Is urban logistics pooling viable? A multistakeholder multicriteria analysis

Jesus Gonzalez-Feliu, Josep-Maria Salanova Grau

IS URBAN LOGISTICS POOLING VIABLE? A MULTISTAKEHOLDER MULTICRITERIA ANALYSIS

Jesus Gonzalez-Feliu
Research Engineer, Laboratoire d'Economie des Transports, CNRS, Lyon, France
Josep-Maria Salanova Grau
Research Assistant, Hellenic Institute of Transport, CERTH, Tessaloniki, Greece

INDEX

ABSTRACT

Collaborative transportation and logistics pooling are relatively new concepts in research, but are very popular in practice. In the last years, collaborative transportation seems a good city logistics alternative to classical urban consolidation centres, but it is still in a development stage. This paper proposes a framework for urban logistics pooling ex-ante evaluation. This framework is developed with two purposes. The first is to generate comparable contrasted or progressive scenarios representing realistic situations; the second to simulate and assess them to make a "before-after" comparative analysis. In this framework, a demand generation model is combined with a route optimization algorithm to simulate the resulting routes of the proposed individual or collaborative distribution schemes assumed by each scenario. Then, several indicators can be obtained, mainly travelled distances, working times, road occupancy rates and operational monetary costs. To illustrate that framework, several scenarios for the urban area of Lyon (France) are simulated and discussed to illustrate the proposed framework possible applications.

Keywords: urban logistics, resource sharing, freight transport pooling, collaborative multicriteria analysis.

I. INTRODUCTION

The freight transport industry is a major source of employment and supports the economic development of the country (Gonzalez-Feliu, 2012a). However, freight transport is also a disturbing activity, due to congestion and environmental nuisances, which negatively affects the quality of life, in particular in urban areas (Crainic et al., 2004). In this context, city logistics has been developed for more than fifteen years, giving solutions and methods to support public authorities and also other stakeholders in urban freight transport planning and management (Taniguchi et al., 2001). Both the new trends in retail and commerce organisation and the technological innovation in supply chain and distribution planning have led decision makers to consider collaborative strategies to reduce overall cost of the supply process (Gonzalez-Feliu and Morana, 2012). This is the case of collaborative urban freight transport systems, where the different stakeholders of urban logistics can make collaborative agreements to improve the efficiency and then reduce the overall costs of the global supply chain activities networks. These schemas are commonly used in the transport field, mostly in logistics sharing (Gonzalez-Feliu and Morana, 2011). In the last decade, several producers and/or transporters have elaborated mutual strategic plans which focus on a better usage of the transport vehicles by sharing them.

The aim of this paper is to present a method to evaluate the viability of logistics sharing. First we present the main concepts of utban consolidation and collaborative freight transportation. Then, a methodology for evaluating such systems is proposed. This framework is organised in several modules, including a scenario simulator, a transportation management system (TMS), a risk management module and a multi-criteria analysis method. In this paper we focus on the multi-criteria analysis tool. After describing the method, five scenarios are described and simulated. Finally, the main results are presented and commented.

II. URBAN CONSOLIDATION AND LOGISTICS SHARING

Traditionally, urban freight transportation planning has been made by the operating companies. In the last years, the public authorities have started to get involved into the development of solutions to deal with the major problems of freight transportation in city centres: congestion, air pollution, noise and other nuisances. Some of the most common measures taken by the authorities in different countries are restrictive policies, mainly regulation on parking, and street access. In several countries, surveys and data collection activities have been undertaken, and several studies give elements of freight transportation analysis and organisation for urban areas (Ambrosini and Routhier, 2004; Allen et al., 2012a). These efforts are aimed at better understanding and quantifying these phenomena and represent a first step in the development of a new discipline, called by several authors City Logistics (Taniguchi et al., 2001) or Urban Logistics (Anderson et al., 2005). The main goals of City Logistics measures and projects are related to congestion and air pollution rates, without a penalisation of the commercial activities in the city centres.

The most popular organizational scheme in urban logistics is that of urban consolidation centre (UCC), defined by Allen et al. (2007) as "*a logistics facility situated in relatively close proximity to the geographic area that it serves (be that a city centre, an entire town or a specific site such as a shopping centre), to which many logistics companies deliver goods destined for the area, from which consolidated deliveries are carried out within that area, in which a range of other value-added logistics and retail services can be provided*". The first UCCs were private or semi-private initiatives, mainly developed for economic and optimization interests (Dablanc and Massé, 1996) and stopped when seen as less viable that other distribution systems. Later, environmental and social issues made public administrations to develop such systems for urban goods distribution (Gonzalez-Feliu, 2008). In order to make a European overview on UCC we have selected the main experiences shown in literature (See Gonzalez-Feliu, 2012a, for a detailed state-of-the art). We present in Table 1 a synthesis of the experiences taken into account.

Country	Total number of UCCs	Operational UCC in 2011
United Kingdom	32	13
Italy	16	10
France - Monaco	16	8
The Netherlands	14	6
Germany	14	3
Sweden	4	0
Switzerland	3	1
Spain	3	0
Austria	1	0
Belgium	1	0
Finland	1	0
Greece	1	0
Portugal	1	0
TOTAL	75	25

Table 1: Synthesis of the main European experiences

We can observe that only few experiences are nowadays operating (about 1/3 of the total), and in many cases they need an important contribution of public authorities, both in terms of funding and organizational support.

The country with a higher number of UCCs is the United Kingdom, which counts up to 13 operational platforms (Allen et al., 2012b). The German UCC success rate, lower than the French and Italian ones, remains still higher than countries like the United Kingdom or The Netherlands, which the public authority support did not result on operational logistics schemes, resulting on a very small number of still opened UCCs (about 20-30% of the total number of projects). Other countries have also projected UCCs in a minor intensity, but the results are not encouraging (if we add all the remaining experiences, we obtain a success rate of 30%). Note than in both cases the UCC systems were supported by the public authorities, mainly in the form of strong regulation policies, but the financial support was lower than in France and Italy.

Italy is the second country in both number of planned and operational UCCs, but presents a higher rate than UK (about 63%). From the case of Siena's UCC (Browne et al., 2005) to the last developments of Cityporto's network of cities with UCC (Gonzalez-Feliu and Morana, 2010), more than 15 UCC have been planned. Most of them derive from public decisions and have an important contribution of public authorities, both related to regulation and funding. The main UCC in Italy are related to medium-sized cities, i.e. cities between 100 000 and 500 000 inhabitants. In the last years, other small cities (from 10 000 to 50 000 inhabitants) have started to develop such systems. The only application cases in big cities is that of Milan, where the public transport operator ATM used their bus depots and other facilities to propose an urban freight delivery system. The system was operational between 2005 and 2008. It stopped because a major change in urban regulation that forbit ATM to use the bus corridors for freight distribution.

On similar patterns, the French UCC have been developed (we include the UCC of Monaco in this category for reasons to culture and geographical proximity to France). Note that in this country, a National Comitee for Urban Goods Transport have been created in 1995 and is still operating , which facilitates the exchanges and promotion of good practices. Two types of UCC are observed: city-based UCC, which are related to an entire city or its historical center (La Rochelle and Monaco are the two that remain still operational); area-based UCC, more related to a neighborhood and used by several companies without an aim of public service (Bordeaux, Paris, Rouen) and private UCCs, like those of Chronopost and Samada-Monoprix (Paris), Colizen and La Petite Reine (several cities in France).

The Netherlands is a curious case. Often considered as a failure (Rosini, 2005), the UCC concept had difficulty to be implemented under operationality conditions until 2006. After that, several UCCs have been developed (Allen et al., 2012b) and although some of them have been stopped, the success rate remains important (about 42% overall and more than 75% after 2006). Germany has also developed several UCCs, but the operational experiences represent about 21% of the total number of projected UCCs. This can be explained by the fact that German UCCs have in general been developed by consortiums of private companies without public funding support for their construction and operational cost balancing, although research and development funds and regulation support have been provided by the authorities in some cases. Indeed, German UCCs are an example of non-direct intervention of public authorities. This makes the number of successful UCC lower than those in France or Italy and has a stronger connection to the market and the business development of the concerned transport operators in UCCs.

The German UCC success rate, lower than the French and Italian ones, remains still higher than countries like the Sweeden and Switzerland, which the public authority support did not result on operational logistics schemes, resulting on a very small number of still opened UCCs. Other countries have also projected UCCs in a minor intensity, but the results are not encouraging (if we add all those experiences, we obtain a success rate of less than 10%). Note than in those cases cases the UCC systems were supported by the public authorities, mainly in the form of strong regulation policies, but the financial support was lower than in France and Italy.

As most of these experiences show, a UCC needs an important initial investment in terms of infrastructures, facilities and human and technical resources, including delivery vehicles, which are often compensated by public financial support. This support is not always enough, as operational costs are not always covered by the UCC overall income. Moreover, transport operators remain still reticent to use UCC under some conditions because the schemes related to these logistics platforms suppose at least an additional rupture of charge. The main limits to the usage of UCC can be grouped on the following categories (Ville et al., 2012):

- *Legislation.* Although it can be seen as a favourizing factor to UCC development in any cases (restrictions on access to some areas of the city for non-UCC vehicles can help the development of UCC), legislation can also be a limitation when it is related to freight compatibility, i.e. the norms and laws that forbid the loading of a vehicle with products of different sorts (for example dangerous goods, fresh food, waste, raw materials, etc.) or when dealing with competition laws that can limit the development of sharing approaches.
- *Organisation.* The physical and organizational conditions for freight compatibility, can limit the development of UCC. For example, dimensions, the type of packaging, the stock unit and the need of specific material for loading

and unloading operations will be a limitation for two shipments to cohabit the same vehicle or consolidation platform. Another organizational factor related to the acceptability of transport carriers arises on the changes they will make on their distribution schemes.

- *Cost.* If a rupture of charge implies organizational changes, it also supposes cost increases. Although some UCCs have found optimization schemes to reduce these costs and facture similar costs to the transport operators, the question is still a current discussion subject when planning and developing these platforms.
- *Responsibility.* The factors related to the transportation operation's responsibility are strictly derived from the contract between the different actors of these operations. If the collaborations among partners and customers of UCC distribution systems follow a contract or a chart where the questions of responsibility are well defined, these questions will not constitute an obstacle to sharing. On the other hand, if these questions are not clearly specified in a contractual document disputes related to responsibility can derive on legal conflicts.

The main issue in UCC is to reach a rentability threshold that ensures the economic balance of the logistics facility. Imposing a unique UCC operator does not seem to be the most efficient solution, as shown by Dablanc et al. (2010), and other strategies have to be found. Collaboration is one of the most promising areas of study in supply chain management and has started to be applied to freight transport management. Logistics sharing and logistics pooling are specific forms of resource sharing (Gonzalez-Feliu et al., 2010). Although in a narrow sense the word "sharing" refers to the joint or alternate use of inherently finite resources, both material and immaterial, it can also refer to the process of dividing and distributing (Gonzalez-Feliu and Morana, 2011). Sharing resources in freight transport is related to three main issues: vehicle sharing, infrastructure sharing and route sharing. Concerning vehicle sharing, the logistics organisation is similar to that of car sharing or bike sharing systems for people transportation (Katzev, 2003, SUGAR project, 2010). Indeed, a freight vehicle sharing system proposes a fleet of shared vehicles, and each user of the system can book and use a vehicle for his or her own purposes. In these systems, each user continues to follow an individual organisation (vehicles are shared but each user continues doing its own transport schemes without merging them with those of other users). The second approach is that of platform sharing (Rakotonarivo et al., 2010), without necessarily a collaboration between users. These two issues have been recently studied in the literature (Simonot and Roure, 2007; Paché, 2008; Blanchard and Carbone, 2010; Gonzalez-Feliu and Morana, 2011). The third, less studied, is that of logistics pooling.

Logistics pooling can be defined by analogy to car pooling (De La Morsanglière et al., 1982; Gärlinga et al., 2000). We can introduce freight transport pooling as the mutual and contemporary use of a vehicle by two or more actors, all of them being conscious and having a direct action on decisions concerning this transport organisational aspects. Note than the usage of a freight forwarder or integrated logistics providers (4PL, LLP) are usual concepts in freight transport (Ville, 2010), but the responsibility and the decision making is relayed to a third party, who assumes its consequences. This is not a collaborative decision making case, as defined by Yearwood and Stranieri (2011). Indeed, in those transport and logistics schemes, the sender (or the receiver) contracts a company that organises all the transport and distribution related operations, involving other actors like transport operators and logistics providers. This company takes decisions and organises all the distribution processes, the sender (or the receiver) being only customers paying for a standard or personalised service. In logistics pooling approaches, the decisions are not taken by only one stakeholder but by the group participating on the pooling operations. As happens on car pooling (De La Morsanglière et al., 1982), a freight transport pooling involves deliveries having a common trip chain in their overall path, and follows the same principles of multi-echelon transport with cross-docking (Gonzalez-Feliu, 2012b).

As logistics pooling follows similar schemes as integrated supply chains, we can envisage adapting methods from supply chain evaluation to estimate the effects of this form of collaboration in a sustainable development viewpoint. However, as several stakeholders are involved, current works do not represent the specificities of pooling strategies on logistics planning and optimization. In next section we will propose a methodology for analysisng the viability of logistics pooling for urban distribution, on the basis of a multi-criteria analysis for a set of different stakeholders.

III. MULTI-STAKEHOLDER MULTI-CRITERIA METHODOLOGY

Although collaborative transportation is a promising approach, there are many limits and not all the stakeholders are a priori disposed to enter on such communities (Gonzalez-Feliu and Morana, 2011). For this reason, public authorities and collaborative communities of practise want to develop decision support tools that help the individuals to consider the advantages and risks of collaboration globally, in order to take the decisions having a better knowledge of this field (Thiengburanathum et al., 2010). In order to support public authorities and private actors in their choices concerning collaboration in urban freight transportation, we propose a framework based on modelling and simulation, that feeds a multi-criteria decision support method. From real urban distribution stakeholders, several data can be collected. From those data, a collaborative decision making multi-criteria analysis can be proposed to define the main indicators used to assist and support both public and private stakeholders' decisions. The framework is organised as show on

Figure 1.

From real urban distribution stakeholders, several data can be collected. Moreover, because the framework is based on simulation, several hypothesis and assumptions will be needed. All these information, as well as other data like geographic and socio-economic information that characterises the chosen urban area, are entered on a knowledge management system (KMS), which is the core of the framework and receives, stores and send all the necessary inputs and outputs of the different modules. Then, a data processing tool integrated on a scenario simulator will be able to produce the cases to simulate. After that, two modules are working in parallel: a risk factor identification that evaluates the risk of the chosen scenario, for each stakeholder and for the community, and a transportation management system (TMS), which finds a good sharing schema and the routes that derive from it. From the TMS, an estimation of the environmental effects is made by a specific model. From these three modules are collected by the multi-criteria analysis tool that finds a set of criteria and analyses them, first in the point of view of each stakeholder, then in a global approach, for the general interest of the collaborative transportation community.

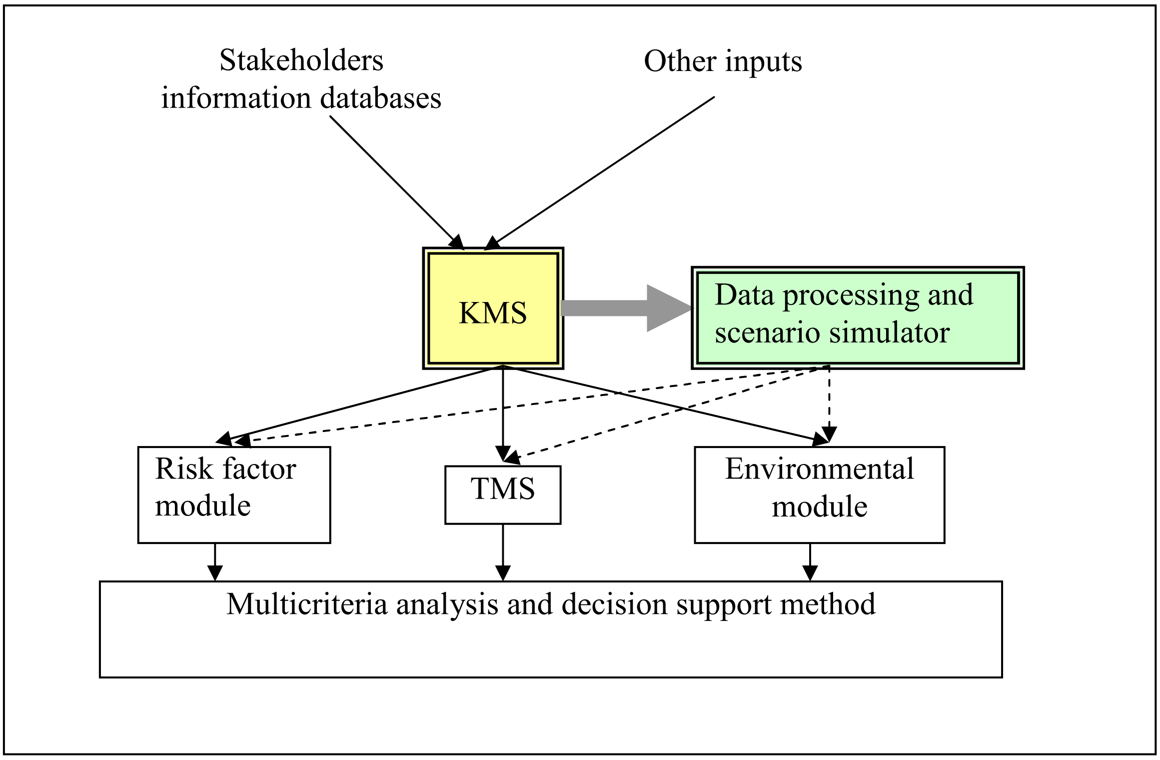

Figure 1: Chart of the strategic evaluation

A) Scenario construction

The scenario simulation is carried out adapting the method proposed by Gonzalez-Feliu et al. (2012) to logistics pooling. The method works as follows. Consider a city, divided into representative zones. Each zone is defined by its population density, its commercial supply in terms of number of employees in each commercial activity class, its level of industry and distribution activity and its position with respect to the city centre. We define a set of commercial activities that will be involved on logistics pooling strategies, for example the grocery distribution sector. Using a delivery generation model (Routhier and Toilier, 2007, 2010), the number of deliveries per establishment can be estimated. Then, from Henriot and Routhier's (2010) ratios, we assign a quantity of freight to each delivery (Gonzalez-Feliu et al., 2012). The route construction procedure is described below. From Patier and Routhier's (2008) empiric results we define the involved transportation companies. These companies are defined by a heterogeneous fleet of vehicles, a set of depots and a set of possible cross-docking platforms. Then, using Gonzalez-Feliu and Salanova's (2011) scenario simulator, we generate the vehicle routing problems that will be solved using the route construction procedure.

B) Transportation Management System (TMS)

The transportation management system is a tool that builds the routes for each transportation carrier involved in the collaborative transportation system and estimates the travelled distances and the environmental impacts, in terms of emissions of greenhouse gases. This module uses an algorithm for the two-echelon vehicle routing problem (Gonzalez-Feliu, 2008, 2012c) adapted to collaborative transportation systems.

The algorithm is a fast heuristics, following a two-step procedure. This has been chosen because the methodology is aimed to support tactical decisions of collaborative communities, so the driving route estimation method has to be assimilated to a commercial route planning tool, in order to be use don real-size cases in a few seconds. First, a sweep algorithm is used in order to make clusters of customers, assigning them to a fist-level route and not to a satellite. When dealing with direct shipping, a classical sweep algorithm as those developed for CVRP applications is applied. For 2E-VRP, the sweep algorithm takes into account the satellite position in order to define the routes (i.e., customers are assigned to a 1st echelon vehicle but taking into account the satellite this vehicle will bring the freight for a cross-docking operation.

Second, the routes are built using a semi-greedy algorithm (Gonzalez-Feliu et al., 2010). There are two types of routes: the 1st-echelon ones go from the depot to the satellites, and the 2nd-echelon ones from the satellites to the customers. The routing phase is common for all the configurations: once the customers are grouped, a semi-greedy is applied in order to build the 2nd-echelon routes. Then, the 1st-echelon ones are obtained easily by a combinatorial procedure, since the number of possibilities is very small. Note that in some cases the instances solved are related to heterogeneous fleets. This issue has been taken into account in the route construction. Finally, a small post-optimisation procedure using fast local search techniques is used.

C) Criteria definition

The criteria that will feed the multi-criteria analysis are obtained from three modules: the TMS (already described), by converting the estimated distances into economic indicators, the environmental module, and the risk management module, to obtain respectively environmental indicators and risk factors.

1. Economic indicators

Economic indicators are related to two main variables. First is the total travelled distances, that can be divided into two categories: the in-route distance and the access distance. The first distance is the distance travelled from the first customer/satellite until the last one (passing by all the customers/satellites in the defined order); the second distance is the distance travelled from the depot/satellite to the first route point and from the last route point back to the depot/satellite. The calculation of the in-route travelled distances is done by the Euclidian distance between each two consecutive route points, excluding the depot/satellite from the route. The calculation of the access distance is done by the Euclidian distance between the depot/satellite and first and last route points. The cost of the routes are fixed costs (driver basically) and variable costs (length, time, consume and contamination). To estimate the travel time, average speeds are used, with higher values for the access to the route, and lower values for the in-route travel. From these distances, we can estimate the yearly quantity of fuel needed.

Second is the total working time, which is composed of total travel time, the time spent for loading and unloading purposes and the driver's pauses imposed by the current legislation. To estimate these times, we define a mean speed between each O/D pair, following the considerations of Routhier (2002) and Presstalis (2011). The travel times are then estimated from the travelled distances. Then, the total work time is calculated associating a loading or unloading time to each pick up or delivery (related to the quantity of freight to pick up or delivery). If a route in terms of travel time does not exceed the legislation working times, we add consequently the corresponding pauses of the driver. If these constraints are not respected, the route is re-optimised, even split, to meet the legislation. From those working times, we can estimate the total number of workers and their annual cost in terms of salary.

Then we calculate the yearly cost by converting the distance travelled of each route to a monetary cost. To do this, we take into account the conversion tables proposed by Generalitat de Catalunya (2011), including fuel costs, maintenance and vehicle insurance (related to the distance travelled) and crew costs, related to travel hours, estimated from the distances travelled and average urban speeds (Routhier, 2002).

2. Environmental indicators

Concerning environmental indicators, several possibilities can be taken int account. Because in this work we aim to study the effect of organisational strategies having the same technological support, pollution emissions of the proposed scenarios are only dependent on the trealled distances and the type of vehicles that can be used, which do not vary from one scenario to the other (the variation will be on the usage rates of these vehicles, but the overall set of possible vehicles remain the same in all scenarios). For this reason, we propose an analysis on only traffic issues. From the travelled distances per truck, we can easily estimate travel road occupancy rates. To do this, each truck distance is weighted by a coefficient depending on its weight, as stated in Table 2:

Table 2: Weight factor for traffic issues (adapted from Routhier et al., 2009)

Total on-load weight	Weight factor
Less than 3.5 t	1
3.5-7 t	1.5
7-16 t	2
More than 12 t	2.5

Another indicator that can be calculated is the total number of parking hours in congested city areas. This indicator is directly related to the total loading and unloading time in central areas. In order to take into account the vehicle's surface, we have pondered the total number of hours by the type of vehicle (i.e. weights presented in table 1), to obtain the total number of h.PCU.

3. Risk factor identification

The risk management module derives from the works of Lambert et al. (1996); Seiersen (2006); Roy et al. (2006); Gonzalez-Feliu et al. (2010) and Gonzalez-Feliu and Morana (2011). It follows the following schema:

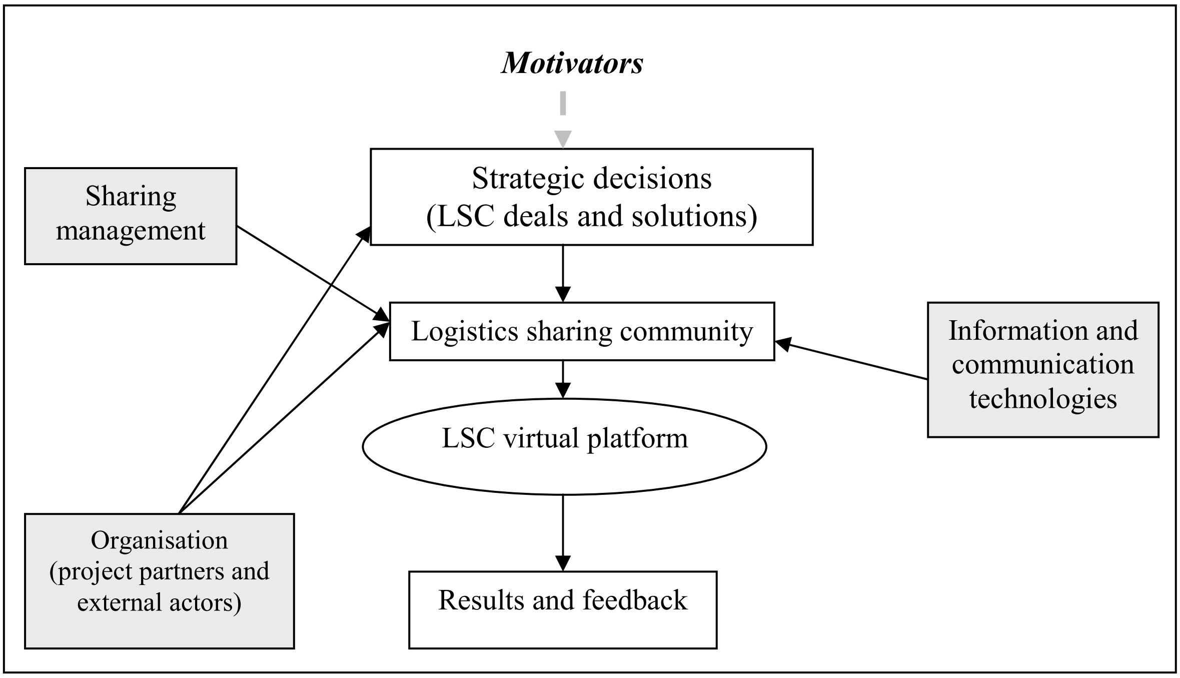

Figure 2: Risk management module (adapted from Gonzalez-Feliu and Morana)

Considering the technologies, tools and their usage levels, several choices must be made in order to set up the best solution of logistic sharing services. In order to make these choices, it is important to formulate questions related to the goals and the risks of the project, and to find the appropriate answers. Accordingly, it is important to make a deep analysis of the possible risks that the project may encounter. From the work of Seiersen (2006), we can list the main categories of risks related to a collaborative transportation sharing project:

- The risks related to the project accounting itself, more precisely to the different type of resources that can be affected by the project, in financial, economical, technical, technological or human terms. In general, each partner of the logistics pooling community knows its implications in financial and accounting terms, and these decisions are individually taken.
- The risks related to the organization of the project and its continuity. Two types of risks can be identified in this category: the risks related to the logistics organisation for operational decisions, which are in general individually made, and those related to tactical and strategic actions, where both individual and collective decisions take place; in this context misunderstandings and other obstacles to collaboration have to be seen as potential risks. It is important to note that the reorganisation of a project can be considered only when the project is operative and stable.
- The technological risks; in general, the technologies present problems related to functionality, robustness and compatibility, among others. Before choosing a technology, it is important to think about these questions.
- The risks related to policies, processes and current practices. The development and usage of new logistics solutions can need an important change in the way people think and act to make them operative. Continuous social analysis during all conception and development phases are crucial to the stability and success of very innovative solutions. These social analyses need to be made on both the collaborative strategy stakeholders and the external actors involved in the different stages of the project.
- The risks related to the impact of the systems in the current and future operations, at both human and technical levels. In this category, the collaboration rules and the respect of them have to be considered.
- The dependence risks; if the information system is based on several technologies, the risks related to the dysfunction of these technologies have to be considered. When a technological tool presents a dysfunction, the system can be less efficient, or can stop because of it. These risks have to be studied in a preliminary phase of a project.
- The juridical risks: as seen in Ville et al. (2010) it is important to take into account the juridical consequences of public policy and the changes this policy implies on the urban organizations.

C) Multicriteria mapping

Once the criteria are defined, we can extract them and make a multi-criteria analysis. Note that the multi-criteria method is developed to choose among a set of solutions. For this reason, different strategies are presented and simulated first separately for each stakeholder and then for the overall group. For each strategy, the TMS and the environmental modules are used in order to estimate the main costs and environmental issues. Moreover, we feed the risk management module with all the scenarios, in order to give the risk factor for each of them. In this simulation we analyse the case of an individual decision maker, i.e. one of the five transportation carriers, who wants to enter on a collaborative transportation system and needs a decision help. From this consideration, we propose the following criteria for our analysis, each of them measured by an indicator:

- Economic costs: Transportation cost (in €)
- Travel distances: Travel distances (in km)
- Contribution to traffic: Road occupancy rates (in km.PCU)
- Contribution to greenhouse gas (GHG) emissions: Individual GHG emissions (in CO2-equivalent units)
- Risks: Risk factor (1 to 5)

After estimating the indicators corresponding to each criterion, a graph is made, first for each stakeholder then for the overal group. Each criterion has its own scale. Moreover, the criteria are graphically positioned consecutively in order to observe them one by one without crossing them. Then they are presented consecutively in the same graph, i.e., they have to be read independently because there is not a relation of scale between the criteria.

IV. AN EXAMPLE OF APPLICATION

In this section we propose a set of scenarios that will be used to illustrate the proposed framework. In our example we supposed 5 different operators (representing each a realistic transportation carrier). Each operator has a depot, a few satellites for consolidating the cargo, and its own fleet of trucks, with two different sizes of trucks. The total number of customers is 408, and the number of satellites 12. Moreover, each customer can be served by more than one transportation carrier. In order to propose a realistic set of scenarios, we used a real urban network: that of Lyon (France), the second largest in France, only after Paris Metropolitan Region.

In 2006, this area consisted of about 2.000.000 inhabitants and 800.000 households. We use a database that derives from the 2006 household trip survey of Lyon urban area (Grand Lyon, 2006). This file contains several databases from which we can extract information related to the population and the demography, as well as to define the main retailing zones of the urban area (the overall surveyed territory has been divided into a set of about 750 zones). The information related to the retailing activities (number of employees, dimension, and type of establishment) are extracted from a SIRENE file, the establishment censorial database of the French Institute of Statistics (INSEE). We took the SIRENE file of the year 2005 in order to have results from a similar time period. From the SIRENE file we extracted the data corresponding to the small grocery retailers of Lyon and Villeurbanne (about 400 establishments). These retailers will be the final destinations of the freight to be delivered and are grocery retailers with a total surface lower than 400 m². Then, using FRETURB, we estimate a weekly number of deliveries per retailer. Then we define 12 cross-docking platforms located in the near periphery of city, mainly in industrial zones. The industrial zones are extracted from the SIRENE file. We define the logistics facilities from the SIRENE file and locate them in the near periphery of city, mainly in industrial zones. The depots are located in the peri-urban area, also known as the far periphery of the city. Then, a quantity of freight is associated to each delivery (as seen on Gonzalez-Feliu et al., 2012). We then estimate each company's transport plan using an adaptation of Gonzalez-Feliu and Salanova's (2011) fast heuristic algorithm for two-echelon transport optimization in urban areas, according to a two-step procedure. First, a non-hierarchical clustering method allows assigning customers to a vehicle. Second, the routes are built using a semi-greedy algorithm (Gonzalez-Feliu and Salanova, 2011). We simulate a total of 5 scenarios, described below:

1. A non-collaborative strategy where only the big trucks are used, visiting a large number of clients due to the bigger capacity of the vehicles. Here we solved five different and independent CVRPs.
2. A second non-collaborative strategy where the big trucks are used for distributing the cargo to the satellites, and from there to the final clients using the smaller trucks. Here we solved five different and independent 2E-VRPs, where the capacity of the big trucks is limiting the capacity of the satellites.
3. A partial transportation pooling network where 2 operators are collaborating, while the other are acting as in the second scenario. The collaborating clients share their satellites, and consolidate cargo destined to the same clients, sharing also their fleets of small trucks. Here we solved four 2E-VRPs, one of them with heterogeneous fleet.
4. A collaborative transportation pooling network where all the operators are collaborating, using all the satellites for consolidating the cargo and sharing their fleet of small trucks. Here we solved one 2E-VRP with heterogeneous fleet.

In the following we propose the results of the multicriteria analysis.

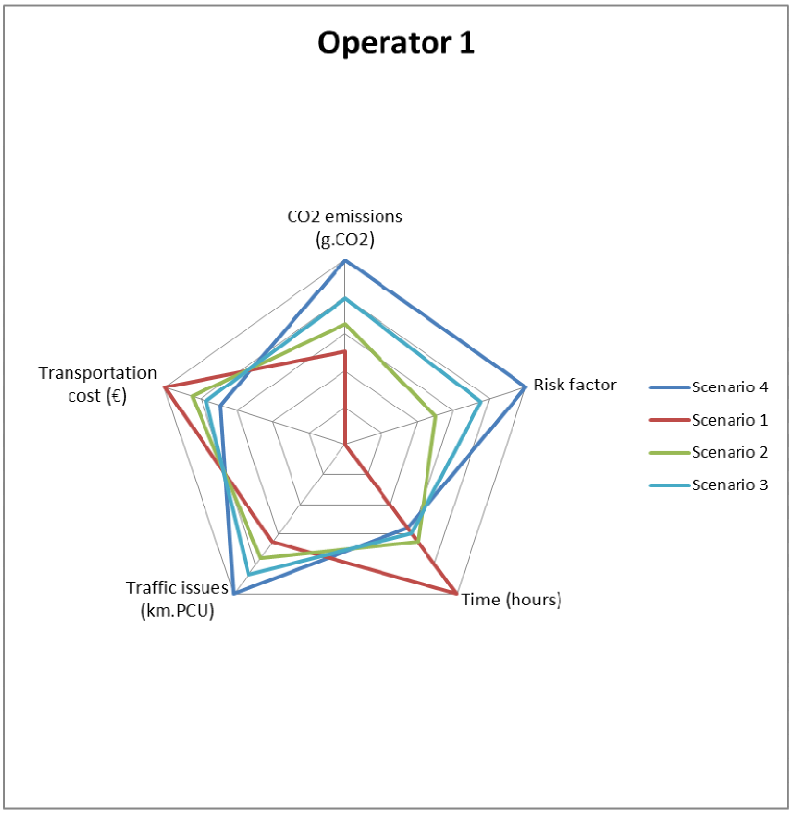

Figure 3. Multicriteria results for operator 1

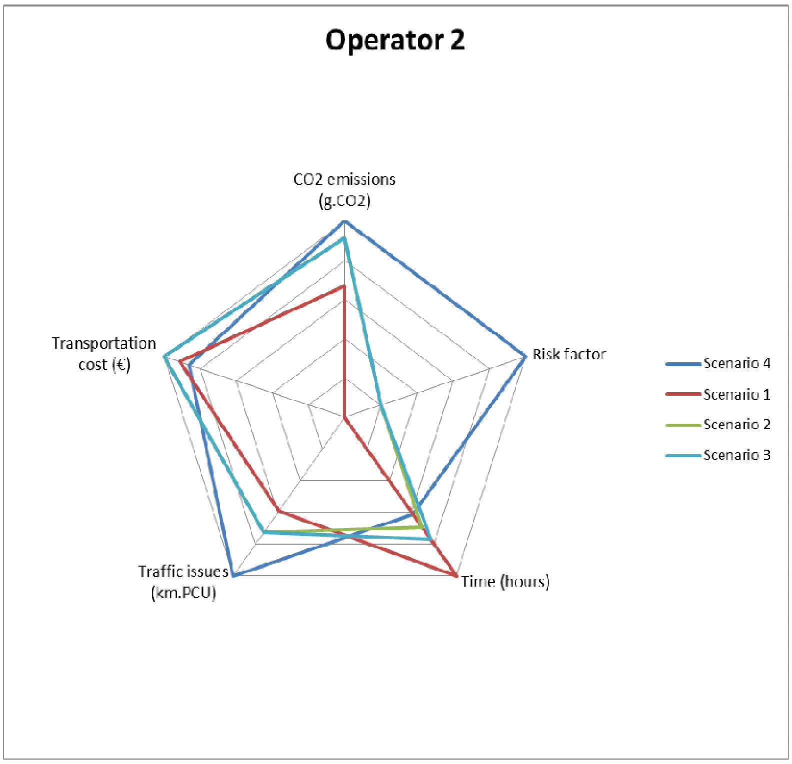

Figure 4. Multicriteria results for operator 2

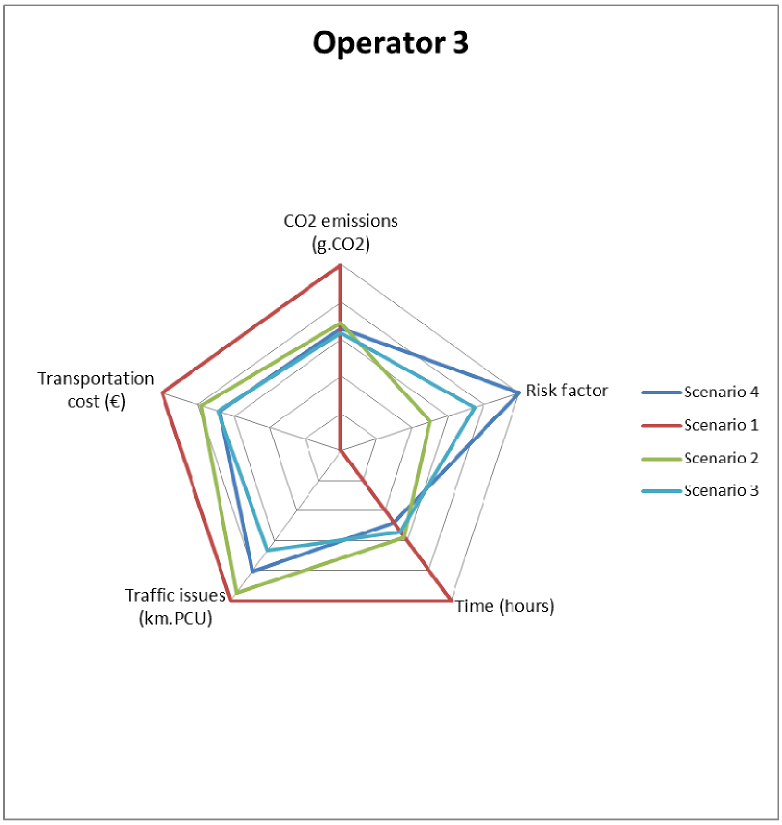

Figure 5. Multicriteria results for operator 3

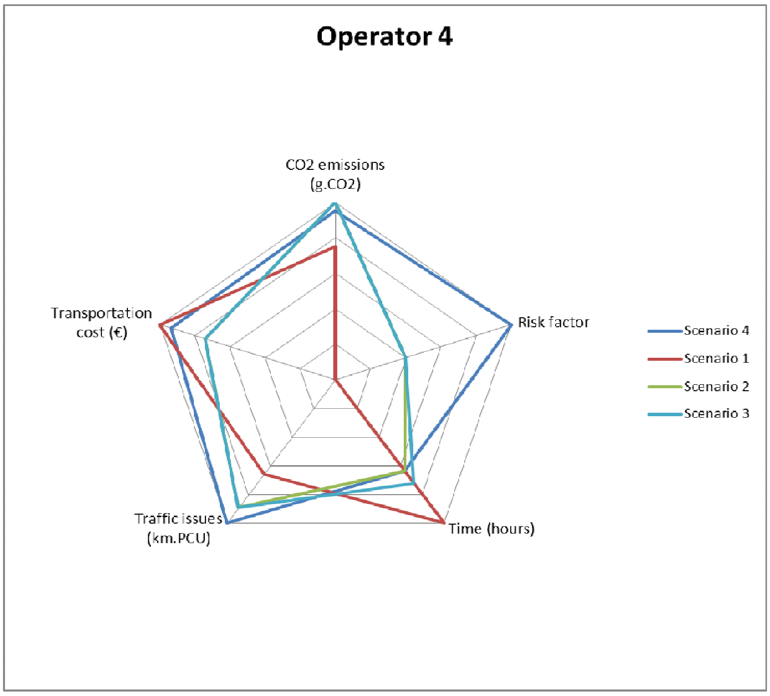

Figure 6. Multicriteria results for operator 4

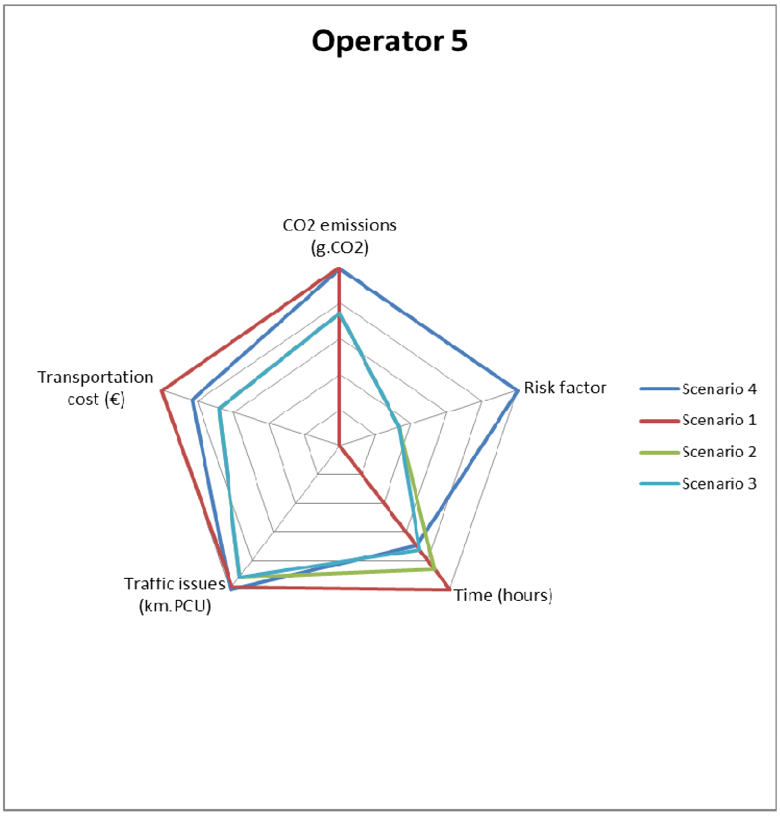

Figure 7. Multicriteria results for operator 5

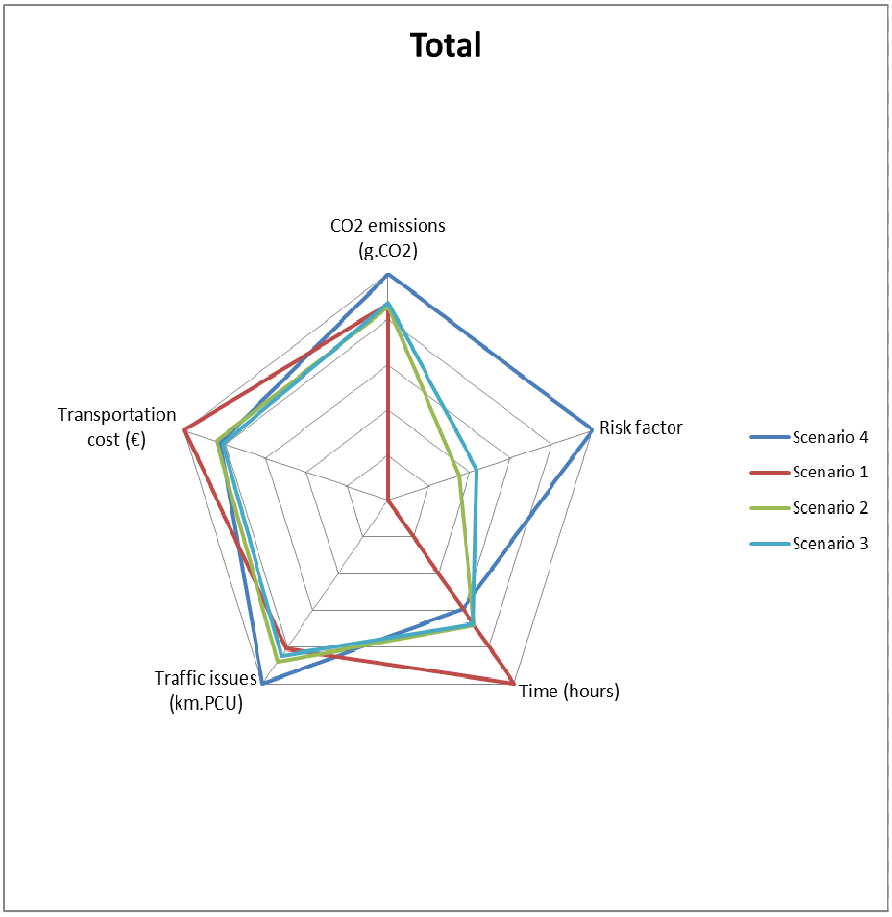

Figure 8. Multicriteria results for the entire group (collective analysis)

We observe from the analysis that finding a solution that satifsfies each stakeholder is not evident. Indeed, although for operators 2 and 4 it seems that scenario 3 is the most suitable, for the other operators it is not easy to find, since each scenario is better tan others in one or more criteria but is dominated in other ones. If we pay attention to the overall system, The logistics sharing approach (scenario 4 is not the best solution, since it represents the higher risk and is overperformed by the others in terms of congestion and pollution (that can be explained by the fact that the small gains on some operators are compensated by big loses on others, due to the fact that each stakeholder presents optimized distribution schemes). On the other hand, it presents the overall lower costs and driving times. Opposignly results are observed for scenario 1 (the reference). Scenarios 2 and 3 remain as middle choices, but can be in this case the most suitable, since they are closer to the best solution for each criteria (they are ranked 2nd and 3rd in all criteria).

V. CONCLUSION

In this paper we have presented the main issues in planning urban freight transportation pooling systems. Moreover, a multi-stakeholder multi-criteria decisión support method for collaborative transportation decision support is presented, more precisely to help the urban goods movement decision makers in their strategic choices (for both public and private stakeholders). The proposed method combines several modules. From the simulation, we observe that collaboration is not evident, and it can lead to cost reduction at some conditions. Moreover, it is the most environmental-friendly solution from those taken into account. However, implementing these systems presents risks that have to be evaluated. From the analysis we observe that although collaboration is an interesting field, it is early to say if it will be well applied to city logistics. For this reason we need to develop decision support systems and sensibilise the public and the private stakeholders in order to find global city logistics solutions in an urban-system point of view.

REFERENCES

ALLEN, J. / THORNE, G. / BROWNE, M., *Good Practice Guide on Urban Freight,* Bestufs, Rijswijk, 2007.

ALLEN, J. / BROWNE, M. / CHERRETT, T., “Survey Techniques in Urban Freight Transport Studies”, *Transport Reviews*, vol. 32, n° 3, 2012a, pp. 287-311.

ALLEN, J. / BROWNE, M. / WOODBURN / LEONARDI, J., “The Role of Urban Consolidation Centres in Sustainable Freight Transport”, *Transport Reviews*, vol. 32, n° 4, 2012b, pp. 473-490.

AMBROSINI, C. / ROUTHIER, J.L., “Objectives, Methods and Results of Surveys Carried out in the Field of Urban Freight Transport: An International Comparison”, *Transport Reviews*, vol. 24, n° 1, 2004, pp. 57 – 77.

ANDERSON, S. / ALLEN, J. / BROWNE, M. “Urban logistics – how can it meet policy makers’ sustainability objectives?”, *Journal of Transport Geography*, vol. 13, n° 1, 2005, pp. 71-81.

BROWNE, M. / SWEET, M. / WOODBURN, A. / ALLEN, J., *Urban freight consolidation centres, Final Report for the Department for transport*, University of Westminster, London, 2005.

CRAINIC, T.G. / RICCIARDI, N. / STORCHI, G., “Advanced Freight Transportation Systems for Congested Urban Areas”, *Transportation Research Part C*, vol. 12, 2004, pp. 119-137.

DABLANC, L. / MASSÉ, F., “Les centres de distribution urbaine: un tableau comparatif”, *Transports Urbains*, n ° 91, 1996, pp. 15-21.

DE LA MORSANGLIÈRE, H. / DIAZ OLVERA, L. / AMBROSINI, C., “La voiture en commun. Quelques données quantitatives sur l'agglomération lyonnaise”, *Transport environnement circulation*, n° 55, 1982, pp. 7-12.

GÄRLINGA, T. / GÄRLINGA, A. / JOHANSSON, A., “Household choices of car-use reduction measures”, *Transportation Research Part A*, vol. 34, n° 5, 2000, pp. 309–320.

GENERALITAT DE CATALUNYA, *Observatori de costos del transport de mercaderies per carretera a Catalunya, Butlletí de transports Número 58 – Març 2011*, Direcció General de Transports i Mobilitat, Generalitat de Catalunya, Barcelone, Spain, 2011.

GONZALEZ-FELIU, J., *Models and methods for the City Logistics - The Two-Echelon Vehicle Routing Problem. PhD. Thesis dissertation*, Politecnico di Torino, Turin, 2008.

GONZALEZ-FELIU, J. / MORANA, J., “Are City Logistics Solutions Sustainable? The Cityporto case”, *TeMA. Journal of Land Use, Mobility and Environment* vol. 3, n° 2, 2010, pp. 55-64.

GONZALEZ-FELIU, J. / PERIS-PLA, C. / RAKOTONARIVO, D., “Simulation and optimisation methods for logistics pooling approachesin the outbound supply chain”. In ROMANO, C.A., ed., *Towards a Sustainable Development and Corporate Social Responsibility Strategies in the 21st Century Global Marke*t. Publicacions de l’Universitat Politècnica de València, Valencia 2010, pp. 394-401.

GONZALEZ-FELIU, J. / MORANA, J., “Collaborative transportation sharing: from theory to practice via a case study from France”. In Yearwood, J.L. and Stranieri, A., eds., *Technologies for Supporting Reasoning Communities and Collaborative Decision Making: Cooperative Approaches*, Information Science Reference, Hershey, 2011 pp. 252-271.

GONZALEZ-FELIU, J., “Costs and benefits of logistics pooling for urban freight distribution: scenario simulation and assessment for strategic decision support”, *Seminario CREI, Rome, Italie, 19/10/2011, Working Paper LET halshs-00688967*, LET, Lyon, 2012a.

GONZALEZ-FELIU, J., Cost optimisation in freight distribution with cross-docking: the N-echelon location routing problem, *Promet – Traffic & Transportation*, vol. 24, n° 2, 2012b, pp. 143-149.

GONZALEZ-FELIU, J., “Freight distribution systems with cross-docking: a multidisciplinary analysis”, *Journal of the Transportation Research Forum*, vol. 51, n° 1, 2012c, pp. 93-109.

GONZALEZ-FELIU, J. / SALANOVA, J., "Defining and evaluating collaborative urban freight distribution systems", *Procedia Social and Behavioral Science*, vol. 39, 2012, pp. 172-183.

HENRIOT, F. / ROUTHIER, J.L., "Scenarios of commercial zoning to reduce impacts of freight movement in the city". In *WCTR 2010. Proceedings of the 12th World Conference on Transport Research*, Lisbon, Portugal, July 2010.

ROUTHIER, J.L., *Du transport de marchandises en ville à la logistique urbaine*, coll. 2001 Synthèses et Recherches n°59, DRAST, Paris, 2002.

ROUTHIER J.L. / TOILIER, F., "Freturb V3 : a Policy Oriented Urban Freight Model". In *Proceedings of the 11th World Conference on Transport Research*, Berkeley, USA, July 2007.

SEIERSEN, N., "Systèmes d'information logistique", *Techniques de l'ingénieur,* n° AG5300.

TANIGUCHI, E. / THOMSON, R.G. / YAMADA, T. / VAN DUIN, J.H.H.R., *City Logistics - Network modelling and Intelligent Transport Systems*, Elsevier, Amsterdam, 2001.

THIENGBURANATHUM, P. / J. GONZALEZ-FELIU / Y.OUZROUT / N. CHAKPITAK / BOURAS, A., "An Integrated Planning-Simulation-Architecture Approach for Logistics Sharing Management: a case study in Northern Thailand and Southern China". In *Proceedings 2nd International Conference on Logistics and Transportation*, Queenstown, New Zealand, December 16th 2010.

VILLE, S. / GONZALEZ-FELIU, J. / DABLANC, L., " The Limits of Public Policy Intervention in Urban Logistics: Lessons from Vicenza (Italy)", *European Planning Studies*, doi: 10.1080/09654313.2012.722954.

VILLE, S. / DABLANC, L. / GONZALEZ-FELIU, J., "Los límites de las políticas públicas en el ámbito de la logística urbana: el caso de la ciudad de Vicenza". In MARTINEZ SANZ, F. / PETIT LAVALL, M.V., eds., *Régimen del transporte en un entorno económico incierto*, Marcial Pons, Madrid, 2010, pp. 801-817.

YEARWOOD, J.L., / STRANIERI, A., eds, *Technologies for Supporting Reasoning Communities and Collaborative Decision Making: Cooperative Approaches*, Information Science Reference, Hershey, 2011.