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Shaping the E-Commerce Logistics Strategy: a Decision Framework

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Antonio Ghezzi, Riccardo Mangiaracina* and Alessandro Perego

1 Politecnico di Milano, Piazza Leonardo da Vinci, ITALIA
* Corresponding author E-mail: riccardo.mangiaracina@polimi.it

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Abstract e-commerce is expected to radically change customers' shopping experiences. Market figures show that even though e-commerce has already taken off, the path to realizing its full potential is still long. In the physical goods segments, the strategic importance of logistics - both as a cost driver and as a service enabler - has been recognised by the majority of companies, but it remains unclear how to adapt the "logistics strategy" to possible forms of the "logistics problem". This issue is even more important for those Dotcoms that need to design their logistics strategies from scratch.

The main objective of this paper is to analyse the relationship between logistics strategies and logistics problems in the e-commerce of physical goods in order to present a general normative model and draw some key managerial implications so as to help B2C merchants design their logistics strategies.

In order to accomplish this task, the combination of a literature review and a multiple case-study approach was used. In particular, 28 case studies of leading B2C e-commerce merchants in Italy - with various business models - in the main online industries that sell products were conducted in order to analyse the relationship between the features of the logistics problem and the logistics strategy adopted.

Keywords e-commerce, logistics strategy, logistics problem

1. Introduction

In spite of the bursting of the Dotcom bubble in 2000, over the last 10 years B2C e-commerce ('e-commerce' from now on) has grown in all the main western markets. Although the absolute value of e-commerce and the average growth per year are strong, its penetration rate is still below 10% as a percentage of overall retail sales in almost all of the leading countries [1-2-3] (Figure 1).

	eCommerce value 2010	CAGR (2003-2010)	Penetration rate 2010
USA	265.5 $	12%	14%
Europe	134.2 €	21%	7%
UK	37.4 £	20%	10%
Germany	29.3 €	20%	7%
France	16.5 €	30%	5%
Italy	7.5 €	26%	1%
	billion	%	%

Figure 1. E-commerce value, CAGR (2003-2010) and penetration as a percentage of the overall retail sales in Europe, the USA and various European countries

The main difference between the USA and the top countries in Europe lies in the penetration rates observed in the physical goods sectors (e.g., apparel, books, consumer electronics, groceries, etc.), which are generally much higher in the USA (see Figure 2). Since physical products - especially apparel and food - represent the majority of consumer expenditure, the impact of the online commerce channel in these categories heavily influences the overall penetration rate.

	USA	Europe	Italy
Apparel	17%	5%	0,8%
Books, CDs and DVDs	35%	15%	4,6%
Grocery	2%	1%	0,1%
Consumer electronics	38%	33%	3,3%
Tourism	25%	22%	12,5%

Figure 2. E-commerce penetration - a comparison between Italy, Europe and the USA (2010).

Among the factors usually considered as drivers or barriers to the diffusion of e-commerce [4] (e.g., broadband availability, the definition of a legal framework for consumer protection, the design of a "secure" value proposition [5], trust in online systems [6], the design of a high-quality customer experience [7], the design of the payment system [8], difficulties in assessing benefits [9-11]) one of the most significant drivers for the online sale of goods is the choice of the best logistics strategy.

The logistical problems faced in the field of e-commerce are often very different from those tackled in offline channels and, as a consequence, different logistics strategies are required compared with those adopted by traditional retailers. Proof of the importance of logistics in the e-commerce market comes, first of all, from the field. Past failures (e.g., Webvan) as well as important successes built on logistics excellence (e.g., Amazon, Vente Privee, Yoox, Tesco and Esselunga) have increased awareness of the importance of logistics as a key factor for success in the online channel. After more than 10 years of e-commerce, the time is ripe for analysing the successful experiences of those merchants who have built their success by implementing efficient and effective logistics strategies.

The importance of logistics in the development of a successful e-commerce initiative is also recognised in the scientific literature. Many authors claim that logistics plays a key role, both as a cost driver and as a service level enabler. Ricker and Kalakota asserted in 1999 [12] that companies succeed or fail in their online business based on the efficiency of their fulfilment strategy, and this was proven in 2008 by Cho et al. [13] whose studies revealed that logistics capabilities are positively related to company performance in the e-commerce market. The identification of a logistics strategy is, however, quite a complex issue, both in the online and offline channels [14-16] due to a wide range of design variables as well as the number of contextual factors to be considered (e.g., demand and product features). The aim of many studies that have focused on logistics strategy - in general - was the identification of the principles which, given the contextual factors characterizing the distribution problem, can drive the generation of the best logistics alternatives [17-24].

The aim of the study presented in this paper is to analyse the relationship between logistics strategies and logistics problems in order to derive a method for identifying an appropriate logistics strategy and managerial implications for new e-commerce players as well as existing players who want to review their logistics strategy. Even though, in the past, many papers have tried to present the different types of logistics problems and logistics strategies in the field of e-commerce, they have very seldom tried to understand the relationship between them. Moreover, they have focused on specific industries and on specific strategies, failing to draw a comprehensive picture useful for identifying the main or common principles.

The following section (i.e., Section 2) presents the research framework and the methodology used. Section 3 illustrates both the main factors of the logistics problem and the most important factors representing the logistics strategy as identified through a comprehensive literature analysis. The analysis of 28 case studies of top Italian e-commerce merchants - selected using a multi-criteria approach (see Section 4) - is used to identify and describe the most typical logistics problems (see Section 5) and the main logistics strategies (see Section 6) adopted in the apparel, book, consumer electronics and groceries industries. Finally, the relationship between logistics problems and logistics strategies is discussed (see Section 7) and a normative model is proposed (see Section 8).

2. Research framework and methodology

The aim of this paper is to identify and describe possible logistics strategies for the e-commerce of physical goods and to find a relationship - if there is one - between logistics strategies and logistics problems. More specifically, three research questions were addressed:

- RQ1- What are the most typical e-commerce logistics problems? Is it possible to classify them into a limited number of homogenous groups?
- RQ2- What are the main e-commerce logistics strategies?
- RQ3- Is it possible to correlate logistics problems with logistics strategies? And, if so, can a normative design model be developed on the basis of these relationships?

The research framework is shown in Figure 3. First, and based on a comprehensive literature analysis, the main descriptors of "logistics problems" and "logistics strategies" were identified. Second, through the cross-case examination of 28 case studies of leading e-commerce merchants in Italy, the main logistics problems and strategies were categorised. Finally, the relationship between logistics problems and strategies was investigated using a contextual variable, i.e., the e-commerce business model. In particular, four industries – (i.e., consumer electronics, apparel, books, groceries) were selected from among those (i) selling products, and (ii) with the best results and the highest e-commerce potential [1-3]. Four types of business models were considered [1], [25-27] on the basis of the competitive advantages that they have [28-29]:

- "Complete online sellers", usually "pure player" companies (i.e., selling goods purely online). Their main critical success factors are the breadth of the variety of products offered (in their specific industry), the richness of the product description and the capability of the research tools (smart search and comparison engines).
- "Focused online sellers", pure players that focus on a narrow product range (typically a specific product category – e.g., mobile phones, cameras, professional books, etc.) offered at a very competitive price. They target customers who want to buy at the lowest price.
- "Online clubs", again pure players that focus on a very limited range of end-of-season or unsold products offered only to club members through sale campaigns lasting just a few days. Their customers impulsively buy very appealing items at a very low price.
- "Traditional sellers", usually large distributors that offer online a selection of the product range (or sometimes the entire range) that they sell offline. The most successful ones take advantage of the reputation of their brands, combine innovation with operational excellence [30-32] and exploit synergies between the traditional and e-commerce channels for both marketing and logistics.

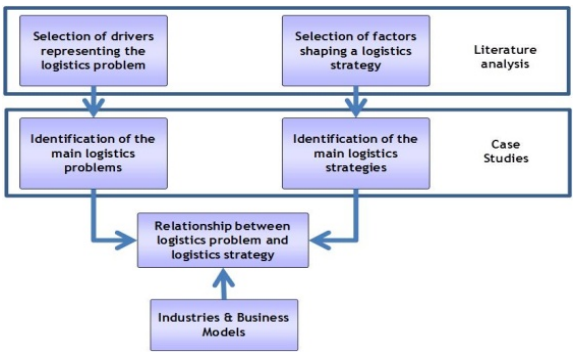

Figure 3. Research framework

3. Literature review

There are more than 50 papers on the subject of logistics in the field of e-commerce, but given the objective of this paper only those contributions that have focused on either logistics problems or logistics strategies were selected.

3.1 Factors affecting the logistics problem

As asserted by many studies in the field of distribution network design,[17], [19-21], [24], the logistics problem can be described as a collection of "product" and "service" drivers of complexity whose values affect the choice of logistics strategy.

3.1.1 Drivers of product complexity

Drivers of product complexity are those factors of physical goods which most impact on logistical performance. They were selected on the basis of the importance ascribed to them in the literature (See Table 1).

Value density. Among the product drivers, this is the most cited (see Table 1). It is considered to be a very important factor for many reasons. First, it is a key driver of inventory carrying costs and influences the choice of inventory ownership [33]. Second, it is related to the incidence of logistical costs on the final product price. This in turn has to do with the inclination of customers to pay the delivery fee and of merchants to provide expensive services (i.e., the management of returns in the apparel and consumer electronics industries) [34]. This is true to the extent that the delivery cost of low value density products becomes a key issue for the profitability of the business [35]. Third, customer expectations are higher for products with a high value density.

Product range. Offering a wider range of products than offline shops is a critical success factor for many e-commerce retailers (i.e., the so called "complete online resellers"). The product range is a very important factor because it has a significant effect on the logistics problem, making inventory management more complex and increasing inventory carrying costs [36]. Moreover, the greater the product range, the greater the complexity of the procurement network and, as a consequence, the higher the procurement costs.

Obsolescence risk. The shorter the product lifecycle, and the more subject to depreciation and/or obsolescence products are, the higher the expected inventory-related costs are. This is typical of many items in the consumer electronics and apparel industries, whose value usually drops significantly within just a few months, and of perishables in the groceries/food industry [37].

Product-specific needs. In the grocery industry, for example, the need for controlled temperature and humidity has to be considered in both the warehouse and in delivery management [34]. Though less demanding, there are also some specific needs in the apparel industry (e.g., the management of folded and hung items) that require efficient solutions in order to maintain profitability.

3.1.2 Drivers of service complexity

Service factors represent the complexity of the logistics problem in terms of service level expectations.

Returns management. In many e-commerce initiatives, the effective management of returns is very important [34], [38](see Table 1). In fact, one of the most significant barriers to online sales is the perception of operational hurdles in product returns in the event of problems. E-commerce companies have to deal with a high incidence of returns because online customers cannot see or try products in advance [35]. The management of returns – the collection of goods, quality controls and possibly the goods' re-introduction into the sales process - is a very expensive activity. As a consequence, inefficient management of the process could constitute a serious threat to bottom-line profitability[35]. Ineffective management of the returns process also negatively impacts customer loyalty[38]. It is therefore fundamental to find the right tradeoff between the quality of returns management and related operational costs [40].

Order cycle time. The order cycle time is one of the most important performance indicators for online customers, who are accustomed to the immediate availability of many goods in traditional stores. Indeed, the expected online order cycle time is usually very short - i.e., from hours to a few days - and represents a real challenge for e-commerce logistics chain designers. The importance of the order cycle time is strongly connected to different features of the online offer [39]. First, if products are offered with very advantageous conditions (i.e., very special discounts) customers are more inclined to wait a bit longer, whereas if products are offered at full price, customer expectations are higher. Second, products with short shelf-lives - e.g., some groceries - require shorter delivery times. The shorter the order cycle time, the "closer" to the customer the inventories must be (i.e., because they are close geographically or because the delivery is fast).

Punctuality. According to a survey conducted by Yankelovich (2000), delivery punctuality is very important for almost 90% of online customers. This factor, like the order cycle time, is sector-specific. For example, the expected punctuality for grocery products is very high, with very narrow (i.e., two hours) time windows [41]. As for the order cycle time, the shorter the delivery time window, the "closer" to the customer the inventories should be located [12].
Flexibility. This means allowing customers to change their orders after they have been issued [42]. It has more to do with the peace of mind that changes may be made than with the frequent real use of this option. Offering flexibility requires the ability to update the order picking and preparation process on the run.

3.2 Logistics strategies

The relevant literature mainly focuses on four main elements that should be taken into account when designing an e-commerce logistics strategy: inventory ownership and location, the order picking policy, the order assembly policy and the order delivery policy (see Table 2).

	Product drivers				**Service drivers**			
Paper	**Value density**	**Product range**	**Obsolescence**	**Logistics-specific needs**	**Returns management**	**Cycle time**	**Punctuality**	**Flexibility**
[39]					*x*	*x*	*x*	
[36]	*x*	*x*			*x*			*x*
[34]	*x*			*x*				
[42]					*x*			*x*
[37]	*x*	*x*	*x*	*x*				*x*
[35]					*x*			*x*
[13]					*x*		*x*	*x*
[38]	*x*				*x*		*x*	
[12]							*x*	
[33]	*x*							
[43]						*x*		
[41]						*x*	*x*	*x*

Table 1. The main factors of the logistics problem

Inventory ownership and location. Inventories can be owned by the merchant, by the merchant's suppliers (manufacturers or distributors) or else by both of them. In the first case, the merchant can use a warehouse dedicated to the e-commerce initiative, a warehouse shared with the offline channel or at the points of sale. The decision about inventory ownership is very important because it might affect the level of service offered to customers. In fact, if inventories are owned by the merchant and available through its structures, the order cycle time is usually shorter [38]. Moreover, where order picking and assembly are under the direct control of the merchant, this could entail greater accuracy and attention to customer needs [34]. On the other hand, inventory ownership generates inventory carrying costs (including the costs of obsolescence). This could be a serious risk in the early stages for an e-commerce pure player.

Order picking policy . Order picking and preparation can be carried out either by the merchant or by the merchant's suppliers (manufacturers or distributors). Where order picking and preparation activities take place in the merchant's warehouse, George (2008) [38] and Weijers et al. (2001) [36] identify three main alternatives: picking at the points of sale, picking at a warehouse dedicated to the online initiative, picking at a warehouse shared with the offline channel. The case of picking at a warehouse dedicated to the online channel can lead to better performance (service level and efficiency) than in the two other cases, but at the expense of a greater investment. Obviously, decisions about "inventory ownership" affect the "order picking policy", since the picking activity has to be carried out where the inventories are located.

Order assembly policy. The order can be assembled - i.e., the grouping of all the items ordered by the customer - at the supplier's warehouse or at the merchant's warehouse. This decision is strongly affected by previous decisions (viz., as to inventory ownership and the order picking policy). In fact, if order picking is carried out at the merchant's warehouse, order assembly will take place at the merchant's warehouse as well. However, if order picking takes place at the supplier's warehouse, orders can be assembled either by the supplier or else at the merchant's warehouse [39].

Order delivery policy. Order delivery can be organised in two different ways. The most common is home delivery [43]. A second alternative is delivery using points of presence in the territory (e.g., pick-up points or points of sale) where customers can pay and/or return products [44]. The delivery can be carried out by a home delivery operator (e.g., an ex-press courier) that can also run a network of pick-up points, or it can be carried out using merchant-owned vehicles and facilities (e.g., points of sale).

Paper	Inventory ownership	Picking	Order assembly	Delivery
[39]			*x*	
[36]	*x*	*x*	*x*	*x*
[34]	*x*	*x*	*x*	*x*
[44]				*x*
[37]		*x*		*x*
[35]	*x*	*x*	*x*	*x*
[38]	*x*	*x*	*x*	*x*
[12]	*x*	*x*	*x*	*x*
[33]				*x*
[43]	*x*	*x*	*x*	*x*
[41]	*x*	*x*	*x*	*x*

Table 2. The main elements of the logistics strategy

4. Case studies

This paper is based on the analysis of multiple case studies [45]. Given the research objectives, this methodology was deemed to be appropriate for two reasons. First, through the case studies - obtaining both qualitative and quantitative data [46] - it was possible to develop a complete picture of both the logistics problems and the logistics strategies. Second, multiple exploratory case studies were needed to develop a theory in an area that is poorly analysed in the literature [47-48]. Some cases were selected as extreme situations and polar types, in which the process of interest is "transparently observable"[49], whereas others were chosen as repetitions in order to check the validity of the proposed theory. The case studies represent a subset of the 200 Italian e-commerce companies that are annually studied by the B2C e-commerce observatory of the Politecnico di Milano School of Management. Every year, this research group carries out an empirical analysis of the main e-commerce merchants' performance indicators (e.g., revenue, growth, number and value of orders, service level) and strategies (regarding logistics, marketing, IT and organization).

In particular, 28 case studies (see Table 3) were chosen according to the following criteria:

- Representation of all the main product industries – i.e., consumer electronics, apparel, books and groceries;
- Opportunity to interview the C-level managers (the CEO in almost all cases);
- Only successful cases - i.e., with consistent growth rates and/or significant market share in their industry;
- Diversity of the business models.

Case Study	Industry	Business model
1	Consumer electronics	*Complete online seller*
2	Consumer electronics	*Complete online seller*
3	Consumer electronics	*Traditional seller*
4	Consumer electronics	*Focused online seller*
5	Consumer electronics	*Traditional seller*
6	Consumer electronics	*Traditional seller*
7	Consumer electronics	*Traditional seller*
8	Consumer electronics	*Focused online seller*
9	Books	*Complete online seller*
10	Books,	*Traditional seller*
11	Books	*Complete online seller*
12	Books,	*Traditional seller*
13	Books,	*Complete online seller*
14	Books	*Focused online seller*
15	Apparel	*Complete online seller*
16	Apparel	*Traditional seller*
17	Apparel	*Traditional seller*
18	Apparel	*Online club*
19	Apparel	*Online club*
20	Apparel	*Online club*
21	Apparel	*Traditional seller*
22	Apparel	*Traditional seller*
23	Apparel	*Traditional seller*
24	Apparel	*Traditional seller*
25	Apparel	*Traditional seller*
26	Groceries	*Traditional seller*
27	Groceries	*Traditional seller*
28	Groceries	*Traditional seller*

Table 3. Overview of the case studies

A questionnaire structured in 4 parts was used. The first part was used to collect general data about the company. The second part included the main performance indicators used to measure the results achieved by the e-commerce merchants (e.g., the value of the annual income, the average conversion rate, the number of orders collected, the average order value and the monthly number of visits to the website). The third section was intended to describe the e-commerce logistics problem (or problems, if more than one). Finally, the fourth section was meant to describe the logistics strategy. The third and fourth parts - indeed the core of the questionnaire - were built on the basis of the results obtained from the literature analysis - i.e., the main drivers describing the logistics problem and strategy. "Direct" interviews were conducted with Chief Executive Officers (CEO) and logistics managers. The responses from the interviewees were summarised, interpreted and tabulated from the transcripts, according to the themes of the research questions.

5. Logistics problems

Consistent with the categorization provided in Section 4, this paper proposes a model that classifies logistics problems on the basis of two main groups of factors:

- Product features - i.e., value density, product range, risk of obsolescence and product-specific needs;
- Customer service level - i.e., returns management, order cycle time, punctuality and flexibility.

The objective is to assess the complexity of the logistics problem as a combination of the complexity of each one of the eight factors. The level of the complexity of each factor is assessed using a five-level scale (L = Low, M/L = Medium/Low, M = Medium, M/H = Medium/High, H = High). The complexity rates - from Low to High - are given on the basis of a correspondence table linking judgements and possible ranges of values (see Table 4).

	Level of complexity				
Driver	***L***	***M/L***	***M***	***M/H***	***H***
Product range [#items]	0 < x < 1.000	1.000 < x < 10.000	10.000 < x < 20.000	20.000 < x < 100.000	x > 100.00
Value density [€/kg]	x < 10	10 < x < 20	20 < x < 100	100 < x < 200	x > 200
Obsolescence risk [months] (i.e., time before expiration)	x > 24	12 < x < 24	6 < x < 12	1 < x < 6	x < 1
Product-specific needs [qualitative]	L	M/L	M	M/H	H
Order cycle time [days]	x > 4	3 < x < 4	2 < x < 3	1 < x < 2	x < 1
Punctuality [hours] (i.e., x = delivery time window)	x > 48	24 < x < 48	5 < x < 24	2 < x < 5	x < 2
Flexibility [qualitative]	L	M/L	M	M/H	H
Returns management [%]	x < 4%	4% < x < 6%	6% < x < 8%	8% < x < 10%	x > 10%

Table 4. The five-level scale for each factor.

The obsolescence risk is measured as the life-time before expiration or, alternatively, as the life-time after which products lose most of their value. Product-specific needs and flexibility were evaluated on a qualitative scale, where the better the performance required, the greater the complexity of the logistics problem.

Finally, the logistics problem can be represented on the matrix in Figure 4, where the levels of the complexity of the different drivers were combined - using a simple average - in order to determine the overall complexity of both the product features and the customer service level. According to the overall complexity of the latter two

groups of factors, the logistics problems can be classified in four main clusters (see Figure 4):

1. "Product-Side Complexity", when the product complexity is comparatively higher than the service complexity.
2. "Service-Side Complexity", when the service complexity is higher than the product complexity.
3. "High-Complexity", when both the product complexity and the service complexity are high.
4. "Comparatively Easy", when both the product complexity and the service complexity are low.

The classification model was applied to the 28 case studies, as shown in Table 5, where the levels of complexity - for each driver and for the two groups of drivers - are reported. The logistics problems were then plotted on the matrix Product features-Customer service level (see Figure 5).

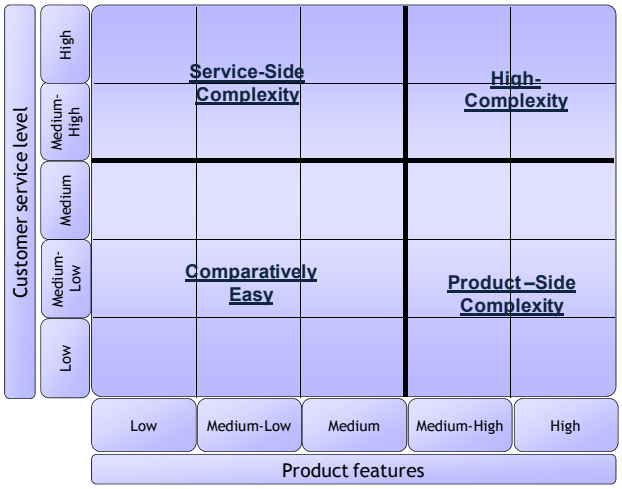

Figure 4. Types of distribution problems

	PRODUCT COMPLEXITY					SERVICE COMPLEXITY					
Case Study	**Value**	**Range**	**Obsolescence**	**Specific Needs**	**AVG**	**Returns management**	**Order cycle time**	**Punctuality**	**Flexibility**	**AVG**	**Distribution problem**
1	H	M/H	M/H	M/L	**M/H**	M/L	M/L	L	M	**M/L**	*Product-Side Complexity*
2	H	M/H	M/H	M/L	**M/H**	M/L	M/L	L	M	**M/L**	*Product-Side Complexity*
3	H	M/L	M	M/L	**M/L**	M/L	M/L	L	M	**M/L**	*Comparatively Easy*
4	H	M	M	M/L	**M**	M/L	M/L	L	M	**M/L**	*Comparatively Easy*
5	H	M/L	M	M/L	**M/L**	M/L	M/L	L	M	**M/L**	*Comparatively Easy*
6	H	M/L	M	M/L	**M/L**	M/L	M/L	L	M	**M/L**	*Comparatively Easy*
7	H	M/L	M	M/L	**M/L**	M/L	M/L	L	M	**M/L**	*Comparatively Easy*
8	H	M	M	M/L	**M**	M/L	M/L	L	M	**M/L**	*Comparatively Easy*
9	M	H	L	L	**M**	L	M/L	L	M	**M/L**	*Comparatively Easy*
10	M	M/H	L	L	**M/L**	L	M/L	L	M	**M/L**	*Comparatively Easy*
11	M	H	L	L	**M**	L	M/L	L	M	**M/L**	*Comparatively Easy*
12	M	M/H	L	L	**M/L**	L	M/L	L	M	**M/L**	*Comparatively Easy*
13	M	H	L	L	**M**	L	M/L	L	M	**M/L**	*Comparatively Easy*
14	M/H	M/H	L	L	**M**	L	M/L	L	M	**M/L**	*Comparatively Easy*
15	M/H	H	M/H	M/H	**H**	H	M/H	L	M	**M/H**	*High-Complexity*
16	M/H	M	M/H	M	**M/H**	H	M/H	L	M	**M/H**	*High-Complexity*
17	M/H	M	M/H	M/H	**M/H**	H	M/H	L	M	**M/H**	*High-Complexity*
18	M/H	L	M	M	**M**	M	L	L	L	**L**	*Comparatively Easy*
19	M/H	L	M	M	**M**	M	L	L	L	**L**	*Comparatively Easy*
20	M/H	L	M	M	**M**	M	L	L	L	**L**	*Comparatively Easy*
21	M/H	M	M/H	M/L	**M/H**	H	M/H	L	M	**M/H**	*High-Complexity*
22	M/H	M/H	M/H	M/H	**M/H**	H	M/H	L	M	**M/H**	*High-Complexity*
23	M/H	M	M/H	M/L	**M/H**	H	M/H	L	M	**M/H**	*High-Complexity*
24	M/H	M	M/H	M/H	**M/H**	H	M/H	L	M	**M/H**	*High-Complexity*
25	M/H	H	M/H	M/H	**H**	H	M/H	L	M	**M/H**	*High-Complexity*
26	L	M/L	H	H	**M**	M	H	H	H	**H**	*Service-Side Complexity*
27	L	M/L	H	H	**M**	M	H	H	H	**H**	*Service-Side Complexity*
28	L	M/L	H	H	**M**	M	H	H	H	**H**	*Service-Side Complexity*

Table 5. Case studies - The complexity of logistics problems

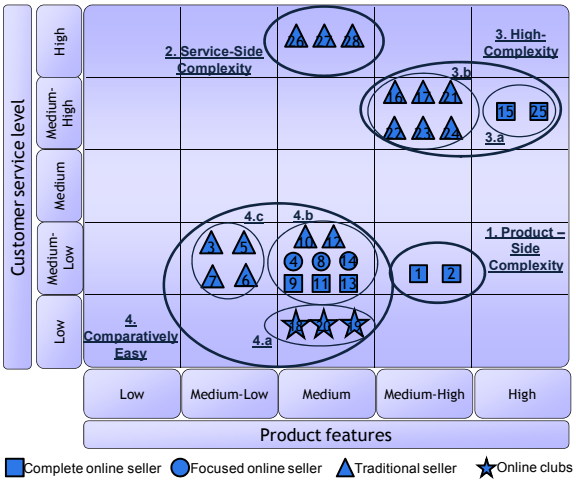

Figure 5. Case studies - Types of logistics problems

In the "Product-Side Complexity" cluster, the Medium/High product complexity is the result of a broad product range, very high value goods and a substantial risk of obsolescence. This is the case for the "Complete sellers" in the consumer electronics industry, who offer up to 50,000 different items the value of which can reach thousands of Euros per kg and with a potentially high risk of obsolescence. With regard to the customer service level, customers are not very demanding and they are ready to accept comparatively long delivery times if they find exactly what they are looking for.

In the "Service-Side Complexity" cluster, the complexity of the logistics problems is mainly due to challenging service requirements in terms of cycle time, punctuality and flexibility. For instance, this is the kind of logistics problem faced by merchants in the groceries industry, who often have to deliver in less than 12 hours within a strict time window (1-2 hours) selected by the customers. The product complexity is usually Medium since some items (e.g., fresh foods) might require storage and transportation at a controlled temperature and the risk of perishing might be high, while the complexity of the other product factors is low.

The "High-Complexity" cluster describes the logistics problem for e-commerce vendors in the apparel industry. The product-side complexity is high due to the extreme value density (up to a few thousand Euros per kg) and risk of obsolescence (fashion effect). The complete sellers (cases 15 and 25 in the matrix - cluster 3.a) also have a broad product range (tens of thousands of items). All of the other merchants in the cluster (16, 17, 21, 22, 23 and 24 – cluster 3.b) are manufacturers that offer a relatively more select product range; thus, they have slightly lower product-side complexity (Medium/High). High levels of returns, due to size mismatches or simply due to customers' changing their minds, make the service level complexity high as well.

Finally, in the "Comparatively Easy" cluster, the logistics problems are less critical. This is a comparative judgement and does not mean that these problems are trivial in an absolute sense. Logistics problems represented in this cluster are those faced by:

- The "Online clubs" in the apparel industry (4.a) where the product complexity is Medium but the service level complexity is Low. Extremely good prices are matched with long delivery times (up to one month);
- The "Focused sellers" in the consumer electronics industry and the complete sellers in the books industry (4.b). The service requirements are not very demanding (a cycle time of within 4 days for the majority of deliveries and no specific requirements for other performance). The product features complexity has been rated as Medium because the complexity is related to only a few drivers (e.g., the product range for "complete sellers" in the books industry);
- The "Traditional sellers" in the Consumer electronics industry (4.c) for which the complexity is Medium/Low in relation to both the product and service aspects, due to a comparatively narrower product range and average service level requirements.

6. Logistics strategies

Consistent with the literature analysis presented in Section 3, six logistics strategies in B2C e-commerce were identified, each differing according to which supply chain member (supplier, merchant or courier) is in charge of which logistics activity (inventory ownership, order picking and preparation, order assembly, order delivery) (see Figure 6).

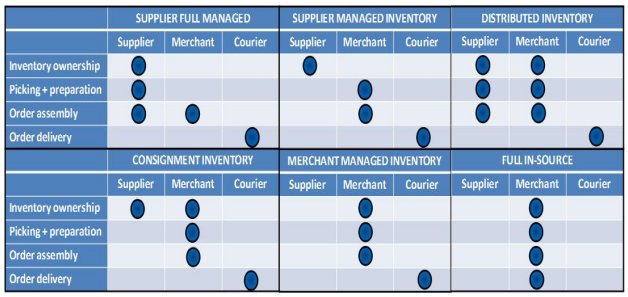

Figure 6. The main logistics strategies

In the "Supplier full-managed" strategy, the overall distribution process is outsourced. The merchant has no inventory (and no warehouse) and delivery is carried out by third party couriers. If the merchant receives a multi-supplier order (i.e., an order made up of items provided by different suppliers) the order is assembled at a transit point in order for all of the products to be delivered together. In the "Supplier managed inventory" strategy,

the merchant has no inventory. It collects orders from customers and then issues large aggregated replenishment orders to suppliers (ordering-upon-sales formula). The picking and order assembly activities are carried out at the merchant's warehouse, whereas delivery is carried out by a third party courier. The difference with respect to the "Supplier full-managed" model is that the picking and assembling of orders are carried out by the merchant rather than by the supplier. In the "Distributed inventory" strategy, the merchant carries an inventory for a limited number of items (usually a few hundred) in order to sell them at a very competitive price or to increase the service level (reducing the response time). For other items, the "Supplier full-managed" model is adopted. Delivery is outsourced to third party couriers. In the "Consignment inventory" strategy, the majority of items are managed according to the consignment stock policy (i.e., they are at the merchant warehouse and are managed through the "payment-upon-sales" formula). All other activities are carried out by the merchant, with the exception of delivery which is outsourced to third party couriers. In the "Merchant managed inventory" strategy, the merchant maintains an inventory at its warehouse, but delivery is outsourced to third party couriers. All the warehousing activities (storing, picking, preparation and assembly) are fulfilled at the merchant's warehouse. Finally, the "Full in-source" strategy is the most integrated model from a logistics point of view. The overall distribution process is managed internally by the merchant. Even the order delivery is carried out through vehicles owned by the merchant.

The classification model of the logistics strategies was applied to the 28 case studies, as shown in Table 6, where the supply chain members that carry out the various logistics activities are reported.

Case Study	Industry	Inventory ownership	Order picking and preparation	Order assembly	Order delivery	Logistic strategy
1	Consumer electronics	S	S	S/M	C	*Supplier full managed*
2	Consumer electronics	S	S	S/M	C	*Supplier full managed*
3	Consumer electronics	M	M	M	C	*Merchant managed inventory*
4	Consumer electronics	S/M	S/M	S/M	C	*Distributed inventory*
5	Consumer electronics	M	M	M	C	*Merchant managed inventory*
6	Consumer electronics	M	M	M	C	*Merchant managed inventory*
7	Consumer electronics	M	M	M	C	*Merchant managed inventory*
8	Consumer electronics	S/M	S/M	S/M	C	*Distributed inventory*
9	Books, CD, DVD	S/M	S/M	S/M	C	*Distributed inventory*
10	Books, CD, DVD	M	M	M	C	*Merchant managed inventory*
11	Books, CD, DVD	S/M	S/M	S/M	C	*Distributed inventory*
12	Books, CD, DVD	S/M	S/M	S/M	C	*Distributed inventory*
13	Books, CD, DVD	S/M	S/M	S/M	C	*Distributed inventory*
14	Books, CD, DVD	M	M	M	C	*Merchant managed inventory*
15	Apparel	S/M	M	M	C	*Consignment inventory*
16	Apparel	M	M	M	C	*Merchant managed inventory*
17	Apparel	M	M	M	C	*Merchant managed inventory*
18	Apparel	S	M	M	C	*Supplier managed inventory*
19	Apparel	S	M	M	C	*Supplier managed inventory*
20	Apparel	S	M	M	C	*Supplier managed inventory*
21	Apparel	M	M	M	C	*Merchant managed inventory*
22	Apparel	M	M	M	C	*Merchant managed inventory*
23	Apparel	M	M	M	C	*Merchant managed inventory*
24	Apparel	M	M	M	C	*Merchant managed inventory*
25	Apparel	M	M	M	C	*Merchant managed inventory*
26	Groceries	M	M	M	M	*Full in-source*
27	Groceries	M	M	M	M	*Full in-source*
28	Groceries	M	M	M	M	*Full in-source*

S: Supplier M: Merchant C: Courier

Table 6. The choices of the merchants according to the four main aspects that influence the logistics strategy

7. The relationships between logistics problems and logistics strategies

This purpose of this section is to investigate the relationship between logistics problems and the logistic strategies adopted by merchants. In order to better represent the relationships, a matrix that groups the 28 case studies according to the type of problem and strategy was used (see Figure 7).

Figure 7. The Logistics problem – Logistics strategy matrix

Some general observations can be made upon an examination of Figure 7. For distribution problems with significant complexity in one of the two categories (Product or Service), the logistics strategy is straightforward. The "Supplier full managed" strategy is the best fit for "Product-Side Complexity" problems: when product complexity is high, it is appropriate to outsource logistics activities and inventory ownership to the supplier in order to mitigate all inventory-related risks. The merchant should focus on all those critical success factors that provide the customer with an excellent online shopping experience (i.e., the design of the website, store management, the design of the purchasing process, online marketing, etc.). On the other hand, the logistics strategy which matches "Service-Side Complexity" problems is the "Full in-source" model: where the control of all logistics activities, including the final delivery, ensures a quick response to customer needs.

In the other cases, the choice of the logistics strategy is not as straightforward as for the two previous types of distribution problems. For "High Complexity" problems, there is no single best logistics strategy. On the one hand, most critical activities should be managed by the merchant (due to Medium/High service complexity); but, on the other hand, the risk of managing the inventory internally could be high (due to Medium/High product complexity). The two strategies that have been adopted, as shown by the matrix, are the "Merchant managed inventory" and the "Consignment inventory" strategies, in which the merchant carries out all of the main warehouse activities and outsources delivery to third party couriers. If the bargaining power of the merchant is strong, suppliers may own the inventory located at the merchant's warehouse in order to reduce the risk for the seller ("Consignment inventory"). If the supplier does not accept ownership of the goods at the merchant's warehouse (the ownership of the inventory is a matter of bargaining power between the merchant) or the merchant can leverage synergies with the offline channel (since it is a traditional player), then the "Merchant managed inventory" strategy is adopted. When service requirements are really critical, the merchant might also have to manage the delivery process internally (even though the latter is not the case in the examples analysed here) and use a "Full in-source" model for a selection of customers who are willing to pay for the additional service.

With the "Comparatively Easy" problem, the merchant has many degrees of freedom in designing the best solution (reasonable service at the lowest possible cost). In this case, the business model plays a key role in determining the logistics strategy.

The choice made by the "Complete and focused online sellers" that do not have the opportunity to maintain the entire product range at their warehouse is the "Distributed inventory" strategy. With this strategy, the merchant decides to maintain control of the logistics process for only a limited part of the product range, for which the service and/or the price is important. The other items (the majority) are managed by the supplier. The choice made by "Complete sellers" is driven by the impressive product range they need to store, whereas for "Focused sellers" the choice is driven by many items of low importance that have to be included in the online catalogue to complete the product range.

Traditional players adopt the "Merchant managed inventory" strategy (i.e., the merchant maintains full control over the inventory and offers a high level of service to its customers). This strategy is appropriate for two reasons. First, traditional players can exploit synergies with the offline channel, sharing their inventory with the network of points of sale (i.e., the inventory in the warehouse serves both the online and the offline channel). Second, since these merchants can offer only a certain selection of their products at highly competitive prices (in accordance with the commercial decisions for the offline channel), they have to focus on service (i.e., product availability and timeliness of delivery).

Finally the "Online clubs" choose the "Supplier managed inventory" strategy, since it can be used when the service level (especially the cycle time) is not demanding and there is no reason to own the inventory (e.g., no need to buy speculative stock). "Online clubs" that offer their products at a significant discount (up to 70% off) can ask customers to wait, even for up to a month, for the delivery of the ordered items.

8. The normative model

This section presents a normative model based on the process used by the most successful B2C e-commerce players and which can support those merchants who want to design their logistics strategy. The model considers 4 steps (see Figure 8). The function of the first 3 is to arrive at a description of the logistics problem, whereas the aim of the fourth is to support the identification of the best logistics strategy.

The first step requires the collection of the data referring to the product features and the customer service level according to the list of drivers proposed in Section 3. In the second step, the level of the complexity of each factor is assessed using Table 4 to rate the factors according to the five-value scale (L = Low, M/L = Medium/Low, M = Medium, M/H = Medium/High, H = High). In the third step, the logistics problem is described by assessing the combined values of product features and customer service level complexity and is plotted on the matrix in Figure 4. According to its position on the matrix, the logistics problem is classified into one of the four clusters (i.e., "Product-Side Complexity", "Comparatively Easy", "High-Complexity" and "Service-Side Complexity").

Finally, in the fourth step, the features of the logistics problem are used to suggest reasonable logistics strategies, in accordance with the relations identified in Section 7. For instance, if the problem is "Service-Side Complexity", a suitable logistic strategy is the "Full in-source" model. If the logistic problem is "High-Complexity", the business model and some specific values of the drivers have to be taken into account in order to make the best choice between the "Merchant Managed Inventory" and "Consignment Inventory", as shown in Figure 7.

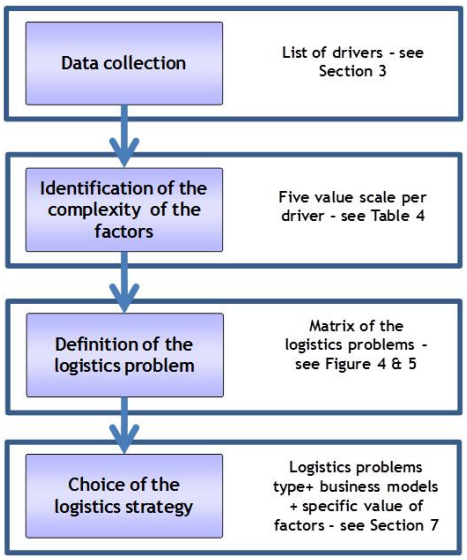

Figure 8. The normative model

9. Conclusions and managerial implications

The aim of this paper is to support the design of an e-commerce logistics strategy on the basis of the main features of the logistics problem. Even though many authors have represented the various types of logistics problems and strategies in the B2C field of e-commerce, the relationship between the problems and strategies has not been analysed in adequate depth. In comparison with the contributions found in the literature, the proposed model has at least two additional strengths. First, it is general and can be used by all goods-selling merchants, as its construction allows various industries and different business models to be considered. On the contrary, the majority of the papers in the literature are focused on specific industries and on specific strategies, lacking a broader perspective which instead is useful to identify common principles in order to drive the main logistical choices in the e-commerce field. Second, the proposed model is based on substantial empirical evidence - i.e., 28 case studies.

At least three important managerial implications can be derived from this analysis. First, it shows that the logistics strategy depends on the specific logistics problem, which has to be fully analysed by the merchant in terms of both the customer service level and product features. The paper provides a process and the instruments to carry out this phase (i.e., the list of drivers, the five-value scale and the matrix of the logistic problems). Second, despite being the most important factor, the logistics problem is not the only element driving the choice of the logistics strategy. The business model is a causal variable as well when there is no clear predominance of either the customer service level or of product features in determining the complexity of the logistics problem. This is the case with the "Comparatively Easy" logistics problems, in which the business model plays a key role in determining the owner of the inventories (i.e., the supplier and/or merchant).

Finally, the model proposed provides the guidelines to decide when to completely outsource or in-source the logistics processes. Managing the whole logistics process internally or the outsourcing them to a supplier are effective and efficient solutions with "Service" and "Product-Side complexity" problems respectively. On the one hand, the merchant should be aware that despite being a very appealing solution (no inventory and no operations), the "Full out-source" model might be critical when the customer service level is crucial. On the other hand, the "Full in-source" model increases control in terms of service level, but it might be inefficient.

The model has two limitations. The first one is that it does not take into account some important operative choices

(e.g., warehouse location and dimensions, storage and picking systems, etc.). Second, even though many international merchants have been included, only national logistical problems were considered. An extension to include other design decisions and global e-commerce problems will be the object of future research.

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