morisugi, 2000). Examples of projects funded on a collective utility viewpoint are the Limited Traffic Zone parking areas in Bologna, Italy (Spinedi, 2008) or the Proximity Logistics Spaces in Bordeaux, France (Gonzalez-Feliu et al., 2013b).

User's refunding strategies consist on making the user pay for benefiting the system or the service, more precisely make transport carriers, retailers and/or shippers pay a fee for using an urban logistics service. That strategy is often motivated for economic reasons and the systems in this category need to be economically viable. For that reason, it is needed to show, via economic analysis the viability of the system on a monetary basis (Mills, 1994). Examples of this strategy are most highways in Europe and, in urban logistics, German Urban Consolidation Centres (Oustin and Guihéry, 2012) or Dresde's cargo-tram (Gonzalez-Feliu, 2008).

2.2 Combined viewpoints

In urban logistics, the main refunding approaches are mixed because of a common factor of most projects: investment costs are difficult to be entirely refunded. For that reason, public authorities accept to partially finance them, then to make them operational and economically viable (for operational costs and a part of the investments). However, combined viewpoints are various in nature and structure and it is not always easy to properly identify all of them. We however propose a categorization of mixed approaches (Bonnafous et al., 2006).

The most common strategy is that of private funding with public intervention. In this viewpoint the public authority does not have an economic benefit with its financing contribution. Indeed, public bodies do not get refunded back, but help private stakeholders to make the projects economically viable, assuming that public utility justifies a partial collaboration to funding without asking an economical return. We find three main forms of public intervention:

- Delegation: public authorities cover a part of the investments (or not) and give a private company the structures to make a service. Sometimes (like in public transport) they cover a part of operational costs, in other cases (like Vicenza's UCC) they cover only the investments and give free usage of the structures, but the operational costs have to be covered by the private company. This is common in highway projects, and some public transport networks, and has been seen in some UCCs: Parma (Morganti, 2011) and Vicenza (Ville et al., 2012) in Italy, La Rochelle (Trentini et al., 2010) in France.
- Subsidies: subsidies are economic helps that must not be refunded back. Such support can be direct (like in Genova UCC) or indirect. Direct subsidies are in general under public market regulations and follow a system of calls. Projects receive in this way a direct economic support from public bodies, which covers a part or the totally of the investment costs and operational costs for a period considered enough to ensure the system's economic viability. Note that several public bodies propose direct subsidies: the European Commission via several support programs, each country national institutions, regional bodies, local bodies or non-governmental associations (Trentini et al., 2012). Indirect subsidies are in general not direct economic support to the project but ways to decrease some costs, such as real estate or manpower. The most popular example is that of Chronopost, at Paris, France, where the real estate stakeholder owning the logistics spaces got a subsidy to reduce land prices in order to allow Chronopost to pay a suitable price (Trentini et al., 2012). Indeed, it is very difficult to develop logistics activities in the city centre without public intervention because the high values of real estate prices.
- Public loans: this is the case of low interest credits to help the development of urban logistics systems. Those economic helps must be refunded back to the public authority but interests are in general set in a direct relation to inflation, so they are more convenient that classical loans. This is the case of several projects like the AMI program of the French National Agency of the Environment[2].

We find also approaches combining various strategies, like in Padova's UCC, where the facility was already owned by the operator. In that case, costs for feasibility analysis and demonstration were not refunded (as paid directly by public authorities), but vehicles were bought on the name of the public transport operator, and given free to the operator. We also observe several types of narrow Public Private Partnerships, which are popular in public transport but are limited few cases in urban logistics (Browne et al., 2004).

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3. Applying Cost-Benefit Analysis (CBA) to urban logistics

3.1 Basic notions of cost-benefit analysis

Cost-benefit analysis methods (CBA) are very popular in economics, and can be often seen in transport infrastructure or public transport network strategic planning (DG REGIO, 2008). Generally, a CBA method consists on listing on one side all investment and operational costs, year after year, for a given time horizon (in general 10 years for infrastructure projects, according to Bonnafous and Faivre d'Arcier, 2013). Then benefits are also listed in the same time horizon. After that, for each year, benefits are confronted to costs and their difference is updated using an update rate in order to take into account the money updating year after year. Finally, an Investment Return Rate (IRR) after the project's time horizon is calculated. In order to take into account the pluri-annual time horizon, it is important to define an updating rate *a* which allows comparing two quantities of money at two different periods. Taking the value of a quantity of money V_t at time *t*, and V_n the value of this quantity at horizon *n*, they are related by the following equation: $V_t = Vn/(1+a)n$.

Then, year by year, benefits are confronted to costs and their difference is updated using an update rate of 4%. Finally, an Investment Return Rate (IRR) is calculated, in a 10-year horizon. IRR is calculated using only economic data, i.e., direct monetary costs and incomes, and represents the capacity of refunding an investment. When dealing with public authorities, it is also suitable to define the indirect costs and benefits, i.e., those which do not take the form of monetary values, such as pollution, stress, security, etc. and monetise them. A return rate based on the generalised costs can be then estimated. This rate is called Economic Return Rate (ERR) and is often used in socio-economic evaluations. In any case, we would like to note that CBA must be adapted to the assessed context, and are strongly dependent on the hypotheses and assumptions made when defining the scenarios to assess. In this paper we do not aim to provide innovation in CBA methodical structure but to study the different hypotheses and assumptions made to adapt such methods to assess technological solutions in the field of urban logistics. For more details on the general methodology of Cost Benefit Analysis, see Layard and Glaister (1994).

3.2 Context, scenario characteristics and assumptions

The different scenarios and situations will be based on development and deployment trends for a delivery space booking (DSB) system like the one tested in Bilbao (Spain) within the FREILOT project. The system consists on a network of delivery bays equipped by a booking system (via for example a parking machine or a website) where drivers or transport carriers can book some of the proposed slots. Users can book in advance (mainly via the website) or, in real time one they arrive to the delivery bay, but this second option is possible only if free space is still available when the driver arrives to the delivery bay. When a driver who has booked a slot parks on the delivery bay, he must identify using an id card via the parking machine. The delivery bays are not equipped of physical barriers to avoid illegal parking, but a sensor system indicates if a vehicle is parked, and via an online communication with the reservation server, it checks if the identified driver (if any) corresponds to the user who booked if the slot was already booked. If a vehicle is on the delivery bay and either no driver has identified nor the identified driver does not corresponds with the user who booked the slot, a light signal indicates the illegal situation and an e-mail is sent to the police office to improve the efficiency of enforcement controls. The system was tested in Bilbao and the main evaluation results can be found in Blanco et al. (2012).

To simulate the scenarios, we need to have a unique basis on which only parameters related to who invests would change. For that reason all simulations are made on Lyon’s conurbation, which counts about 1.900.000 inhabitants. Delivery space booking being more useful in city centres, we focus on the downtown, which is a very dense zone with a plethora of retailing, service and leisure activities. 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 the collective community) and the transport carriers (or individuals).

We assume a VAT of 20% and, for each system personnel fees 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 précised in the corresponding section). Another important assumption concerns the time period where investments are made. Oppositely to public transport infrastructures (Hayashi and Morisugi, 2000), investments are not made in the first two years, but the systems are introduced gradually (Gonzalez-Feliu et al., 2013a). This assumption enforces that of money availability, i.e., we assume that money is available and no loans are required. Although that is a strong assumption, it can be set as a basis for comparison since it allows avoiding further artefacts related to loan refunding, which is a subject that merits specific research and will not be explored in this paper. Indeed, avoiding entering on loan refunding, we assume that all scenarios have equal refunding conditions, enforcing the comparability between them.

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 (Litman, 2004). 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. Moreover, we define a target internal return rate (IRR) of 15% for the private company and 4% for the public entity. Last but not least, we assume that invested money is available by each investor, so no hypotheses on how the money is obtained are made.

3.3 Model calibration and sensibility analysis

The Cost-Benefit Analysis is made on the basis of a mathematical model which relates costs and benefits to several tactical and operational variables. Since the model is standard (Layard and Glaister, 1994), we are not re-proposing the entire model (the main calculations and cost determinants are presented in Gonzalez-Feliu et al., 2012). However, each cost-benefit model needs to be calibrated. Furthermore, it is also important to analyse the sensitivity of the proposed approach. To do this, a first simulation of a system with a deployment of 25 delivery bays equipped with the booking system, following the trends shown in Gonzalez-Feliu et al. (2013b), is made, i.e. considering four delivery bays the first year, and the addition of other five each year until the fourth one, where six delivery bays are installed.

First, costs are estimated and a starting fee is defined. A first CBA is made, then iteratively it is repeated changing the fee until an IRR of 4% or higher is obtained. For this analysis, we take an IRR of 4% since it corresponds to the requested minimum in a case of public investment where no loans are asked (i.e. considering the investment capital is available). This procedure leads to the definition of a starting fee of 250 € VAT included.

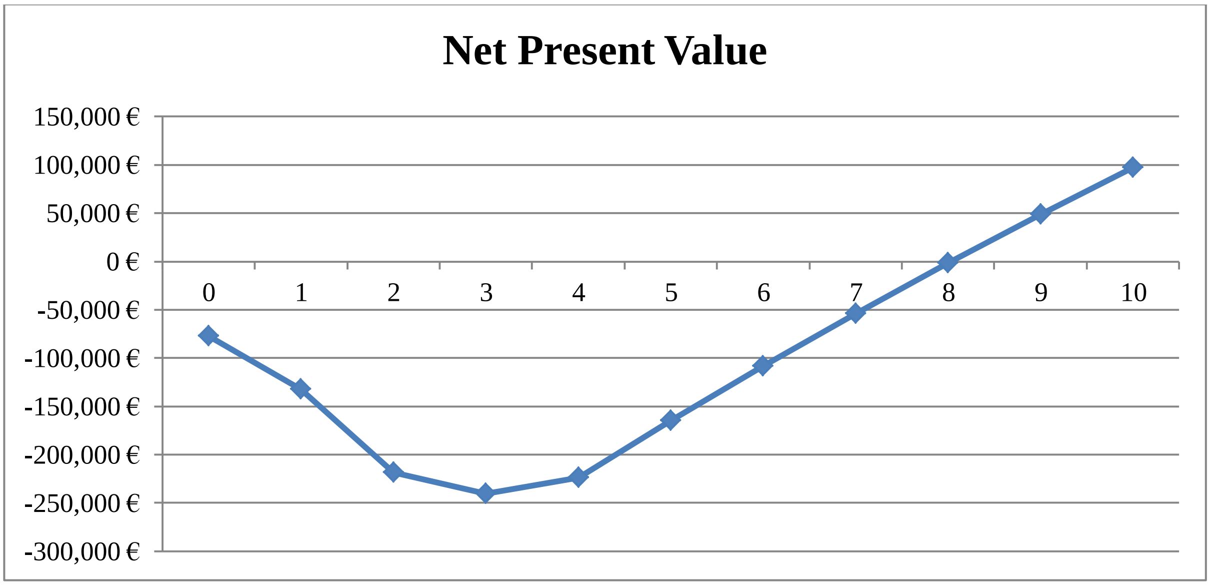

Figure 1: Net Present Value trend in a 10-years horizon with 100 scheduled bookable delivery bays and a fee of 250 € per vehicle and year (including VAT)

Once a reference situation is chosen and assessed, we make a set simulation changing the values of each group of variables. We assume a margin of 10% in cost estimations, i.e. we consider that each group of costs, either investment (infrastructure and civil works, on board unit acquisition, advertising) or operational (enforcement, back office maintenance, infrastructure maintenance). We observe that operational costs influence is higher than that of investment costs, since they are higher. For that reason, we separate them in three main categories: police enforcement costs, related to police controls to make the system be used only by trucks reserving it (and persuading cars to keep the place free for an usage by delivery vehicles only), back office maintenance costs, related to system and reservation management and technical maintenance, and infrastructure maintenance costs, related to DSB’s physical maintenance.

Table 1: Sensitivity analysis results

+10%	10 years IRR	Gap
Initial Situation	**5,87%**	**-**
Investment costs	**4,54%**	**-1,33%**
Enforcement costs	**3,78%**	**-2,09%**
Back office maintenance costs	**3,63%**	**-2,24%**
Infrastructure maintenance costs	**2,01%**	**-3,86%**

-10%	10 years IRR	Gap
Initial Situation	**5,87%**	**-**
Investment costs	**7,23%**	**+1,36%**
Enforcement costs	**8,04%**	**+2,17%**
Back office maintenance costs	**8,20%**	**+2,33%**
Infrastructure maintenance costs	**10,03%**	**+4,16%**

It is obvious that cost estimation rely on a limited information set that can lead to estimation errors. Such costs being of different nature and related to different sources, they have different impact on the overall IRR estimation. In order to understand the influence of such errors into the global estimation, we provide a table synthesising the main categories of costs and the IRR gaps when such costs are estimated with an $\pm 10\%$ error. Regarding our application case, it emerges that infrastructure maintenance dominates all other costs, since their influence leads to cost variations of about $\pm 4\%$, whereas the other operational costs lead to variations around $\pm 2\%$. Investment costs lead to variations of near $\pm 1\%$. In any case, we observe that a 10% variation on such costs has a small but non-negligible consequence on overall CBA. In other words, infrastructure maintenance costs have the highest influence on the overall IRR of a deployment project of a DSB network, having an impact factor of 0,4, which is the double of operational costs for back office maintenance or enforcement. This is due to the fact that, in the pilot, the technological solution needed to install captors that present high operational costs in terms of maintenance and replacement. Although new solutions are envisaged to reduce such costs, in the present simulation we exactly adopted the system of Bilbao. This implies to take care on well estimating operational costs, and highlights the importance of well dimensioning the network, since such costs are directly linked to the number of DSB deployed.

3.4 Estimation of benefits

After testing the cost-benefit model on the only basis of the costs, we need to define the benefits needed to make the project economically viable. To do this, it is necessary to define the maximum fee it can be asked to users. In other words, we need to examine the individual benefits for users in order to define the maximum value they would accept to pay for using the system. To estimate those costs on a comparable basis we assume that both investment and operational costs do not change in time. The details of those costs are found in Gonzalez-Feliu et al. (2012). They are summarized as follows:

Table 2: Main unitary costs (aggregated)

Cost type	Cost	Unit
Fixed investment costs	25 000	€
Variable investment costs	2 500	€/ unit
Fixed operational costs	45 000	€/ year
Variable operational costs	1 000	€/ unit and year

Individual benefits are related to a plethora of factors, which are not always easy to identify (Gonzalez-Feliu et al., 2013b). In this case, we have identified four direct benefits for a carrier. Such benefits are obtained from the different evaluation results of the system (Blanco et al., 2012):

- 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).

We make the assumption 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. We extrapolate the results of Bilbao's DSB evaluation with a small calibration concerning vehicles (details on evaluation and conversion are respectively seen in Blanco et al., 2013 and Gonzalez-Feliu et al., 2012). In this context, we assume a unitary fuel and CO_2 savings per vehicle per DSB stop as follows:

Table 3: 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

Moreover, it is assumed that after the third year of deployment, an operational threshold is reached, i.e., the number of DSB in the network allows a re-organization of delivery routes that allow visiting between 9 and 11 delivery bays in average. A speed gain related to congestion decreasing can be assumed. This gain 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 (Gonzalez-Feliu et al., 2012). Fuel savings are estimated in gram, then converted into litres using an average volumetric mass for fuel of 750 g/l (Gonzalez-Feliu et al., 2012). 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). The benefit table for the transport carrier is the following:

Table 4: Benefit monetary conversion, for each savings category

Type of gain	**Economic gain per vehicle (€/year)**
Time savings	360 €/year
Fuel savings	90 €/year
Total savings	450 €/year

With these assumptions, after year 5 and that each transport carrier would have an average benefit of 450 €/vehicle each year. After defining individual benefits for transport carriers, it is important to define the collective benefits in order to estimate the interest of municipal authorities on investing on such systems. Some of those benefits derive from those of transport carriers but others have to be estimated by taking into account global traffic on the DSB influence areas. The main benefits that have been identified are:

- Time savings for personal and commercial trips, which can be translated into economic gains (money savings related to timetabling and working hours). However, since it is difficult to make this estimation, we assume an average cost of time according to World Bank (2005) for monetary value estimation of travel time.
- Distance savings, indirectly translated into economic gains (money savings related to vehicle usage) are as for transport carriers savings, negligible.
- CO_2 savings, which can be related to economic gains if a Carbon Tax is assumed. The estimation method is made assuming a carbon tax for each transport carrier. Although the current value is 17€/ton, we aim to set it to 100 €/ton, according to the last European Considerations (French Ministery of Land Use and Transport, 2005). Then, we estimate current traffic in concerned areas (for all personal, commercial and goods transport) on the basis of traffic distribution (Crozet et al., 2012), assuming a current distribution of vehicle types on the considered city and translating it to the traffic in the parts of the city where we supposed to have DSB systems operationally working.

The collective benefits table is the following:

Table 5. Collective benefit monetary conversion, for each savings category

Type of gain	**Overall economic gain (€/year)**
Time savings	250 €/year and vehicle
CO_2 reduction	10 €/year and vehicle
Total savings	260 €/year and vehicle

The overall benefits by year are estimated to be comparable to those of investments, so that will justify a collective utility vision.

4. Application examples, scenario assessment and results analysis

To illustrate the interest of CBA, we propose various application examples of CBA using the DSB deployment example presented above. The first use of CBA we propose is related to dimensioning the delivery bays network. To do this, a socio-economic approach is taken, i.e., we think in terms of ERR and not of IRR.

To dimension the network, it needs to be taken into account the conditions under what the expected benefits can be observed, i.e., each route needs to use between 8 and 11

DSB systems per day. Taking into account the average fleet of vehicles that use such systems (Pluvinet et al., 2010), we can state semi-articulated vehicles will seldom use them. Moreover, such vehicles deliver mainly in the early morning (Pluvinet et al., 2012). Furthermore, delivery bays in France are set to a length standard, which allows dividing them into three sub-spaces in order to host either a semi-articulated vehicle, a single truck plus a small commercial vehicle or three small commercial vehicles. Taking into account the current usage of vehicles during the DSB demonstration and the average fleet of vehicles in Lyon (Pluvinet et al., 2012), we can set the average number of vehicles contemporaneously in a delivery bay to 2. Given a number N of delivery bays, the maximum weekly capacity C^{week} of the delivery bays can be defined as:

$$C^{week}=2*T^{open}*N*P$$

where P is the period of the week (in days) when the DSB system is active; T^{open} is the period of the day (in hours) during which the DSB are open to reservation.

We assume that this period is 5.5 (i.e., from Monday to Friday plus Saturday morning), following the state-of-the-practice in Lyon (Pluvinet et al., 2012). Moreover, we see from evaluation results (Blanco et al., 2012) that DSB, if open to reservation, can be used up to 8.00 p.m.; for that reason we assume that each delivery bay is operational from 6.00 a.m. to 8.00 p.m.

Taking into account that each vehicle makes in average 3.5 routes per week, the need of visiting at least 9 delivery bays, and the average size of the potential vehicles for DSB usage purposes, we can estimate the weekly need of capacity NC^{week} to ensure the system is working efficiently:

$$NC^{week}=3.5*9*m$$

where m is the number of vehicles using the system.

With that information, we can compare the weekly capacity of delivery bays to the need of capacity, given a set of vehicles using the system. Via the Cost Benefit Analysis tool, we can assess different cases, with the same assumptions, making then vary only the number of delivery bays and the number of vehicles using the system, then observe the consequent ERR to analyse the suitability of such network. Assuming a set of 2000 users, this estimation has been made:

Number of vehicles	Number of DSBs	Total capacity	Need of capacity	Residual capacity	ERR
2000	200	5133	7000	-27%	10%
2000	250	6415	7000	-8%	15%
2000	275	7078	7000	1%	9%
2000	300	7700	7000	10%	9%
2000	350	8983	7000	28%	5%
2000	400	10266	7000	47%	1%

This simulation confirms the sensitivity analysis conclusions, since the ERR is well related to the number of DSB systems in the network, but presents non-linear trends. Indeed, for a network in under-capacity (i.e. less than 275 DSBs) the ERR is higher than for a system with enough capacity, mainly due to the high operational costs for system maintenance. When increasing the number of DSBs to 250, the ERR increases since the costs remain still less important than the socio-economic benefits related to increasing the capacity of the DSB network (some companies will not be able to use the system at their best, which would lead to a customers' decrease, but also a lower impact on congestion decreasing and CO2 reduction).

We observe from the proposed case that a threshold 300 DSB need to be reached to offer enough capacity and then obtain the expected environmental and social benefits. However, with a network of 275 DSBs, the ERR is about 9% in 10 years. For the two last cases (350 and 400 DSB), there is an over-capacity, and the economic investments are not compensated by the overall benefits. Moreover, the differences between 275 and 300 DSB systems are small, both in terms of costs and benefits, and a 10% of residual capacity seems suitable to avoid a congestion of the system, according to a qualitative evaluation of the system's usage (Blanco et al., 2012). For those reasons, a network of 300 DSB systems has been chosen.

Then, a second usage of Cost Benefit Analysis is that of defining suitable fees of users. 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 300 DSB will be operational in 5 years, and we assume a total number of users (per year) up to 2000 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 6: Deployment trends for the chosen scenario (respectively in total number of DSB systems and vehicles using them)

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6+
Number of DSB systems	0	40	110	180	250	300	300
Number of vehicles in the DSB network	0	300	800	1300	1700	2000	2000

Following the deployment trends shown in Table 2, we estimate for each scenario the costs and the benefits, starting on an initial fee of 250 € including VAT, and iteratively changing its value until obtaining a suitable IRR. We make the assumption that inflation has an equal effect on both costs and benefits. We iterate the calculation of the fee until a value of 8% is reached for IRR. After making the iterative analysis, we set the starting fee to 365 € including VAT.

After that, a third usage of cost benefit analysis can be made to define the funding strategy of the network. To do this, we propose a scenario simulation on the basis of 5 scenarios of public and/or private funding of the DSB system. The aim of the scenario assessment is then to define a fee of usage, so we are placed on user's refunding and mixed strategies. We propose then 4 scenarios to assess:

- S1: Public funding with a user's refunding strategy. Investment and management costs covered by the public authority on the basis user's refunding. Public funds are only loaned for a part of investment costs then refunded back on the basis of the public funding interest rates. For this reason, and according to Bonnafous and Faivre d'Arcier (2013), an IRR of 8% is necessary to justify the economic feasibility of the system.

- S2: Private funding with an user's refunding strategy. Investment and management costs covered by a private company, on the basis of public delegation of service. No financing is made by public funds, and the company needs to ensure a minimum benefit that can be translated on an IRR of at least 15%.
- S3: Investment and operational costs covered by a private company, on the basis of public delegation of service. Costs of police controls are entirely covered by the public authorities and no IRR is requested. The company needs to ensure however an IRR of at least 15% based on overall investment and operational costs (without police enforcement).
- S4: Management costs covered by a private company, on the basis of public delegation of service, with a public subsidy that covers all investment costs for years 0 to 5. That amount is funded by a public mechanism and no IRR is asked. The company needs to ensure however an IRR of at least 15% for operational costs.

After defining the scenarios, they are assessed using the CBA method introduced above. In Table 7 we synthesise the results of the assessment:

Table 7: Scenario simulation synthesis

Scenario	**IRR**	**ERR**	**Yearly fee[3] (per vehicle)**
S1	8.5%	34.1%	365 €
S2	15.6%	30.0%	390 €
S3	15.6%	34.6%	380 €
S4	15.9%	42.9%	190 €

We observe from the table the main differences in terms of IRR and ERR, ass well as the value of the yearly fee that has to be asked to transport carriers (per vehicle) to reach the expected IRR. In the current economic context a situation of free usage (i.e. without asking a fee) based on public utility is not viable, since at least operational costs and if possible a part of investment costs need to be refunded by the user to ensure its continuity. In that context different possibilities are shown. Scenario S1 leads to a fee of 365 € in case of a total funding by public authorities, which ensures the best ERR and an IRR of 8.5%, which is, according to Bonnafous and Faivre d'Arcier (2013), acceptable for public authorities taking into account both inflation and interest rates variations. S2 and S3, which are quite similar, lead to similar results. The first needs a fee of 390 €, and the second a fee of 380 €, with similar IRR and ERR values. Note that the main difference between both situations arises on enforcement controls. Indeed, the first assumes a private control, made by mobility agents, whereas the second uses public police enforcement. In any case, the conclusions of both simulations are similar: yearly operational costs being quite similar to yearly investment costs for the first 5 years, even higher, the two main support actions seem to be arisen on either financing a part (or the

[3] Including VAT

totality) of investment costs or giving a yearly subsidy to cover operational costs. For that reason, S4 assumes a subsidy that covers investment costs. The resulting fee is much lower, i.e. 190 € with VAT. Obviously, this situation assumes that the collective authorities see an interest on financing the system, which is the case when the ERR is about 43%. So, only a strong support, mainly in terms of subsidy, can lead to a strong fee decreasing, which will directly impact the acceptability of the system by potential users.

5. Conclusion

Through an example derived from a real experiment and demonstration, this paper presented the main issues related to the financing of urban logistics solutions, specifically on the contribution cost benefit analysis on strategic decisions related to investment refunding. After presenting the main funding strategies in urban economics applied to urban logistics, we addressed the methodological issues of cost benefit analysis. Then, we adapted it to the case of deploying a network of delivery space booking systems in the city of Lyon (France), having the main results and conclusions of a demonstration of the same system carried out in Bilbao (Spain). Several examples of usage, on the example of deploying a delivery space booking network, are presented and discusses. From the different simulations, it is observed that the way the system is financed has strong impacts on both its individual cost(for potential users) and its attractiveness.

From the scenario assessment, we observe that only public or only private strategies, with minor support, lead to few changes in terms of fee value. Only a strong financial support, as for example a subsidy to cover investment costs, has a positive impact on the fee to pay and then on the incitation to use the system. In any case, such results need to be discussed with the concerned stakeholders (both public and private) in order to reach consensus. To do this, further work to implement decision support tools will lead to the integration of multi-criteria methods to economic analysis

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