Exchange Mechanisms in Logistics Services Markets ♦

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Abstract

Outsourcing of business processes, including logistics, requires the use of adequate mechanisms for the coordination of activities carried out across the organizational boundaries of different companies. These mechanisms must manage the interdependencies between supply chain's activities and support their performance. This paper discusses effective management of the relationships of supply chains with their logistics providers. It proposes a model to design a procurement strategy for logistics services, which is aligned with the characteristics of the services, the procurement process, and the mechanism to conduct transactions with the provider. The model is positioned in the logistics services procurement context and illustrated with an example of the point-to-point transportation.

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1. Introduction

Distribution of production among firms across the world, effective management of large supply chains, and new production processes all require design and implementation of techniques that ensure timely receipt of inputs and delivery of finished products to the marketplaces. Efforts of reduction of inventory and storage costs, large-scale product customization and the just-in-time production require matching of supply and demand in near real-time to reduce inventory. The spread of geographic information systems and other ICTs has enabled the adoption of geo-referencing, being able to raise the product value, as perceived by final customers.

These emerging phenomena have noticeably changed the common belief that logistics activities are of secondarily importance for firms, which drove the logistics service procurement for decades: since the early 1990s, organizations are ever more aware that an effective management of logistics dramatically affects their competitive advantage. This has been accompanied by the need for a high specialization of logistics services, which at the same time may benefit when provided as a bundle. As a result, manufacturers increasingly entrust the logistics functions of their supply chain operations to third-party logistics providers (3PLs).

These are service providers who carry out one or more logistics functions on behalf of their customers [Lieb et al. 1993]. Close integration and long-term relationship between 3PLs and their customers increase both mutual commitment and knowledge of needs and constraints of their counterpart [Skjoett-Larsen 2000]. Using 3PLs allows manufacturers to focus on their core business activities. They also benefit from the economies of scale of their 3PL partners and the broad range of services offered by specialized logistics services providers.

Specialization of logistics providers coupled with the increasing variety of logistics services and the need for a higher integration in the supply chain resulted in the appearance of fourth-party logistics providers (4PLs): firms positioned between logistics companies and their customers in order to provide comprehensive logistics services [Visser et al. 2006]. In that sense, 4PLs act as integrators, capable of delivering complete solutions, from the strategic design of the logistics network to the day-by-day operational issues, by managing both their own resources and the ones of other asset-based logistics operators.

This paper presents a framework for the identification of effective management of the relationships with their logistics providers. The purpose is to design a tool to formulate a procurement strategy formulation, which is aligned with the characteristics of the logistics service, the procurement process, and the mechanism to conduct transactions with the provider.

Outsourcing of logistics has become more complex, it requires the use of adequate mechanisms for the coordination of logistics functions.

The key coordination mechanisms are hierarchy and markets. The pure hierarchies and perfect markets are the extremes with many mechanisms used in real-life lying somewhere in-between. In-house logistics activities are coordinated through some forms of *hierarchy-based mechanism*. Coordination of the activities of logistics providers needs to be indirect through some type of a *market-based mechanism*.

Contemporary markets are governed, both directly and indirectly, by many different rules. One particular set of rules directly specifies the ways the transactions can take place. This set of rules is in the paper referred to as *exchange mechanism* (known in literature also as market mechanisms or market institutions).

Exchange mechanisms used in interactions between supply chain firms and logistic providers are rules which the firms and providers use in order to conduct transactions; they specify the permissible behaviors of these organizations, the interaction processes and the terms of completed transactions.

There are three main types of exchange mechanisms: *auctions*, *negotiations* and *catalogues*; each may be implemented in a variety of ways. Mechanisms that use an auction and catalogue focus on price as the key, often the sole criterion for the choice of a logistic provider. Negotiation-based mechanisms allow focusing on a single attribute, typically price, but also discussing many attributes, for example, trustworthiness, understanding of the supply chain operations, reliability, reputation and potential for synergy. A study of LSPs in Australia found out that while negotiation on price is a significant factor it may have adverse effect on the relationship between the firms and the providers [Gattorna, Ogulin et al. 2004]. The types of situations which a supply chain should be concerned while establishing a relationship with LPs, is one of the issues discussed in this paper.

The effort and investment a firm devotes to the relationship with its LP is closely related to firm's time orientation. The degree and scope of the relationship may also depend on such aspects as the mission, organizational culture and the importance of services. The suitability of the exchange mechanisms for relationship building and maintenance should be an important criterion for mechanism selection.

The selection of the buyer-supplier relationship and the exchange mechanism for use in their transactions are part of the sourcing strategy. The main approach to the formulation of this strategy is based on the portfolio approach, first proposed by Kraljic [1983]. It has been argued, however, that this approach does not allow for the formulation of suitable sourcing strategies [Cox and Thompson 1997; Nellore and Söderquist 2000]. Efforts to increase the richness of the portfolio approach through adding the factors defining the portfolio are limited because of the portfolio reliance on two kinds of dimensions. A complementary way to make the portfolio approach more suitable to the strategy formulation and also to the specification of operational practices is discussed here. It relies on the identification of components other than portfolio that are useful for strategy formulation and, subsequently, to the establishment of linkages between portfolio and these components.

The reminder of this paper is organized as follows: In Section 2 exchange mechanisms are briefly discussed. Section 3 introduces the portfolio models in procurement and their various specific dimensions as well as their generalizations. The two key types of supplier-buyer relationships are presented in Section 4. Section 5 integrates time orientation and exchange mechanisms with the procurement proposed in portfolio approach. The three concepts are then positioned in the logistics services procurement context in Section 6. In Section 7 the concepts are illustrated with an example and conclusions are given in Section 8.

2. Exchange mechanisms

Market transactions are voluntary exchanges between the parties who agree to the exchange terms and conduct it according to the rules of the marketplace [McMillan 2002]. This definition holds both for physical products and for services, including logistics.

The parties involved in a transaction have their innate characteristics and preferences, which determine their motivations [Smith 2003]. The behaviour of participants, however, is a middle layer between their motivations and the feasible actions confined by the exchange mechanism adopted in such a transaction. Therefore, the latter ideally restricts participants' behaviour, without uniquely prescribing it [Hurwicz 1973].

The three marked-based exchange mechanisms mentioned in Section 1 can be classified according to their characteristics, such as: the number of issues (i.e. attributes) of goods which are considered in the transaction, their communication patterns (unidirectional vs. bidirectional, based on the number of sides providing information to their counterpart), their outcomes, both direct (e.g. price and amount of goods that players exchange) and indirect (e.g. satisfaction, change in relationships and trust, etc.).

Each type of exchange mechanism may be implemented in a variety of ways, but has a common basic structure, schematically illustrated in Figure 1.[1] The structures depicted refer to mechanisms in which the two sides are distinct: one representing buyers and the other—sellers. The situation in which each side can be both buyers and sellers is not applicable to supply chains interactions with logistics providers.

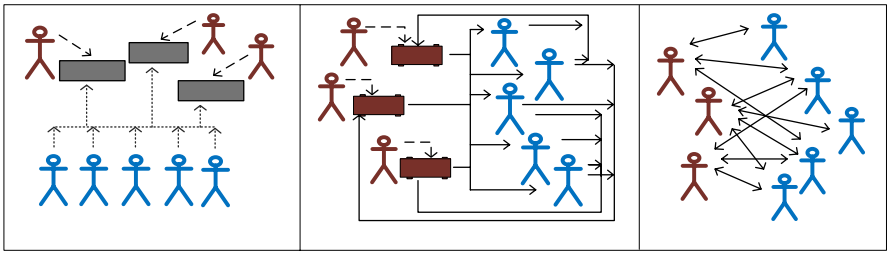

Figure 1. Catalogue, auction and negotiation mechanisms among three sellers and five buyers.

One important difference between catalogues and single-sided auctions on one hand and negotiations on the other, is the non-participation of the side that activates the mechanism. Only the other side is involved in the process. In contrast, in negotiations both sides actively participate in the transaction process. The non-participation of the mechanism activator may foster competition among agents representing the other side. At the same time it makes transactions involving only one or two buyers impractical. On the other hand, negotiation often involves only one buyer.

[1] **Three types of activities are indicated by the lines: (1) the dashed line depicts a single action of activating a mechanism; (2) the dotted line depicts observation or scanning of prices, and (3) the continuous line depicts repetitive actions of the participants.**

We are interested here in the use of exchange mechanisms in procurement and logistic services. Therefore, we assume that the owner or activator of the mechanism is the buyer and the auctions used are *reverse auctions*.

In reverse auctions the buyer activates the mechanism and then is passive. But unlike catalogue mechanisms, in auctions the sellers compete and decide on the price and the buyer who is willing to be paid the least for his service or product. In some auctions the sellers actually propose prices, in others the prices are offered to them and if no seller accepts a proposed price a higher price is automatically offered. Thus, for sellers, the catalogues are passive and auctions are active mechanisms.

3. Portfolio models in procurement

Models based on portfolio analysis in procurement have their roots in financial planning, where they were used for the selection of the equity investments [Markowitz 1952]. Kraljic [1983] proposed a simple two-dimensional model for the classification of the purchased goods. The two dimensions are: (i) the goods importance for the buyer, and (ii) the supply market complexity. The first dimension measures the percentage of total purchasing cost, the value added to the buyer's production, and the impact on profitability. The second dimension measures the scarcity of suppliers, the entry barriers in the supply market, the ease of good replacement, and other purchasing conditions.

By assuming two values (i.e. *high* and *low*) for each dimension, the procurement is classified into the following four categories [Olsen and Ellram 1997]:

1. Non critical has low importance and low market complexity;
2. Leverage has high importance but low market complexity;
3. Bottleneck has low importance but high market complexity; and
4. Strategic procurement involves goods which have high impact on profitability and high market complexity.

For each of the above four categories specific operational practices have been suggested. They concern sourcing strategy, time horizon, and degree of cooperation.

Following the model proposed by Kraljic [1983], several scholars have adopted similar approaches amending his portfolio matrix so as to better define the dimensions to be taken into account in classifying goods. Van Stekelenborg and Kornelius [1994] adopt as drivers the level of control that the buyer senses: (i) on the internal market demand and (ii) on the external supply market.

Olsen and Ellram [1997] state that the key dimensions to be considered to define the appropriate sourcing strategy are the strategic importance of the purchase and the difficulty of managing the purchasing situation.

Gelderman and van Weele [2000] argue that the relative bargaining power between the buyer and their suppliers needs consideration. They propose mutual dependence as a key dimension. Bensaou [1999] focuses on the role of the buyer's and/or supplier's investments that are specific to their relationship as a proxy for their bargaining power.

All the dimensions proposed can be classified into one of two categories, internal and external, and the resulting models use one dimension from each category. That is, a portfolio model has one *internal* and one *external* dimension. The internal dimension is defined by the use of the good by the buyer (e.g., the good's importance). The second dimension is defined by the external conditions (e.g. the nature of the supply market, and the supplier and buyer's specific investments).

We should note studies that criticise these models as overly simplistic. Dubois and Pedersen [2002] argue that important variables describing risk are ignored. Furthermore, the association of each dimension with multiple factors leading to the construction of aggregate dimensions requires high managerial effort that cuts down the benefits of the technique [Haspelagh 1982; Gelderman and van Weele 2003]. It has been also argued that portfolio approach give limited explanation regarding the management of different categories of goods in practice [Cox and Thompson 1997]. Empirical evidences also suggests that firms implementing portfolio models tend to focus more on the classification of goods than on the development of effective action plans [Nellore and Söderquist 2000].

4. Time orientation

An important attribute of vendor-buyer relationships is time orientation. We discuss here the two ideal approaches, namely *short-term* and *long-term orientation*. The former affects transactions where parties are concerned with the given purchasing process and its outcomes rather than future exchanges. This leads to *transactional exchanges* which rely on efficiency. The emerging relationship in procurement is thus competitive and based on an arm's length approach [Simchi-Levi, Kaminsky et al. 2000]. For such exchanges, highly efficient mechanisms are preferable to mechanisms implying close relationship. The latter may even have a negative impact on the buyer's position when it constrains sourcing flexibility and requires significant effort.

Short-term orientation does not imply the use of a particular mechanism per se. Negotiation, for example, has been used in such procurement situations [Perdue and Summers 1991]. Field studies indicate however, that such a mechanism may be inferior to others. The results of a survey of over a 100 procurement agents of several department chains confirm Kraljic's [1983] that short-term orientation contributes to competitive behavior leading to the use of competing approaches to negotiation [Ganesan 1993]. The use of this approach caused some negotiators to eventually make greater concessions other than negotiators who used different approaches (i.e. collaborating and compromising).

Ganesan observes that these statistically significant results suggest a dysfunctional use of strategies based on competing approach even when the buyer has significantly more power than the supplier. When complexity and risk of the exchange increase, cooperation between actors, mitigation of such phenomena is essential. It consists of several kinds of interaction, with respect to the product (customization, joint product development) [Primo 2002] as well as to the process (joint production and inventory management). Both imply sharing risk and rewards as well as confidential information.

Typically, buyer-supplier relationships based on cooperation require high effort, both in terms of specific investments and in terms of time spent. It makes the switching cost high

and impose the adoption of a long-term orientation in such relationships. Such transactions are also defined as *relational exchanges* [Barringer 1997], which underlines the primary importance of soft aspects, including the mutual trust.

5. Mechanism, model and orientation

In every procurement situation an exchange mechanism has to be used. And a particular time orientation and relationship between the participating firms can observed. A natural premise is that some of the mechanisms and some of the orientations are more suitable to the particular procurement situation than others. Using this premise and observations reported in literature, we may associate these three elements.

Bajari, McMillan and Tadelis [2008] observed that 43% building contracts in Northern California were procured using negotiations, while 18% were procured through auctions. They noted that projects which are complex and require adaptations are more likely to be negotiated, while auctions is used for projects that are considered routine and simple. Handfield, and Straight [2003] identify reverse auctions and negotiations as possible exchange mechanisms in procurement but view them as alternatives to other types of auctions, 4PLs or service integrators.

Theoretical comparisons of auctions and negotiations [Bulow and Klemperer 1996], results of experimental studies [Thomas and Wilson 2005] and a succinct review by Subramanian and Zeckhauser [2004] provide the basis for the allocation of these two mechanisms in the portfolio matrix given in Table 1.

Table 1. Procurement portfolio matrix, exchange mechanisms, and time orientation.

Leverage - *Mechanisms*: reverse auctions, negotiation, mix - *Time orientation*: short to medium	**Strategic** - *Mechanisms*: Negotiation - *Time orientation*: long
Non-critical - *Mechanisms:* Spot markets, automation, reverse auctions - *Time orientation:* short	**Bottleneck** - *Mechanisms*: Posted price, automation - *Time orientation*: medium to long

Before we discuss the four cells in Table 1, we should note that there are two different purposes of exchange mechanisms usage. One usage is focused on the establishment of the relationship with a supplier and, once such a relationship is achieved, on its maintenance and management. We acknowledge the significance of such a usage but in this work we are interested in the implementation of the procurement itself rather than the issues related to the relationship.

Noncritical exchanges involve goods of low priority for the firm, whose procurement is easy due to their standardization and the high number of potential suppliers. Therefore, both supply risk and procurement complexity are low, and buyers often have *short-term*

orientation. For instance, to reduce the risk of undersupply, they can adopt multiple sourcing [Seshadri et al. 1991; Berger et al. 2004; Berger and Zeng 2006].

Such exchanges use highly efficient mechanisms with no care about the building of close relationships. Automation of purchasing is probably the best solution providing that prices are periodically reviewed. Reverse auctions may be used as long as they do not consume too many resources. This is the type of relationship where the negotiation software agents may be effectively adopted.

Firms tend to adopt a short-term orientation in procurement of *leverage exchanges*, as well. This kind of procurement, indeed, involves goods which are widely available but which impact on firm's profitability is high. The analysis indicates that the matching exchange mechanism for leverage exchanges is a reverse auction. The high importance of such goods may require negotiation or a mix of these two mechanisms (e.g., an auction followed by a negotiation with a few of selected suppliers).

Unlike leverage ones, *strategic exchanges* (concerned with the procurement of strategic goods) are complex and risky, due to the features of their supply market (e.g. there are few large suppliers, or the supply capacity might be lower than market demand). Moreover, the good itself is critical from the buyer's perspective, as well. For this kind of exchanges, the need to continually interact and exchange private information requires that parties adopt a relational approach based on mutual trust.

Psychologists assert that trust building needs face-to-face interactions. It is thus not surprising that auctions, whose participants have poor knowledge of the counterpart, cannot be effectively adopted in purchasing strategic goods. Negotiation seems then to be the most proper exchange mechanism. A more intense use of ICT (aimed at increasing automation) can possibly be helpful for the discussion on and formulation of complex contracts, once trust has been established.

Finally, *bottleneck exchanges* concern goods that are complex in terms of supply market but have low priority under the buyer's perspective. In this case the preferred mechanism is catalogue. However, the market risk and complexity suggests the need to carefully manage the buyer-seller relationship, possibly with high automation of purchasing. In such transactions, indeed, the use of exchange mechanisms requiring higher effort, such as negotiation, would increase the transaction cost without assuring an increase of payoffs in return.

6. Logistics services procurement

Subsection Title Procurement portfolio models proposed in literature typically refer to physical products and do not explicitly consider services. Attention has to be paid when applying these models to services, due to their different nature: services are intangible and perishable, they are often complex, and their production and consumption must be concurrent. Moreover, the definition itself of a service as well as the performance measurement usually involves the evaluation of many variables. Thus, a specific portfolio model should be developed to address service purchasing.

In particular, this paper is focused on logistics services. To our knowledge, only two papers have already addressed the topic. Africk and Calkins [1994] suggest the use of a portfolio model to distinguish the services offered by third-party operators, by means of their complexity and customization in terms of (i) physical and (ii) management services required. Such a model classifies logistics providers as asset-based, management-based or integrated, depending on the services they offer. However, it lacks in providing buying firms with practical suggestions or provisions to manage the procurement.

Andersson and Norrman [2002] propose a portfolio model of the logistics services whose drivers are the supply risk and the financial impact on the buyers. The authors, however, assert that nowadays logistics services are clustering in two market areas only (i.e. *basic* and *advanced* services), depending on their degree of complexity and the time horizon adopted in buying them. The cluster to which a logistics service belongs can be identified taking into account several factors, such as: the predominance of managerial or operative activities, the effort required for their customization and re-engineering according to the customer's needs, and the bundling of sub-services.

The first step to define a portfolio for the procurement of logistics services is to identify the variables which characterize both the internal and external dimensions. We name the internal and external dimension as "importance of logistics service" and "complexity and risk of service procurement", respectively and introduce the attendant descriptive variables.

Importance of logistics service measures the extent to which the considered service impact on the buyer's product and refers to issues that, under the buyer's perspective, includes both economic and strategic variables, such as:

- Relative cost of the service, e.g. the ratio of the total cost of the buyer's product;
- Potential savings in the other costs, e.g. a reliable transportation may reduce the need for buffer inventory against uncertainty;
- Value added to the final product, e.g. an effective tracking is usually key in the food industry in terms of perceived value by the consumer;
- Premium price that customers are willing to pay for a better logistics performance, e.g. nowadays there is a greater concern on environmental issue and this could make consumers pay such a premium price for companies caring about reverse logistics.

Complexity and risk of service procurement is mainly related to the structure of the supply market and the nature of the service. Specific variables to be considered include:

- Novelty and complexity of the service;
- Switching costs, e.g. sharing information related to inventory might require high switching cost if communication protocols are not common or standardized;
- Number of the potential providers and entry barriers, e.g. tracking through RFID may require specific assets or investments that prevent other providers from entering the market;
- Uncertainty of the supply, e.g. factors related to weather may have impact on transportation (in terms of time of delivery, goods perishability, etc.);

- Risk associated with private information that is not known to the buyer, e.g. the provider could modify the use of his capacity under a peak of demand caused by other buyers;
- Relative bargaining power (buyer vs. provider).

To operationalize each of the two portfolio dimensions the variables that characterize it have to be measured and weighted. By establishing a suitable threshold value, two values for each dimension (i.e. high/low) can be defined, which results in four classes of logistics services. We label them as *non-critical*, *leverage*, *bottleneck*, and *strategic*, according to the main stream of the literature on portfolio models. Once logistics services are classified according to this specific portfolio, the prescriptions given in the general procurement case can then be properly applied.

7. Point-to-point transportation example

To give an example, we consider the procurement of point-to-point transportation service. Under this label, we refer to the transportation from a given pick-up point to a given delivery point, according to a fixed time schedule assigned by the buyer, provided by a mean of transportation entirely dedicated for the given service. Therefore, such a service is different from both common carriage and distribution management. In fact, the former allows several buyers/services to be supplied at the same time through the given mean of transportation, which for example would require the provider to adjust the time schedule (e.g. postal service); the latter involves several pick-up or delivery points and possibly a few intermediate warehouses or distribution centres, which for example entails the design of a network (possibly jointly made by the provider and customer).

Note that point-to-point transportation can be viewed as outbound, inbound, or internal transportation, according to the role of the buyer as the owner of the pick-up point, or the owner of the delivery point, or the owner or both points, respectively.

The main attributes of the point-to-point transportation are:

- Shipped quantity, which usually depends on the buyer's needs (e.g. production planning, her customers' orders, etc.), but can be to some extent modified through the interaction with the provider (e.g. this could be useful to optimize the loading of the mean of transportation).
- Freight rate, namely the cost of the transportation. Several ways exist to define this attribute (freight rate per distance or per shipment, per volume/weight of goods, per means of transportation used, etc.).
- Mean of transportation. This choice may depends on capacity, speed, the need to keep under control temperature, humidity, and other environmental conditions.
- Pick-up and delivery time. If the service is provided on a regular basis, often these times are defined in terms of daily hour or weekly day (sometimes monthly day) at which the pick up and deliver must be scheduled.
- Penalties for delay (in deliveries or loadings). They may be charged to the provider, based on the number of delays and/or the lateness amount in a given time, as ways to

make him more committed and responsible for time reliability. Some flexibility in time constraints and the associated penalties might be considered.

All the above attributes characterized the service and need to be carefully considered so as to check whether the selected exchange mechanism is suitable to handle them, which is a condition to effectively manage the transaction.

Based on the above, the design of the transaction needs to set the values of the service attributes. Some of them are assigned by one of the party, others are jointly defined. Table 2 addresses the latter issue (who sets the attribute values).

Table 2. Attributes of point-to-point transportation and their prevalent decision maker.

Service attribute	**Prevalent decision maker**
Shipped quantity	Buyer (interacting with provider)
Freight rate	Provider
Mean of transportation	Provider (might be strongly affected by buyer's specs)
Pick-up and delivery time	Buyer
Penalties for delay	Buyer (interacting with provider)

To show how point-to-point transportation can be positioned in the portfolio model we describe it in terms of its variables.

In terms of its importance from the buyer's perspective, the cost of this service is often low, the added value to the final product as well as the premium price that customers are willing to pay are negligible, and potential savings can be estimated as moderate. On the other hand, in terms of complexity and risk of procurement, these can be evaluated as quite low with respect to all the variables introduced in Section 6. In such a case, the considered service is *non-critical*. However, it may happen that uncertainty of supply as well as risk associated with private information not known to the buyer are as much high to make complexity and risk of service procurement be high; this lets the service move into the bottleneck category. With respect to the proper exchange mechanism, Table 1 associates spot markets or reverse auctions in the former case (*non-critical*), whereas catalogue in the latter (*bottleneck*).

We claim that not only the exchange mechanism has to be appropriate to the service category, but it must fit the service attributes as well. In particular, it can be noticed that penalties for delay and, to a minor extent, shipped quantity and mean of transportation,

could benefit from the use of negotiation as this exchange mechanism would let parties better interact.

The analyzed case shows that, with reference to the goods considered in this paper, i.e. logistics services, resorting to a standard procurement portfolio model may not be enough. The prescriptions of such a standard model are indeed usually defined at a high level of analysis, whereas more practical issues (namely the attributes of the specific logistics service) need to be taken into account as well.

8. Discussion

The procurement of logistics services cannot blindly follow a procurement portfolio model, which the literature has developed for physical products, rather requires its own portfolio model. In this paper we propose such a model; it classifies the services into four categories (non-critical, leverage, bottleneck, and strategic). These categories are based on the high-low values for two dimensions, i.e. the importance of logistics service and the complexity and risk of service procurement.

The exchange mechanisms used to establish and manage the procurement relationship should also be considered in the design of such a relationship. These mechanisms are key for effectively handling the service attributes, including the relational attributes. In this paper we discuss only the relationship management aspect and included it in the mechanism selection in the portfolio model.

To illustrate the proposed model we have applied the portfolio to one example: the point-to-point transportation. The latter has been classified as either non critical or bottleneck according to the value assumed by the variables defining both dimensions. In any case, such a classification in turn results in exchange mechanisms that do not include negotiation, which on the contrary might be necessary to handle some attributes characterizing this service. Future work will include model verification with other examples and its application to real-life situations and its specification to different industries and supply chains.

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