RAI
Revista de Administração e Inovação

ELECTRONIC COMMERCE AND LOGISTICS: THE LAST MILE DILEMMA REFERENCE FRAMEWORK AND SIMULATION

Alberto Grando
Professor of Production and Operations Management at Bocconi University of Milan
Professor of Production Management at Technology Department, SDA – Bocconi School of Management
E-mail: **alberto.grando@sdabocconi.it**. [Italy]

Marco Gosso
Managing Director at Cemat S.p.A., Milan
Lecturer of Logistics and Suply Chain Management at Technology Department, SDA – Bocconi School of Management
E-mail: **mgosso@cemat.it**. [Italy]

ABSTRACT

The electronic commerce companies that are involved in BtoC business and physical goods delivery have to deal with the Last Mile Logistics Dilemma, looking for the most apropriate solutions according to the characteristics of business models and service concepts proposed. To provide some useful suggestions to this dilemma, the article is aimed at: a) highlighting the crucial relationship between such e-commerce aproaches and logistics planning, in which the management of physical flows plays a fundamental role in providing profitability to the business; b) proposing a reference model to underly the relevant costs in the trade off between home delivery and delivery to a shop or pick-up point; c) linking those relevant costs to the main design and management leverages that can be used to define an apropriate and coherent solution to the problem; d)showing the risk of the "e-commerce trap", that occurs when click and mortar companies have to manage multiple delivery processes and related costs.The work offers an analytical aproach to the last mile logistics design and the implementation of main alternatives. The final section reports a simulation of the final delivery process for "family durable products" showing how the described framework can be put in practice and how the different variables identified can influence the economics of the distribution process.

Keywords: Elecrtonic commerce; Last mile logistics; Logistics design; Distribution.

1 INTRODUCTION

After the Internet "flop", in the last few years a new renaissance of e-commerce occured; the average on line expenditure in USA grew by 25% in 2001, 15% in 2003 and 12% (expected) in 2004 (Emarketer, 2003). Even if information goods have the lyon's share, also physical goods online sales are expected to grow: in 2007, online channel will cover 44% of software sales, 35% of ICT goods, 23% small electro-devices and 21% of CDs and videos (Forrester Research, February, 2004). Customer satisfaction of internet shopers is also increasing: 63.1% of online shopers claims for satisfaction in 2003 (against 59% in 2002); nevertheless serious problems on e-commerce are reported: order not received when promised (2.4%), received incorrect or defective product (1.2%), etc. (Goldman Sachs, December 2003). Performances are better on the web, but the delivery process need to be improved: on average, 3.67 minutes and 4.6 clicks to order, but 4.4 days to receive goods (E-tailing Group Inc., February 2004).

Still, logistics seems to be a bottleneck for the development of physical goods e-commerce: to be effective, companies must invest, namely in the last mile logistics. Companies engaged in e-commerce are increasingly being forced to re-think their logistics strategies in the light of a growing dilemma: how to recoup the additional costs involved in home deliveries (STARR, 2003).

In fact, the development of electronic commerce might be jeopardized by the logistical systems used to complete the order-to-delivery cycle, at least for those companies dealing with "physical products". Such logistical systems might prove inadequate to satisfy the requirements of an innovative organizational model: no more large deliveries to few and well-known destinations but many small deliveries to a large number of non recurring destinations, with a personalized customer service, available 24/7 and allowing a reliable delivery of products sourced from all over the world. In spite of the past debacles, residential deliveries generated by electronic commerce are growing more and more and, although the value of the orders connected to such deliveries represents a small percentage of the total value annually purchased by the final users, the ability to effectively and efficiently manage several hundred of million residential deliveries per year will be an element critical enough to jeopardize the traditional aproach to the physical distribution process.

In fact, when products are purchased through the Internet, the logic of the order-to-delivery cycle radically changes: the customer is no longer visiting the shop to collect the required products; it is the shop that "moves" to the customer's place to "deliver" the required products. This inverted logic leads to an underestimated transfer of some logistical costs from the "customer's account" to the e-tailer's one. Moreover, in most cases, while supliers are charged with the additional costs of home delivery, final customers do not benefit of any cost reduction since they are still obliged to go shoping (at least until all purchases can be delivered at home). For this reason, supliers can hardly "reverse" on final customers the additional costs related to the home delivery process, thus causing an erosion of their profit margins. Efficiency recovery can only be obtained by eliminating the traditional outlet network, but since, so far, most companies (with the exception of the "pure e-tailers") realise a very small portion of their business through the Internet, they are obliged to maintain their traditional outlet networks and the above mentioned efficiency recovery is much lower than the additional costs these companies pay for carrying out home deliveries.

The new growth of electronic commerce, therefore, calls for a critical analysis of the logistics systems currently used. This analysis should lead to the introduction of a new organizational model as well as to a dynamic redesign of the logistics systems allowing companies to more effectively and efficiently manage their physical distribution processes.

2 BACKGROUND, SCOPE AND PURPOSES OF THE ARTICLE

Literature emphasised the growing complexity of the e-business phenomena due to the newest technologies and strategic oportunities offered by the new tools (HAGEL, 1999; MAHADEVAN, 2001; PORTER, 2001; KENNY and MARSHALL, 2000; FEENY, 2001; CAGLIANO, CANIATO AND SPINA, 2003). Some authors stressed value creation through an adequate use of the Internet-based strategies (FRASER , FRASER and MCDONALD, 2000; URBAN, SULTAN and QUALLS, 2000; KEENEY, 1999; ZOTT, AMIT AND DONLEVY, 2000; AMIT and ZOTT, 2001; BARUA et al. 2001) and highlighted the main mistakes to be avoided (BERRY, 2001; YRJOLA, 2001; DAHLÉN and LANGE, 2000; KANTER, 2001, MAHAJAN, SRINIVASAN and WIND, 2002) lessons learned by failures (TANSKANEN, YRJOLA and HOLMSTROM, 2002; RANGAN and ADNER, 2001). Specifically referring to the relations between Suply Chain Management and ICT, they described the main strategic and operational implications (ELLRAM, LA LONDE and WEBER, 1999; SOLIMAN and YOUSSEF, 2001; WALTERS and RANDS, 1999; KERN, AZITOUTI and VAN de VELDE, 2000; GRAHAM and HARDAKER, 2000; MURILLO, 2001; DA SILVEIRA, 2003; MARUCA et al, 2001) focusing on the design of specific “bricks and mortar” business models (BARSH, CRAWFORD and GROSSO, 2000; GULATI and GARINO, 2000; ENDERS and JELASSI, 2000; WILLCOCKS and PLANT, 2001) and the new requirements of logistical infrastructure for e-commerce (TANG and XING, 2001; GOLCIC et al. 2002; YRJOLA 2000) Comparisons between conventional retailers and on line pure players have also been made (BAKOS and BRYNJOLFSSON, 1999; BRYNJOLFSSON and SMITH, 2000; LAL and SARVARY, 1999).

As for the B2C distribution, in many articles, both researchers and practitioners, emphasised the crucial role of logistics and channels design (DELEERSNYDER et. al, 2002), especially in terms of service breed of concern (SMAROS, HOLMSTROM. and KAMARAINEN, 2000; KAHL and BERQUIST, 2000) and e-fulfillment choices (LUMMUS and VOKURKA, 2002). Finally, special attention was paid to the last mile logistics issues, through the simulation of some distribution alternative (LEE and WHANG, 2001; KUMAR and VOLLMANN, 2000; BHISE et al., 2000), the analysis of the delivery process (KAMARAINEN, SARENSE and HOLMSTROM, 2001; PUNAKIVI and SARENSEN, 2000; KAMARAINEN, 2001; PUNAKIWI, YRJOLA and HOLMSTROM, 2001; YRJOLA, 2001) and the delivery performance measurement system (KALLIO, SAARINEN, TINNILA and VOPSALAINEN, 2000; WOLFINBARGER and GILLY, 2003). The customer role, his loyalty (REICHHELD and SHEFTER, 2000; SHANKAR, SMITH and RANGASWAMY, 2003; SRINIVASAN, ANDERSON and PONNAVOLU, 2002), behaviour (DEGERATU, RANGASWAMY and WU, 2000; TEO, LIM and LAI, 1999; TEO and YEONG, 2003; MENON and KAHN, 2002 satisfaction (SZYMANSKI and HISE, 2000) in the channel selction and buying process were been also deeply studied. (MATHWICK, MALHORTA. and RIGDON, 2001-2002).

The authors have deliberately limited the scope of this paper to a specific part of the wider electronic business, i.e. the logistics component of the commercial transaction. Besides, the attention has been focused on the logistics issues (AURAMO, AMINOFF and PUNAKIVI, 2002; DELFMANN, ALBERS and GEHRING, 2002) and, therefore, on the implications related to the management of the physical flow of goods. Finally, it has been decided to concentrate on the “business to consumer” segment of electronic commerce (HEIM and SINHA, 2001a; 2002b) thus paying particular attention to the implications that this new way of doing business has on the residential delivery process. All the work has been done considering the point of view of the retailer (KOTZAB and MADLBERGER, 2001).

This paper has, therefore, two main objectives.

First of all, the study aims to describe the relationship existing between electronic commerce and business logistics, highlighting the impact that such a branch of the new economy has on the logistics structures.

Secondly, the purpose of this paper is also to identify the main variables that can affect the distribution logistics models eligeable by companies involved in the electronic commerce (B2C) of “physical products”. A reference framework has been developed to evaluate the main distribution alternatives: direct (home) delivery to final customer versus delivery through a logistics platform (sales outlet, cross-docking point, local distribution center, etc.). With this framework, it is possible to more accurately understand the relationships among customer service requirements and total logistics cost levels, variables that can be managed by the network designer and choices of the most effective way to perform the physical delivery service.

The final section reports a simulation of the final delivery process for “family durable products” showing how the described framework can be put in practice and how the different variables identified can influence the economics of the distribution process.

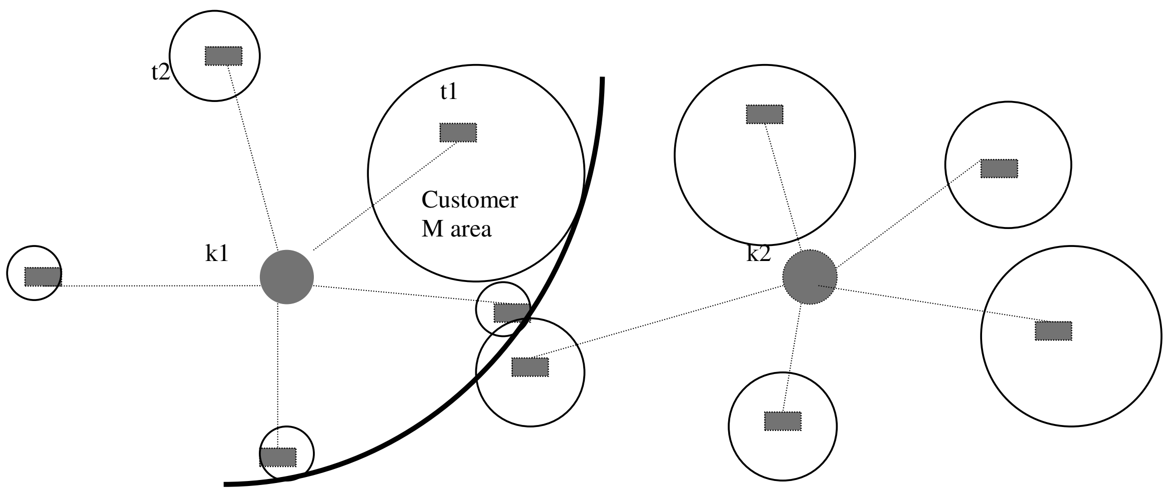
3 A PROPOSAL FOR FORMALIZATION: THE REFERENCE MODEL

The choice of the most effective way to perform a physical delivery service (delivery of the ordered product to end customers by means of a network of traditional sales outlets, or direct delivery to the customers’ homes) is conditioned both by the standard of service offered to the end customer and by the relative economic advantages of these two organizational alternatives.

The purpose of this paper is to offer useful suggestions to suplier firms and their partners in the planning of deliveries in this last section of the logistics chain. Although we have analyzed the problem from the point of view of the suplier, we have also considered the role of the customer which is not secondary. From the customer’s point of view, the choice between one alternative and another, if determined on an economically rational basis, depends on his/her perception of the value attributed to the price/service relationship, and this element in turn determines the choice between alternative distribution methods (BELL, HO and TANG, 1998; MESSINGER and NARASIMHAN, 1997; GEFEN, 2000). This might seem obvious, but in fact the chosen valuation method can include the “cost” associated with the contribution that the customer is willing to make in the transaction, through his/her willingness to dedicate time and money to the “pick-up” (or consignment) of the ordered products from a logistics terminal (whether it is a shop or a simple distribution point). In this perspective, the customer takes over some of the traditional functions of the suplier in the customer-suplier relationship, partially replacing the latter and absorbing a portion of his logistics costs. This willingness seems to be closely linked with the value attributed by the customer to his/her own time and money, which can vary (in virtual terms) from values close to zero to extremely significant amounts according to the context in which the relationship unfolds and the oportunity cost of time available for the transaction.

In order to simplify the analysis, our description of the proposed model begins with an estimate of the cost that would be incurred by the system in performing all secondary physical distribution activities, where the service offered to the customer remains the same.

As illustrated in Figure 1, the possibility of identifying the ideal territory of the different peripheral nodes (T) suplied by a distribution point (K), the distribution point itself with respect to the others that can be profitably located in the selected market area, and the possible points of convergence amongst these latter locations becomes critical.



Box 1. Key to symbols

T = Peripheral logistical nodes (shops or distribution points) = t1, t2, tn
K = Distribution point = k1, k2, kn
M = End customers = m1, m2, mn, referring to a "tn" logistical node
Q = Quantity of merchandise delivered per unit of time to a peripheral node (tn) or, alternatively, to the end customers (m1, mn) located in the market area served by tn, in the respective amounts (q1, q2, qn)
d = spatial-temporal distance from the distribution point K: dt, dm1, dm2, dx, dy, dmn = shop and customers located at specific distances from distribution point k1, respectively
π' = profit margin for home deliveries
π" = profit margin for shop deliveris

Figure 1 - The interactions between distribution points, peripheral nodes, and served customers

If the levels of service offered by the secondary distribution systems were identical for both of the organizational solutions considered, the relative economic advantage of choosing one or the other would be revealed by making a simple comparison between the transport costs that the firm would incur to make home delivery and the sum of the logistical costs (for warehousing, order preparation, and transport to the sales outlets) incurred by the firm itself, and summed with those incurred by the end customer in order to receive the ordered product. From the point of view of the distribution firm, with the end customers (M) who purchase products from (t) peripheral node (e.g. shop) operating in the area considered and suplied by the same distribution point (k) for secondary distribution, it is more economical to offer home delivery of the ordered products than to deliver them through shops when, for each secondary distribution point and where the total merchandise (Q) purchased by end customers is the same, the following condition is satisfied:

$$\Sigma_t(\Sigma_q Ddc) < \Sigma_t Bdc$$

where $\Sigma_t(\Sigma_q Ddc)$ represents the Direct Delivery Cost and $\Sigma_t Bdc$ represents the Brokered Delivery Cost; this latter cost is equal to $\Sigma_t[Ccn + (Cfn + Cvn + Cps) + \Sigma_q Pc]$, where:

ΣDdc (Direct Delivery Cost): cost incurred to make all the home deliveries of merchandise (q) ordered, by the customers (m) (normally served by the t-nth shop), starting from the distribution point (k) located in the interested area.

Ccn (Cost of Delivery to Shop): cost incurred to deliver the merchandise (Q) from the distribution point (k) to the t-nth shop operating in the area considered and successively destined to the customers normally served by this shop.

Cfn (Fixed Shop Costs): fixed costs that are incurred to establish the t-nth shop.

Cvn (Variable Shop Costs): the variable costs incurred to establish the t-nth shop.

Cps (Inventory Carrying Charges): this cost groups together the financial costs of carrying product inventories at the t-nth shop, product obsolescence risk costs, and inventory insurance costs.

ΣPc (Product Pick-Up Cost): cost incurred by customers (m) to pick up merchandise (q) at the t-nth shop. As pointed out above, this cost can theoretically be brought to zero or assume an extremely high value according to the value assigned by each customer to the general utility of his/her own available time. For those customers who are willing to pick up products in person because they have no valid alternatives in terms of time value, this cost will decline to the full advantage of the brokered alternative, whose relative importance will increase. On the other hand, in the case of customers who assign a high value to their time, the oportunity cost of using it will make direct delivery more desirable.

From the suplier's (distribution firm) point of view, the cost incurred by its customers to pick up ordered merchandise from the peripheral logistical nodes is not manifested in terms of an explicit configuration, however sensible it might seem to imagine that the suplier firm must take account of this component when planning its logistics. But in the point of view of the customer, distribution alternative (home delivery or through sales outlets) is influenced by a comparison between the subjectively perceived value assigned by the customer (m) to the home delivery service (Svm) and the cost he/she sustains for picking the order from the nearest outlet. In the scenarios just described, this comparison is between the price he/she would pay for home delivery, in the first case, and the sales price of the product charged by the shop plus the value assigned by the customer to the time/cost necessary to visit the shop and pick up the ordered merchandise, in the second case[i].

In this sense, the system of variables at play is completed as follows:

Suplier's point of view

$$\overset{\xleftarrow{\hspace{12em}}\;\text{Suplier's point of view}\;\xrightarrow{\hspace{12em}}}{(Ddc + \pi') \;\langle\; \frac{Ccn + (Cfn + Cvn + Cps)}{Q} + \pi'' + Ppc \;\langle\; Svm} \qquad (2)$$

Customer's point of view

Where:

- π', π'' = margins assigned to the two distribution alternatives, respectively.
- $Ddc + \pi'$ = price of home delivery.
- $\frac{Ccn + (Cfn + Cvn + Cps)}{Q} + \pi''$ = price of brokered delivery.
- Pc = customer order pick-up cost.
- Svm = subjective value assigned by customers to home delivery service.

It is possible to create a graphic representation of this economic oportunity equation. As illustrated in Figure 2, a Cartesian plane is used to show the relationship between the spatial-temporal distances that separate the local distribution point (placed at the origin on the x-axis) from the t-nth shop and the various end customers (m) who are normally served by the t-nth shop, with the costs/prices incurred by the system. Box 1 defines the symbols used.

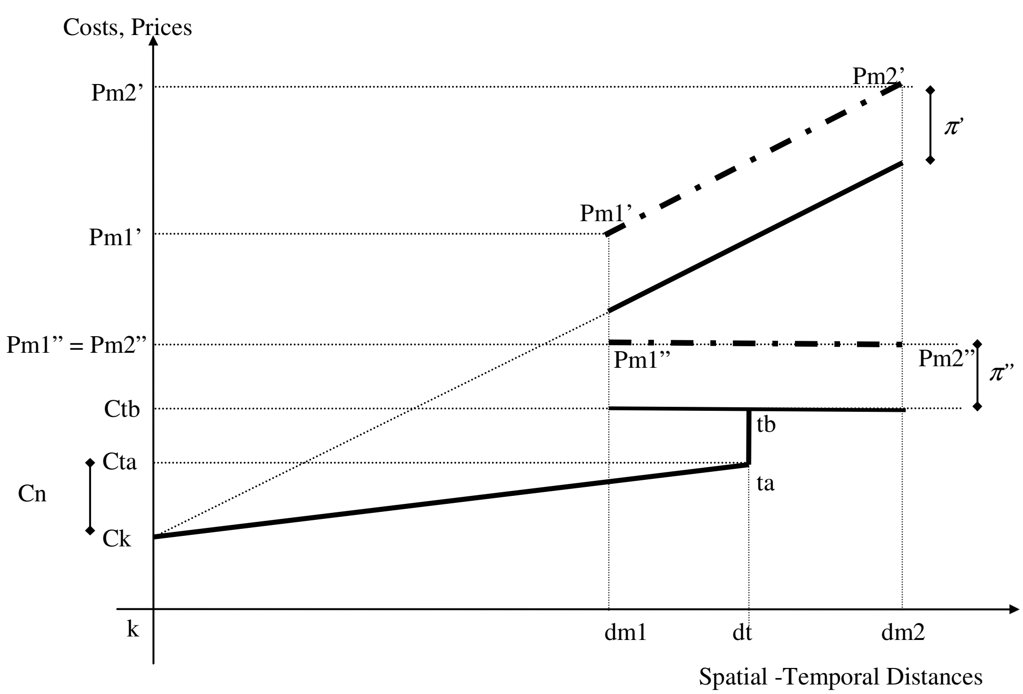


Figure 2 - Distribution costs, prices, profit margins for the logistical alternatives

Given the local distribution point k, any shop t belonging to the area of k, two customers m1 and m2 residing in the area normally served by t and who are respectively located at the minimum and maximum spatial-temporal distance separating the end customers from distribution point k, and the cost Ck to start up distribution point k, cost Cn incurred to make delivery of product (Q) from distribution point k to shop t can be represented by the segment linking Cta and Ck. The costs (Cfn+Cvn+Csp) can instead be represented by the segment that links Cta with Ctb.

Therefore, the cost of making a delivery of merchandise q from the shop to the customer m is expressed by the segment with value Ctb, to which must be added the pick up cost (Pc), which is also associated with subjective components incurred by the customer in order to pick up the products purchased from the shop most convenient to him/her. Alternatively, the overall cost of delivering merchandise Q from distribution point k directly to the homes of the various customers is expressed by the sum of the costs of the various deliveries to the individual customers, in the radical scenario illustrated in the figure, where the entire home-bound distribution is delivered directly from the distribution point and no mixed distribution including shops is provided for. If, as often hapens, the two forms of distribution are not considered as absolute alternatives, but rather manageable in complementary fashion, unsaturated and otherwise uncompensated fixed costs must be added to these costs for all the shops existing in the territory of distribution point k.

Furthermore, it is assumed for the sake of simplicity and by analogy with the costs of home delivery that the costs incurred to make individual home deliveries vary linearly according to variations in the spatial-temporal distance that separates the individual customers from distribution point k and that margins are constant and have the same value for both distribution alterantives.

Finally, if the costs (Pc) sustained by the end customers to pick up products at shop t are represented by points inside the polygon that connects the vertices $Pm_{1'}$, $Pm_{2'}$, $Pm_{1''}$, and $Pm_{2''}$, the most economical solution for the customers is to pick up the products at the shop. Otherwise, the most efficient organizational aproach is home delivery. Figure 3 shows the cases of two end customers X and Y, located at distance dx and dy from k, and characterized by different transport cost and cost of time. The segment representing the pickup cost (Pc) incurred by each customer varies in length according to the combination of the two components mentioned above (transport cost which is proportional to the spatial-temporal distance of the customer's home from the shop considered and the value assigned by the customer to his own time). When the total pickup cost for the customer exceeds the difference between the home delivery cost and the cost to deliver the order to the shop, the home delivery option is the preferred one.

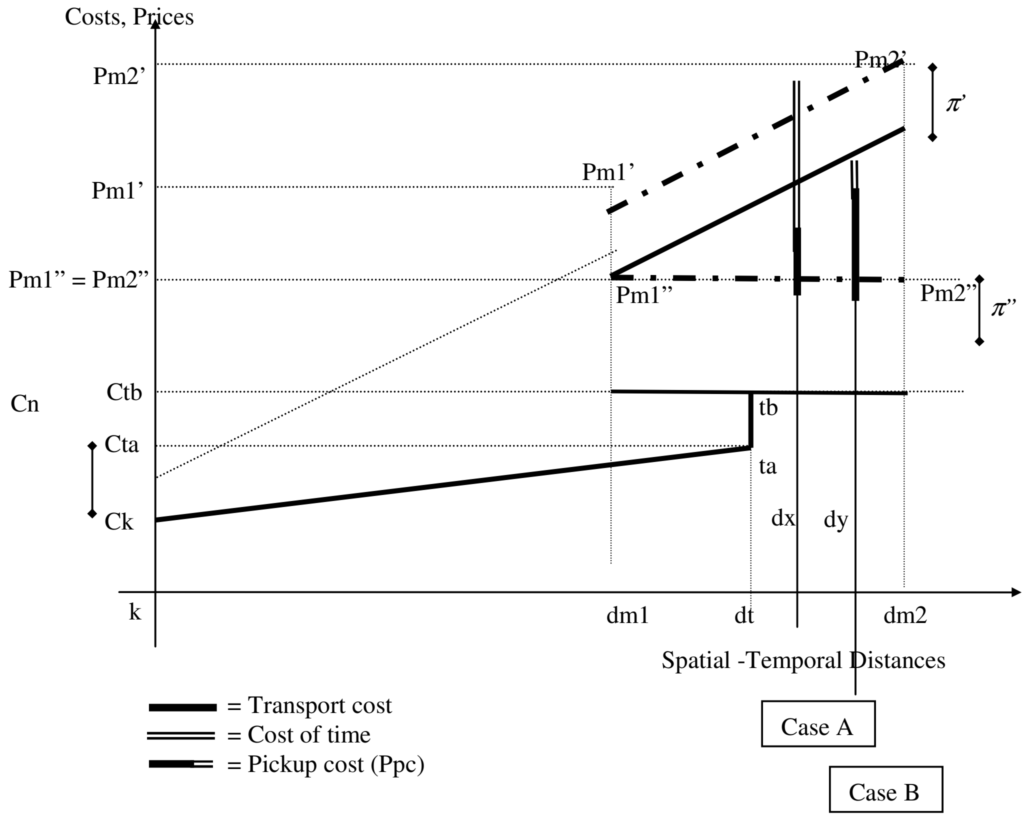


Figure 3 - Logistical alternatives and customer behaviours

Attribution of increasing value by customers to their own time causes the area of economical home delivery to grow (case a). On the other hand, the less value customers assign to their own time, the greater the apeal of brokered solutions (case b).

Finally, it is worth considering that we have assumed so far that the fixed costs of the intermediate logistical distribution network can be avoided when the home delivery alternative is performed by the distributor. As shown in figure 4, if such an assumption is eliminated and the fixed costs of the logistics network cannot be eliminated by the distributor when performing home deliveries, the interest in home delivery would be further eroded (there would be a shift towards the uper end of the cost curve equal to the sum of the fixed costs [Csf] for the shops kept open). This leads either to a proportional reduction of the suplier's profit margins or to a proportional price increase, thus determining a modification of the polygon (from $Pm_{1'}$, $Pm_{2'}$, $Pm_{1''}$, and $Pm_{2''}$, to Pm_{1*}, Pm_{2*}, $Pm_{1''}$, and $Pm_{2''}$) that makes the intermediate logistics alternative even more convenient for the customer: as highlighted in figure 4, if the cost shift does not reflect in a correspondent margin reduction for the distributor, even customers like the one previously mentioned in "Case A" would change their minds and prefer to pick up their orders from the shop. Therefore, the decision to eliminate the intermediate logistical structure cannot be made without a careful analysis of the costs incurred by current and potential customers to pick up ordered products from shops. This decision, which can lead to a veritable "e-commerce trap" if taken rashly, is complicated by the fact that the fixed costs for shops generally do not permit gradual entry.

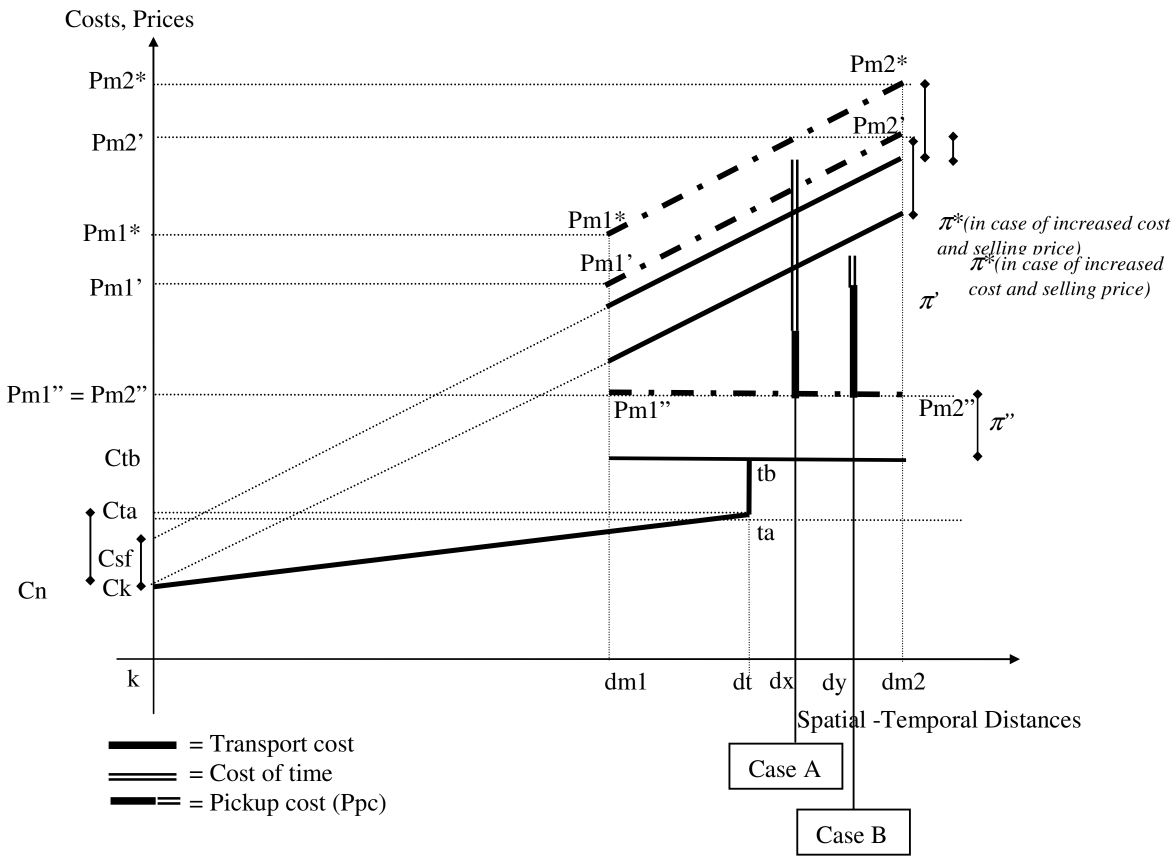


Figure 4 - The e-commerce trap: complementary organizational solutions (network of shops or home delivery)

Thus, a decision to maintain mixed logistical channels (direct and brokered delivery) stimulates the search for existing logistical networks that can be used to defray a portion of marginal fixed costs through intense levels of use. The attempt made by firms to minimize the impact of fixed costs for intermediate logistical distribution without compromising the distribution alternatives available to customers has led to the creation of a series of entrepreneurial initiatives offering the market with logistical brokering on behalf of third parties. The “Mail Box Etc.” shop network is a case in point, with it offering the possibility of acting as broker in the distribution process at completely variable costs[ii].

4 THE CRITICAL VARIABLES FOR PLANNING AN OPTIMAL LOGISTICS STRUCTURE

In order to identify the principal planning inducements and precautions to be taken in the course of determining the logistical structure best suited to satisfying the needs of a certain product/market combination, we shall first attempt to isolate those variables that are critical to a proper design and then proceed to illustrate how these variables can affect the intensity of logistical costs and how these latter can condition the choice of the best logistical structure.

These critical variables can be grouped into five main categories according to their nature:

variables related to the order;

variables related to the offered range and the product;
variables related to demand and the market;
variables related to the logistical structure;
variables related to the infrastructure.

The variables belonging to the five proposed categories can in turn be further broken down into **external** variables **(E.V.)**, which are more difficult to measure and control – and thus only marginally susceptible to managerial manipulation – and **internal** variables **(I.V.)**, which can generally be manipulated rather than passively accommodated and constitute a veritable incentive for company management to achieve the standards of efficiency and service imposed by the competition. These variables have a more or less pronounced and direct influence on the various cost items that govern the balance between home delivery and traditional shop distribution.

Table 1 - Logistics variables and costs

CATEGORIES	VARIABLES	E.V. / I.V.	MAIN IMPACT ON LOGISTICS COSTS
ORDER			
	Order value density	E.V. – I.V.	It influences the costs to make deliveries or pick up the products considered.
	Average size of order	E.V. – I.V.	It influences the ratio between transport costs and delivery stop costs that comprise the overall cost of distribution
	Ancillary delivery services	E.V. – I.V.	It influences both the distribution costs, especially the delivery stop costs, and the variable shop operating costs
	Degree of urgency of order	E.V.	It has a great impact on all cost components
	Handling of returns	I.V.	It has a major influence on distribution costs
RANGE/PRODUCT			
	Breadth/depth of range of products offered	I.V.	They essentially influence the operating costs of peripheral inventories (shop stocks).
	Product value density	E.V. – I.V.	It affects transport and stocking costs of the product itself.
	Weight-volume of product	E.V. – I.V.	It influences the transportability of the product
DEMAND/MARKET			
	Predictability of demand	E.V. – I.V.	It makes it possible to streamline inventory carrying costs, with availability for customers remaining equal, and the cycle (and thus cost) of restocking sales outlets
	Geographic concentration of demand	E.V.	It influences the transport costs from the distribution point to the shops and from the distribution point to the end customers.
	Customers density	E.V. – I.V.	It has a major influence on the costs for making home delivery
	Schedule of acceptance of merchandise	E.V.	It influences the efficiency and effectiveness of delivery rounds made by secondary distribution delivery vehicles.
	Value assigned by customer to his own time	E.V.	It has a substantial impact on the economic balance, that enables one to make the best choice between home delivery and shop pick-up.
LOGISTICS STRUCTURE			
	Characteristics of vehicles	I.V.	They largely affect transport costs (travel cost and stop cost)
	Characteristics of shops (location, ability to receive and stock products)	I.V.	They influence the fixed and variable costs of the shop, the costs of delivering the merchandise from the local distribution point, and the costs of picking up ordered products from the shop.
	Location of intermediate operators	I.V.	It influences the cost of delivering the merchandise to the shops located in the area of the individual distribution point
GENERAL INFRASTRUCTURE			
	Quality of transportation network (roads, railways, etc.)	E.V.	It directly influences the costs incurred in making shipments
	Congestion of route segments	E.V.	It influences the speed, thus the time, and consequently also the cost incurred to link origin and destination points in a specific transportation network
	differential cost between means of transport	E.V.	It expresses the difference in the cost incurred to transport a unit of product over a unit of distance with the different means available and where service standards are equal

In Table 2, the relations existing between the variables discussed above and the items of cost that determine the economic equilibrium between shop delivery and direct delivery to the end customer's home are summarized.

Table 2 - Logistics variables and delivery cost components

	COSTS	Ddc	Ccn	Cfn	Cvn	Cps	Pc
VARIABLES (related to:)							
ORDER							
	Order value density	- - -	-	=	=	=	- -
	Average size of order	- -	-	=	-	=	-
	Ancillary delivery services	+ + +	=	=	+ +	=	+ +
	Degree of urgency of order	+	+ +	=	+	=	+ + +
	Handling of returns	+ + +	+	=	+ +	+	=
RANGE/PRODUCT							
	Breadth/depth of range of products offered	=	=	=	+	+	=
	Product value density	- - -	-	=	=	+	- -
	Weight-volume of product	-	-	=	=	=	-
DEMAND/MARKET							
	Predictability of demand	-	- -	=	-	- -	-
	Geographic concentration of demand	- -	- -	=	=	=	-
	Density of customers	- - -	- -	=	=	=	- -
	Schedule of acceptance of merchandise[1]	++	+	=	+++	=	- -
	Value assigned by customer to his own time	=	=	=	=	=	+ + +
LOGISTICAL STRUCTURE							
	Characteristics of vehicles	- -	- -	=	=	=	=
	Characteristics of shops	=	-	+ +	- -	=	- -
	Location of intermediate operators	=	- -	=	=	=	=
INFRASTRUCTURE							
	Quality of transportation network	- -	-	=	=	=	+
	Congestion of route segments	+ + +	- -	=	=	=	+ +
	Cost differential between modes of transport	-	=	=	=	=	-

Legend: three symbols (e.g. +++) for strong impact, two for medium impact, and one for weak impact. "+"correlation is direct; "-" correlation is inverse; "=" correlation is negligible.

Notwithstanding its summary and non-rigorous nature, this qualitative analysis of the variables at play and the items of cost influenced by them reveal how:

- the variables that encourage adoption of a home delivery organizational structure are:
  - the density of value of the product/order;
  - the density of customers in the area considered;
  - the urgency with which the delivery must be made;
  - the need to guarantee delivery any hour of the day;
  - the value attributed by the final customer to his own time;
- the variables that instead encourage adoption of a shop delivery organizational system are:

- the need to provide ancillary delivery services;
- the need to handle returns;
- the increasing congestion of the transportation route segments.

5 SIMULATION

On the basis of the framework so far presented, a simulation has been carried out in order to evaluate the impact of some of the mentioned variables on the logistics design choices. The case of a distributor of "family durable products[iii]" evaluating the best alternative between selling products through a network of shops or adopting an on-line sales model providing home delivery has been simulated (see the simulation parameters used in apendix 1). The main differences have been analysed highlighting the relative importance of the different variables considered and their impact on the cost and service levels of the considered system.

The outputs of the simulation (see apendix 2) show how the delivery performances (cost and time) depend on both the mode of delivery (delivery to the shop, manned home delivery and unmanned home delivery) and the delivery variables (order-to-delivery cycle time and delivery window).

The distribution of delivery expectations of both shops and final customers along the various time fences is shown in Figure 5. It can be noticed that the delivery expectation at the shops are much more concentrated in few time fences than the final customers' home deliveries.

Figure 5 - Delivery expectation profiles

The different delivery profiles make the delivery to the shop more efficient than the home delivery process, up to a certain volume of activity. Once overcome the threshold of the utmost vehicle exploitation, longer working times enable interesting efficiency recovery (more drivers with the same number of vehicles used).

In general, the longer the order-to-delivery cycle time the lower the home delivery cost. As shown in Figure 6, the delivery cost decreases as the order-to-delivery cycle expands from 12 hours to 48 hours. Such a reduction ranges from a minimum of –11,8% to a maximum of –21,4%. Such a cost reduction seems to be due to the possibility for the distributor to better plan the delivery missions (i.e. higher number of deliveries per unit of time).

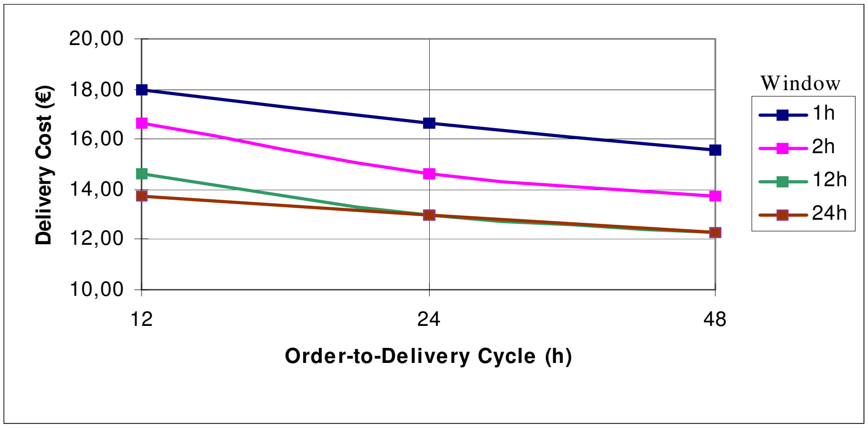


Figure 6 - Delivery cost versus Order-To-Delivery cycle

At the same time, the smaller the delivery window the higher the home delivery cost. Figure 6 shows that such cost increase ranges from 0% to 30,8% as the delivery window narrows from 24 hours to 12 hours and down to 1 hour. The cost increase is caused by the growing complexity for planning efficient delivery missions.

Figure 7 - Delivery cost versus delivery window

Besides, unmanned deliveries allow maximum optimisation of the delivery missions. As shown in Figure 8, the cost differences between manned and unmanned home deliveries range from –9,5%, with the same level of service, to –28,6% if only the order-to-delivery cycle time remains the same. Such cost difference is due to both lower delivery time to perform an unmanned delivery (if compared with the manned one) and to a better planning of the delivery missions.

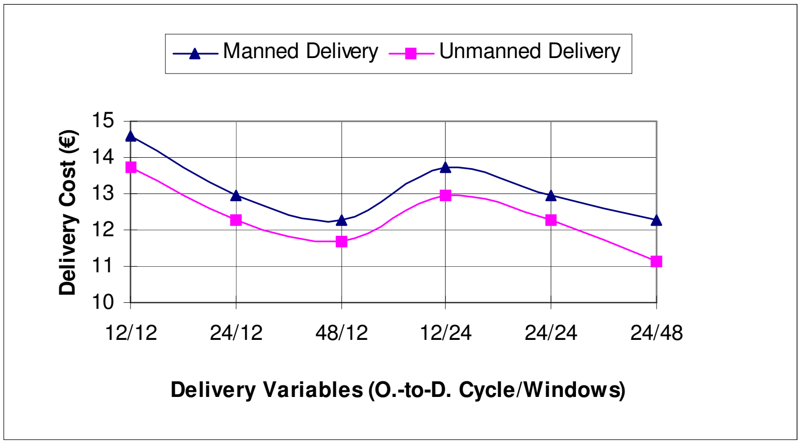


Figure 8 - Delivery cost: manned versus unmanned home delivery

As far as the impact of the delivery cost on the customer order value is concerned, it is interesting to notice that the home delivery cost is not particularly influenced by the customer order value (see Figure 9). This is due to the fact that the scarce resource in the delivery process is normally time (more than capacity). For this reason, it takes the same time (and cost) to deliver a 50€ order or a 25€ one.

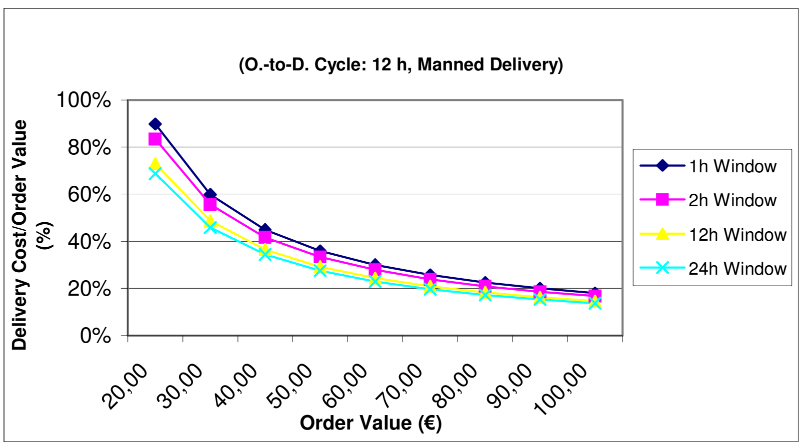


Figure 9 - Impact of delivery cost on order value

Finally, the simulation has highlighted a negative correlation between the customer density (amount of customer per unit of geographical area) and the transit time of the truck. As shown in Figure 10, the higher the customer density the lower the cost of the single delivery: a 10% increase in customer density determined a 5,3% (manned home delivery, 48 hour order-to-delivery cycle time, 24 hour delivery window) to 7,8% (manned home delivery, 12 hour order-to-delivery cycle time, 1 hour delivery window) reduction in the home delivery cost. In this case, even if the delivery constraints and, therefore, the customer service level offered are higher, by increasing customer density, higher delivery cost reductions are achievable.

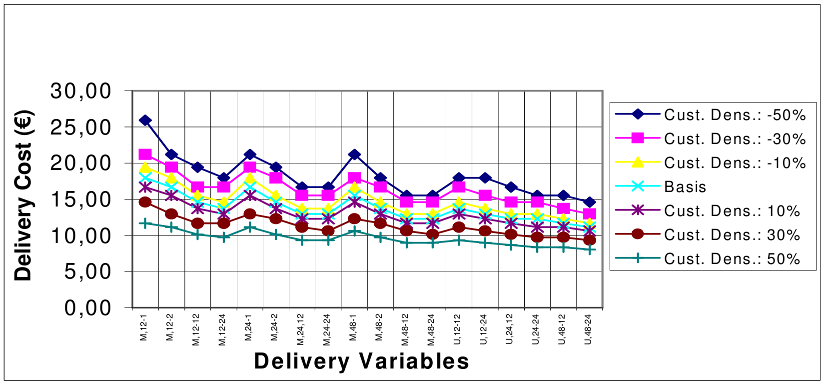


Figure 10 - Impact of customer density of home delivery cost

The high impact of the secondary distribution costs has been, so far, the main hindrance to the spreading of the “B2C” e-commerce. Very often, it is more convenient to collect products (especially low value density products) from the shop than to have them delivered directy at home. Therefore, assuming an average distance between the customer’s house and the nearest shop equal to 3,6 km, the direct cost for the customers to drive to the shop of 0,16€/km (including fuel, tyres, maintenance and insurance), 35 minutes for the purchase (nealy half of the time spent in the shop) and considering the customer’s own time value of 9,34€/h, the cost for the customer to collect an order from the shop is 6,57€, while the cost to deliver the same order directly to the customer’s place is almost 50% more expensive. It is interesting to notice that the higher the value attributed by the customer to his own time, the distance between his house and the nearest shop, the cost of the transportation means he uses to go to the shop and the time needed for the shoping activity, the lower such a cost difference.

Thus, the development of e-commerce demands that special attention be paid to the logistical aspects of distribution, with special reference to the last mile of the delivery process. Only by means of an attentive and fully thought-out critical analysis of the variables in play can the design and management of the apropriate logistical structures be undertaken, in such a way as to combine the effectiveness offered by the standard of service expected by the market with acceptable levels of operating economy.

6 CONCLUSIONS

The electronic commerce companies that are involved in BtoC business and physical goods delivery have to deal with the Last Mile Logistics Dilemma, looking for the most apropriate solutions according to the characteristics of business models and service concepts proposed.

To provide some usefull suggestions to this dilemma, the article is aimed at:

- highlighting the crucial relationship between such e-commerce aproaches and logistics planning, in which the management of physical flows plays a fundamental role in providing profitability to the business;
- proposing a reference model to underly the relevant costs in the trade off between

home delivery and delivery to a shop or pick-up point;

- linking those relevant costs to the main design and management leverages that can be used to define an apropriate and coherent solution to the problem;
- showing the risk of the “e-commerce trap”, that occurs when click and mortar companies have to manage multiple delivery processes and related costs.

In conclusion, the work offers an analytical aproach to the last mile logistics design and the implementation of main alternatives. Asimulation a simulation has been also carried out in order to evaluate the impact of the mentioned variables on the logistics design choices.

REFERENCES

AMIT, R. and ZOTT C., Value Creation in E-business. *Strategic Management Journal*, v.22, June-July 2001, p. 493-520.

AURAMO J., AMINOFF A. and PUNAKIVI M., Research agenda for e-business logistics based on professional options. *International Journal of Physical Distribution & Logistics Management*, V. 32, n.7 2002, p. 513-531.

BAKOS Y. and BRYNJOLFSSON E., Bundling information goods: pricing, profits and efficiency. *Management Science*, v.45, n.12 1999, p. 1613-1630.

BARSH J., CRAWFORD B. and GROSSO C., How E-tailing can rise from the Ashes. *The McKinsey Quarterly*, n.3 2000, p.58-109.

BARUA A., KONANA P., WHINSTON A.B. and YIN F., Dirving e-business excellence. *Sloan Management Review*, v.42, n.1 fall 2001, p. 36-44.

BELL D.R., HO T. and TANG C.S., Determining where to shop – fixed and variable costs of shoping. *Journal of Marketing Research*, v.35, n.3 1998, p. 360-369.

BERRY L.L., The Old Pillars New Retailing. *Harvard Business Review*, v.79, n.4, April, 2001, p. 131-137.

BHISE H., FARREL D., MILLER H., VANIER A. and ZAINULBHAI A., The duel for the Doorstep. *The McKinsey Quarterly*, n.2 2000, p. 33-41.

BRYNJOLFSSON E. and SMITH M.D., Frictionless Comerce? A comaparison of Internet and Conventional Retailers. *Management Science*, v.46, n.4 April 2000, p.563-585.

CAGLIANO R., CANIATO F. and SPINA G., E-business strategy. How companies are shaping their suply chain through the Internet. *International Journal of Operations & Production Management*, v.23, n.10 2003, p. 1142-1162

DA SILVEIRA G.J.C., Towards a framework for operations management in e-commerce. *International Journal of Operations & Production Management*, v.23, n.2 2003, p. 200-212

DAHLÉN M. and LANGE F., Missed oportunities in the virtual store. *European Business Forum*, n. 2, summer 2000, p. 42-46.

DEGERATU A.M., RANGASWAMY A. and WU J., Consumer choice behavior in online and traditional supermarkets: the effects of brand name, price, and other serach attributes. *International Journal of Research in Marketing*, v. 17 2000, p. 55-78.

DELFMANN W., ALBERS S. and GEHRING M., The impact of electronic commerce on logistics service providers, International. *Journal of Physical Distribution & Logistics Management,* v.32, n.3 2002, p. 203-222.

DELEERSNYDER B., GEYSKENS Gielens K. and DEKIMPE M.G., How cannibalistic is the Internet Channel? A study of the newspaper industry in the United Kingdom and The Netherlands. *International Journal of Research in Marketing*, v. 19 2002, p. 337-348.

ELLRAM L.M., LA LONDE B.J. and WEBER M.M., Retail Logistics. *International Journal of Physical Distribution & Logistics Management,* v.29, n.7/8 1999, p. 477-494.

ENDERS A. and JELASSI T., The Converging Business Models of Internet and Bricks-and-Mortar Retailers. *European Management Journal*, v.18, n.5 October 2000, p. 542-550.

FEENY, D., Making business sense of the e-oportunity. *Sloan Management Review*, v.42, n.2 Winter 2001, p. 41-51.

FRASER J., FRASER N. and McDonald F., The strategic challenge of electronic commerce, Suply Chain Management. *An International Journal*, v.5, n.1 2000, p.7-14.

GEFEN D., E-commerce: the role of familiarity and trust, Omega. *The International Journal of Management Science*, v. 28 2000, p. 725-737.

GOLCIC S.L., DAVIS D.F., MCCARTHY T.M. and Mentzer J.T., The impact of e-commerce on suply chain relationship. *International Journal of Physical Distribution & Logistics Management*, v. 32, n. 10 2002, p.851-871.

GRAHAM G. and HARDAKER G., Suply-Chain Management across the Internet. *International Journal of Physical Distribution and Logistics Management,* V. 30, n.3/4 2000, p. 286-295.

GULATI R. and GARINO J., Get the Right Mix of Bricks & Clicks. *Harvard Business Review*, V. 78, n.3 May-June 2000, p. 107-114.

HAGEL, J. III°, Unbundling the Corporation. *Harvard Business Review*, v. 77, n.2, march-april 1999, p. 133-141.

HEIM G.R. and Sinha K.K., A product-process matrix for electronic B2C operations for delivery of customer value. *Journal of Service Research*, v.3, n.4 May 2001a, p. 286-299

_______. Service process configuration in electronic retailing: a taxonomy analysis of electronic food retailers. *Production and Operations Management*, v. 11, n.1 2001b, p. 54-73.

KAHL S.J. and BERQUIST T.P., A primer on the Internet Suply Chain. *Suply Chain Management Review*, September-October 2000, p.41-49.

KALLIO J., SAARINEN T., TINNILA M. and VOPSALAINEN A.P.J., Measuring Delivery Process Performance. *The International Journal of Logistics Management*, v.11, n.1 2000, p.75-87.

KAMARAINEN V., The reception box impact on home delivery efficiency in the e-grocery business. *International Journal of Physical Distribution & Logistics Management*, v.32, n.6 2001, p. 414-426.

KAMARAINEN V., SARENSE J. and HOLMSTROM J., The reception box impact on home delivery efficiency in the e-grocery business. *International Journal of Physical Distribution & Logistics Mnagament,* v.31, n.6 2001, p. 414-426.

KANTER R.M., The Ten Deadly Mistakes of Wanna-dots. *Harvard Business Review*, v.79, n.1, January 2001, p.91-100.

KEENEY R.L., The value of Internet commerce to the customer. *Management Science*, v.45, n.4 1999, p.533-542.

KENNY D. and Marshall J.F., Contextual Marketing. The real Business for the Internet. *Harvard Business Review*, v.78, n.6, November-december 2000, p. 119-125.

KERN T., AZITOUTI A. and VAN de VELDE S.L., The impact of Internet Technologiy on Integration and Brokerage in *Suply Chain*, Working Paper, Rotterdam School of Management, Erasmus University, Rotterdam, 2000.

KOTZAB H. and MADLBERGER M., European retailing in e-transition?: An empirical evaluation of Web-based retailing indications from Austria. *International Journal of Physical Distribution & Logistics Management,* v. 31, n.6 2001, p. 440-462.

KUMAR N. and VOLLMANN T.E., Building the last mile. How to solve the logistics in e-business. *European Business Forum*, n.4 Winter 2000, p. 66-70

LAL R. and SARVARY M., When and how is the Internet likely to decrease price competition? *Marketing Science*, V.18, n.4 1999, p. 485-503.

LEE H.L. and WHANG S., Winning the last mile of e-commerce. *Sloan Management Review*, v. 42, n.1 summer 2001, p. 54-62.

LUMMUS R.R. and VOKURKA R.J., Making the Right E-fulfillment Decision. *Production and Inventory Management Journal,* First and second quarters, v.43, n.1 and 2 2002, p.50-55.

MAHADEVAN B., Business Models for Internet-Based E-commerce: an Anatomy. *California Management Review*, summer, v.42, n.4 2000, p. 55-69.

MAHAJAN V., SRINIVASAN R. and WIND J., The Dot-Com Retyail Failures of 2000: where there any Winners?, *Journal of the Academy of Marketing Science*, V.30, n.4 October 2002, p.474-486.

MARUCA R.F. et Alii, Retailing: Confronting the Challenges that Face Bricks-and-mortar Stores. *Harvard Business Review*, V. 77, n.4, July-August 1999, p.159-168.

MESSINGER P.R. and Narasimhan C., A model of retail formats based on customers' economizing on shoping time. *Marketing Science*, v. 16, n.1 1997, p. 1-23.

MURILLO L., Suply Chain Management and the International Dissemination of e-commerce. *Industrial Management & Data Systems, v.101, n.7 2001, p.370-377.*

PORTER M., Strategy and the Internet. *Harvard Business review*, v. 79, n.3 2001, p.62-78.

PUNAKIVI M. and SARENSEN J. *Developing Home Delivery for E-Grocery by Simulation*, Logistics Research Network 5th Annual Conference, Cardiff, 7-8 September 2000.

PUNAKIWI M., YRJOLA H. and Holmstrom J., Solving the last mile issue: reception box or delivery box?, International. *Journal of Physical Distribution & Logistics Management,* v.31, n.6 2001, p.427-439.

REICHHELD F.F. and SHEFTER P., E-Loyalty. Your Secret Weapon on the Web. *Harvard Business Review*, V.78, n.4 July-August 2000, p.105-113.

RANGAN, S. and ADNER R., Profit and the Internet: seven misconceptions. *Sloan Management Review*, v.42, n.4 summer 2001, p. 44-53.

SMAROS J., HOLMSTROM J. and KAMARAINEN V., New Service Oportunities in the E-grocery Business. *The International Journal of Logistics Management*, v.11, n.1 2000, p. 61-73.

SOLIMAN F. and YOUSSEF M., The impact of some recent developments in e-business in the management of next generation manufacturing. *International Journal of Operations & Production Management*, v.21, n.5/6 2001, p. 538-564.

SHANKAR V., SMITH A.K. and Rangaswamy A., Customer satisfaction and loyalty in online and offline environments. *International Journal of Research in Marketing*, v. 20 2003, p. 153-175.

SRINIVASAN S.S., ANDERSON R. and Ponnavolu K., Customer loyalty in e-commerce: an exploration of its antenedents and consequences. *Journal of Retailing*, V. 78 2002, p. 41-50.

STARR M. K., Aplications of POM to e-business: B2C e-shoping. *International Journal of Operations & Production Management*, v.23, n. 1 2003, p. 105-124.

TANG F.F. and XING X.,Will the growth of multi-channel retailing diminish the pricing efficiency of the web? *Journal of Retailing*, v.77 2001, p. 319-333.

TANSKANEN K., YRJOLA H. and HOLMSTROM J., The way to profitable Internet grocery retailing. Six lessons learned. *International Journal of Retail & Distribution Management*, V.30, n.4 2002, p. 169-178.

TEO T.S.H., LIM V.K.G. and LAI R.Y.C., Intrinsic and extrinsic motivation in Internet usage, Omega. *The International Journal of Management Science*, v.27 1999, p. 25-37.

TEO T.S.H. and YEONG Y.D.,Assesing the consumer decision process in the digital marketplace, Omega. *The International Journal of Management Science*, v.31 2003, p. 349-363

URBAN G.L., SULTAN F. and Qualls W.J. ,Placing trust at center of your Internet strategy. *Sloan Management Review*, v.42, n.1 fall 2000, p. 39-48.

VENKATRAMAN, N., Five steps to a dot-com strategy: how to fined your footing on the web. *Sloan Management Review*, v. 41, n.3 spring 2000, p.15-28.

WALTERS D. and RANDS C.A., Computers in retailing. *International Journal of Physical Distribution & Logistics Management*, v.29, n.7/8 1999, p. 465-476.

WILLCOCKS, L.P. and Plant, R., Pathways to e-business leadership: getting from bricks to clicks. *Sloan Management Review*, v.42, n.3 spring 2001, p.50-59.

WOLFINBARGER M. and Gilly M.C., EtailQ: dimensionalizing, measuring and predicting etail quality. *Journal of Retailing*, v.79 2003, p. 183-198.

YRJOLA H., *New Logistical Infrastructure Required for and Created by Electronic Commerce*, Proceeedings of the Logistics Research Network, 5th Annual Conference, Cardiff University, 7-8 september 2000.

_______. Physical distribution considerations for electronic grocery shoping. *International Journal of Physical Distribution & Logistics Management*, v.31, n.10 2001, p. 746-761.

ZOTT C., Amit R. and Donlevy J., Strategies for Value Creation in E-Commerce. Best Practices in Europe. *European Management Journal*, v. 18, n.5 October 2000, p. 463-475.

MENON S. and Kahn B., Cross-category effects of induced arousal and pleasure on the Internet shoping experience. *Journal of Retailing*, v.78 2002, p. 31-40.

SZYMANSKI D.M. and Hise R.T., E-satisfaction: an initial examination. *Journal of Retailing*, v.73, n.3 2000, p. 309-322.

MATHWICK C., MALHORTA N. and RIGDON E., Experiential value: conceptualization, measurement and aplication in the catalog and Internet shoping environment. *Journal of Retailing,* v. 77 2001, p. 39-56.

_______. The effect of dynamic experiences on experiential perceptions of value: an Internet and catalog comparison. *Journal of Retailing*, v. 78 2002, p. 51-60.

[i] On closer examination, the value attributed by the customer to his/her own time is also revealed by home delivery, where the customer incurs an opportunity cost associated with the time slot assigned by the supplier for delivery (see simulation below). In labor terms, this cost is considered negligible in consideration of the efforts made by distribution firms steadily to reduce the length and increase the number of these slots; it also seems evident that a reliable estimation of this cost is impossible due to its nature (opportunity cost), as compared with the nature (out-of-pocket cost) of the transport cost component in the alternative case of pick-up at the shop.

[ii] For the same reasons, in the case of local distribution, retail networks that are widely and densely scattered throughout the territory, such as tobacconists, newstands, etc. can be highly desirable.

[iii] The term “Family durables” covers the following categories: household electric appliances (black, white and small), furniture, telephones, office equipment, photographic equipment and do-it-yourself materials. Such division is consistent with SEC95, the new classification of national accounts largely used all over Europe.

Data do recebimento do artigo: 14/03/2005

Data do aceite de publicação: 20/07/2005