ELECTRONIC COMMERCE AND LOGISTICS PLANNING: AN UNDERRATED RELATIONSHIP

Marco Gosso* and Alberto Grando**

Abstract

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 will have on the logistics structures, in the next future. The purpose of this paper is also to identify the organizational model characterizing the outbound logistics process and that will most likely be implemented by those companies that will be succesful in the electronic commerce (B2C) of "physical products". In order to provide further design advices, a specific section of this paper has been dedicated to the identification of the critical variables that may influence the design of the logistics network, with specific reference to the logistics "last mile" issue. The analysis of the combination of such variables has allowed the formulation of a reference framework which can easily be used to evaluate the main distribution alternatives: direct (home) delivery to final customer vs. 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 cost levels, variables that can be managed by the network designer and choices of the most effective way to perform the physiacal delivery service.

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KEYWORDS: Logistic, E-Commerce, Business to consumer.

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INTRODUCTION[1]

Despite the failure of some dot.com companies, the use of the Internet is still growing. Today, some 200 million people worldwide are online and, according to recent predictions made by Forrester Research and De Loitte Research, by 2002 Internet B2B and B2C transactions will exceed 1050 billion dollars (J.V. Murphy, 2000, p.26).

Thanks to the Internet, companies will be able to simultaneously interact with a growing number of customers, offering them a customized service. Such a new approach will be so radical to question many of the business rules determining companies' competitive advantage .

Yet, the recent boom of electronic commerce might be jeopardized by the logistics systems used to complete the order-to- delivery cycle, at least for those companies dealing with "physical products". Such logistics 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. Influential sources (Forrester, 2000; DeLoitte, 2000) recently reported that residential deliveries generated by electronic commerce have exceeded 1,5 million packages per day, in 2000, 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 approach to the physical distribution process (Forrester Research, 2000, p.64).

The foreseen 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 (Dabbiere A., 1999, p.14).

SCOPE OF THE PAPER

In order to highlight the focus of this work, it is important to specify that, first of all, the authors have deliberately limited the scope of the work to a specific part of the wider electronic business, i.e. the logistics component of the commercial transaction. By taking this approach, it has been decided to deliberately omit the remaining aspects characterizing the commercial transaction, such as those related to communication, payments, security, privacy, etc.(Scott W.G., 1999; Korper S., Ellis J., 2000), aspects that, althuogh very important, go beyond the scope of this paper.

Secondly, since it has been decided to focus the attention on the logistics issues and, therefore, on the implications related to the management of the physical flow of goods, the wide and diversified world of services has deliberately been excluded by this work.

Thirdly, within electronic commerce, it has been decided to concentrate on the "business to consumer" segment, thus paying particular attention to the implications that this new way of doing business has on the residential delivery process (an area whose growth seems to be seriously threatened by the logistics choices).

Finally, it is important to specify the fact that the work has been done considering the point of view of the retailer. Nevertheless, in order to enrich the analysis carried out, a number of comments related to the other

[1] This paper is the fruit of a close collaborative relationship between the authors.

subjects involved in the supply chain (i.e. manufacturers, final customers, logistics service providers, etc.) have also been included.

This paper has, therefore, a number of objectives that differ by nature and degree of complexity and that can be placed at different levels.

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 will have on the logistics structures, in the next future. The problem of effectively redesigning the logistics flows is, in fact, particularly critical in countries like Italy where its infrastructural characteristics may affect the success of companies which rely on electronic commerce.

The purpose of this paper is also to identify the organizational model characterizing the outbound logistics process and that will most likely be implemented by those companies that will be succesful in the electronic commerce (B2C) of "physical products". In order to provide further design advices, a specific section of this paper has been dedicated to the identification of the critical variables that may influence the design of the logistics network, with specific reference to the logistics "last mile" issue. The analysis of the combination of such variables has allowed the formulation of a reference framework which can easily be used to evaluate the main distribution alternatives: direct (home) delivery to final customer vs. 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 cost levels, variables that can be managed by the network designer and choices of the most effective way to perform the physiacal delivery service.

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 delivery directly to the customers' homes) is conditioned both by the standard of service offered to the end customer and the relative economic advantages of these two organizational alternatives.

Authors and pratictioners agree that last mile delivery is a crucial point of dotcom logistical systems (Kumar N., Vollmann T.E., 2000, pp.66-70); nevertheless, few specific research are published on this issue, because of the difficulties in modelling and capturing all the variables involved in. Recentely, some authors developed interesting studies focused on simulation of urban delivery models (Rowat C., 1998; Punakivi M., Saranen J., 2000, pp. 480-488).

The purpose of this paper is to offer useful suggestions to supplier firms and their partners in the planning of deliveries in this last section of the logistic chain. We shall first explain the methods that we have applied to define the underlying elements used in modeling the system of variables and relations used to select the most effective distribution system.

Although we analyze the problem from the point of view of the supplier, we shall also consider the role of the customer, who, as we shall see, is not secondary. Given that the problem in question involves a service, the issue of innovative physical distribution methods ultimately involves the customer as well on account of his pre-eminent position in the commercial relationship and determining influence on how the "service" aspect of the exchange relationship is governed. It thus seems clear that, from the consumer's point of view, the choice between one alternative and another, if determined on an economically rational basis, depends on his perception of the value attributed to the price/service relationship, and this element in turn determines the choice between alternative distribution methods. 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 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 simple distribution point). In this perspective, the customer takes over some of the traditional functions of the supplier in the customer-supplier 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 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 opportunity cost of the amount of time available for the transaction.

We have made the foregoing observations simply in order to point out that even if we adopt the point of view of the business that markets the product, the need to take into account the principal variables in question also requires us to make assumptions about the hypothetical behavior of the consumer.

The complex operating structure underlying the variables considered thus conditions our ability to model the range of choices for optimum allocation of resources by the supplier firm in a detailed, effective, and concretely usable way. In order to simplify the following 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[2].

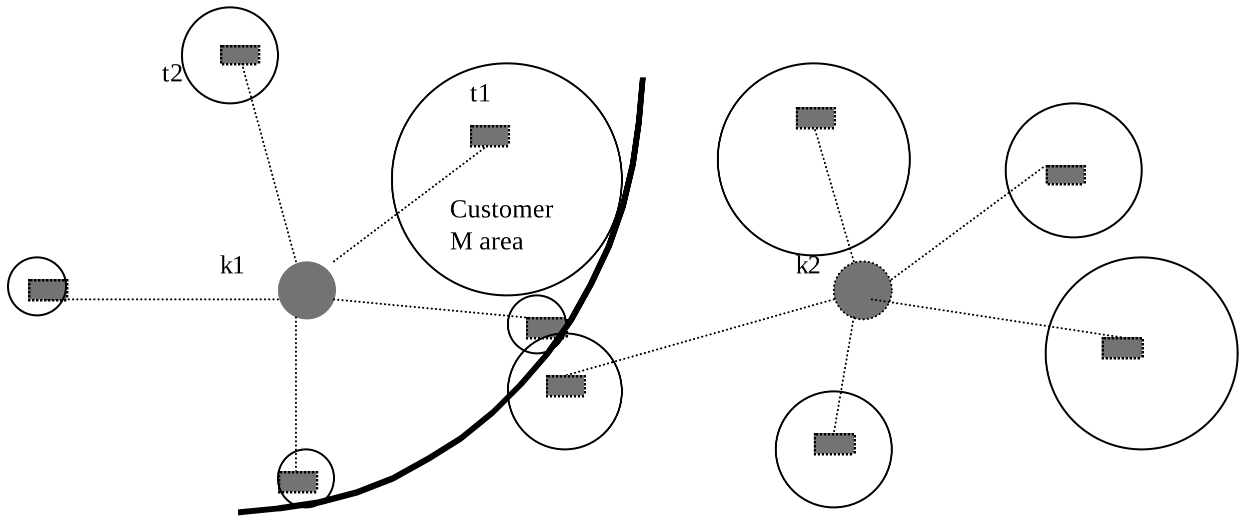
As mentioned above, the underlying assumption of this study is that it is possible to offer useful suggestions regarding the variables that can influence the alternative of direct distribution from the distribution point, as compared with physical distribution through the intermediate stage of a peripheral node frequented by customers (M). At the same time, as illustrated in Figure 1, the possibility of identifying the ideal territory of the different peripheral nodes (T) supplied 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.

In the first scenario, if the level of service offered by the secondary distribution system were identical for both of the organizational solutions considered, the relative economic advantage of choosing one and not 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[3].

[2] However, it seems clear that, in general, introduction of different levels of service by means of different combinations of logistical alternatives does not change the variables, while the magnitude of the underlying quantities (costs and prices) do change.

[3] In this regard, it has been observed that "The trade-off is thus defined by the possibility of covering the cost of preparing the customer order and transporting it to his home at a cost less than or equal to the savings resulting from elimination of the sales outlets" (Pellegrini L., 1999, pg. 112).

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



From the point of view of the distribution firm, with the end customers (M) who purchase products from (T) peripheral nodes (e.g. shops) operating in the area considered and supplied 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:

$$\Sigma t(\Sigma qDdc) < \Sigma tBdc$$

where Σt(ΣqDdc) represents the Direct Delivery Cost and ΣtBdc represents the Brokered Delivery Cost; this latter cost is equal to Σt(Ccn + (Cfn + Cvn + Cps) + ΣqPpc), where:

- **ΣDdc (Direct Delivery Cost)**: cost incurred to make all home deliveries of merchandise (q) ordered, per unit of time, by customers (m) normally served by the t-nth shop, starting from the distribution point (k) located in the interested area. This cost depends on the product characteristics (density of value, weight-volume, installation requirements, etc.), the demand characteristics (nature of order, product substitutability, etc.), nature of the market and the infrastructure situation in the area considered (number of customers, spatial-temporal distance between the distribution point and the residences of the various customers, customer density per unit of geographical area, etc.).
- **Ccn (Cost of Delivery to Shop)**: cost incurred to make delivery of 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. This cost depends on the characteristics of the products (density of value, weight-volume, installation requirements, etc.), the characteristics of the restocking process (amount and frequency of shop restocking, etc.), the characteristics of the market and the infrastructure situation of the specific area considered (spatial-temporal distance between the distribution point and the various shops, etc.).

- **Cfn (Fixed Shop Costs)**: fixed costs that are incurred to establish the t-nth shop's operating inventory. These costs are comprised by the rental or depreciation cost of the property, furnishing costs, general and administrative expenses, etc., and largely depend on the geographical location of the shop (downtown or suburbs), the structural characteristics of the property, the type of business operated (segment), and the organizational structure of the shop.
- **Cvn (Variable Shop Costs)**: the variable costs incurred to establish the t-nth shop's operating inventory. These costs vary according to differences in the volume of business handled by the t-nth shop and thus depend on the nature of the product, orders handled, etc. A typical example of a variable shop cost is the cost of preparing orders.
- **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. The variables influencing this cost item are comprised by the nature of the products (density of value, depth of product range handled, etc.), characteristics of demand (nature of order, product substitutability, etc.), and market characteristics (predictability of demand, length of product life cycle, etc.).
- **S Ppc (Product Pick-Up Cost)**: cost incurred by customers (m) to pick up merchandise (q) at the t-nth shop. This cost is incurred by the end customers when they decide to visit shop (t) to purchase the desired product. It is thus influenced by the nature of the products (value density, weight-volume, etc.), the type of demand (nature of order, product substitutability, etc.), and the infrastructure situation in the area considered (spatial-temporal distance between the shop (t) and the home of the m-th customer, customer's possibility of combining other purchases during the same shopping trip, etc.). 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 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 opportunity cost of using it will make direct delivery more desirable.

From the supplier'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 supplier firm must take account of this component when planning its logistics. But in the point of view of the customer, who has a very clear idea of the value of his own contribution, we can imagine that his preference between distribution alternatives (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), strictly related to the Product Pick-up Cost, and the cost he sustains for the two alternatives. In the scenarios just described, this cost is equal to the price paid 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 necessary to visit the shop and pick up the ordered merchandise, in the second case[4].

[4] On closer look, the value attributed by the customer to his 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 section 8 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 estimate of this

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

Supplier’s point of view

←--→

$$Ddc + \pi' < \frac{Ccn + (Cfn + Cvn + Cps)}{Q} + \pi'' + Ppc < Vsm$$

←--→

Customer’s point of view

Where:

π', π'' = margins assigned to the two distribution alternatives, respectively;

$Ddc + \pi'$ = price of home delivery;

$$\frac{Ccn + (Cfn + Cvn + Csp)}{Q} + \pi'' + Ppc$$ = price of brokered delivery and product pick-up cost;.

Vsm = subjective value assigned by customer to home delivery service.

It is possible to create a graphic representation of this economic opportunity 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 incurred by the system.
To facilitate reading of the graphs illustrated below, Box 2 defines the symbols used.

Box 2. 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
Q = Quantity of merchandise delivered per unit of time to a peripheral node (tn) or, alternatively, to an end customer (m1, mn) in the respective amounts (q1, q2, qn)
d = spatial-temporal distance from distribution point K: dt, dm1, dm2, dmn = shop and customers located at specific distances from distribution point k1, respectively
α = angular coefficient that expresses the variation in costs for transport to shops according to differences in the spatial-temporal distance from the local distribution point
β = angular coefficient that expresses the variation in home delivery costs according to differences in the spatial-temporal distance of homes from the local distribution point
p’ = price curve for home delivery (p1’ = variation of curve)
p” = price curve for shop delivery (p1” = variation of curve)
c’ = cost curve for home deliveries
c” = cost curve for shop deliveries
π' = profit margin for home delivery
π'' = profit margin for shop delivery

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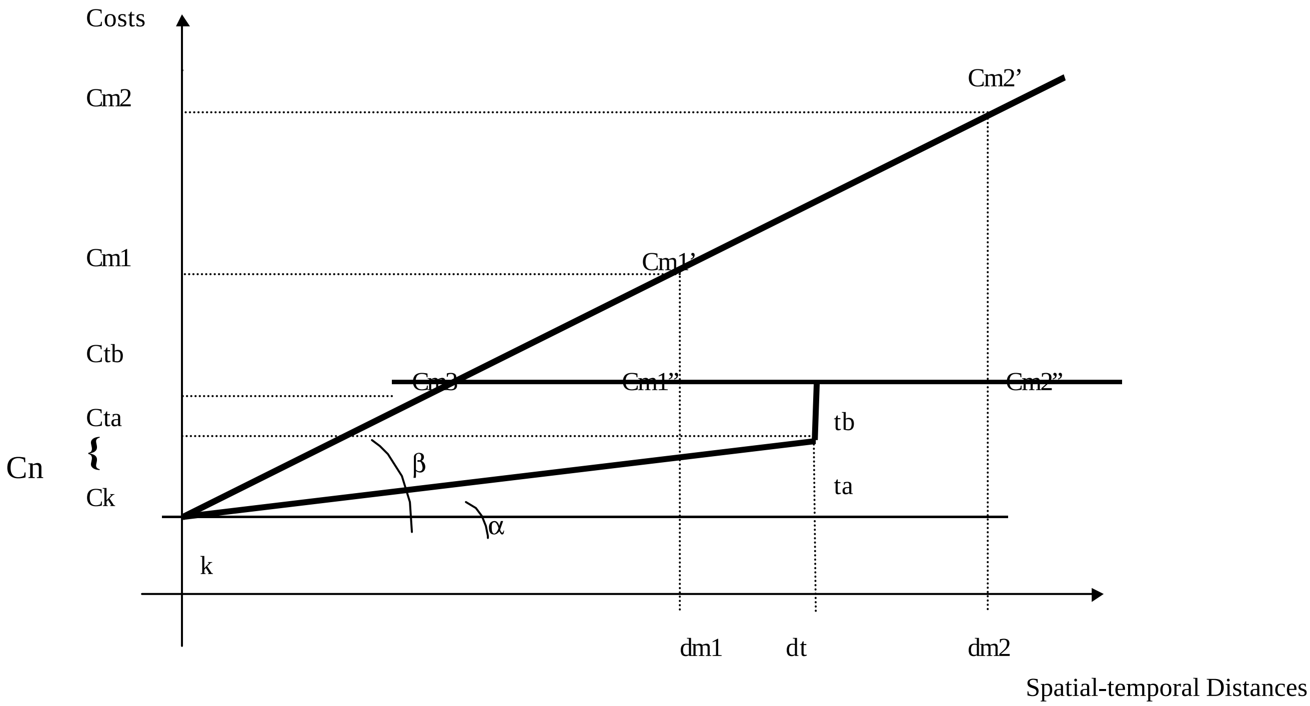
cost is impossible due to its nature (opportunity cost), as compared with the nature (out-of-pocket cost) of the transport cost component in the alternative case of pick-up at the shop.

Figure 2. Distribution costs and logistical alternatives



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. This assumption discounts the simplifying hypothesis of considering the transport costs as proportionate to the spatial-temporal distance covered by the vehicles. Furthermore, this proportion is characterized by its linear trend, in other words, a constant angular coefficient α. Nevertheless, such an hypothesis is restrictive (and shall be discarded later), since in reality transport costs often vary in non-linear fashion according to the spatial-temporal distance that separates the origin from the delivery destination.

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 cost (Ppc), 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. 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 happens, 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[5].

[5] This is an important point and will be brought up again in figure 7 below in regard to the "E-commerce Trap."

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.
Thus, angular coefficient β expresses this very relation between costs and spatial-temporal distances.
Angle β is normally greater than α due to the different type of vehicles used to make the deliveries and the different saturation of available loading capacity on these vehicles, on account of the different types of packing materials used for the products to be delivered.
Moreover, the larger the conversion ratio characterizing shop t, the greater β will be than α, in other words, the more end customers that can be served with the same quantity of product delivered to the shop (Q).
Finally, if the costs (Ppc) sustained by the end customers to pick up products at shop t are represented by points inside the polygon that connects the vertices Cm1', Cm2', Cm1", and Cm2", the most economical solution for the customers is to pick up the products at the shop[6]. Otherwise, the most efficient organizational approach is home delivery.

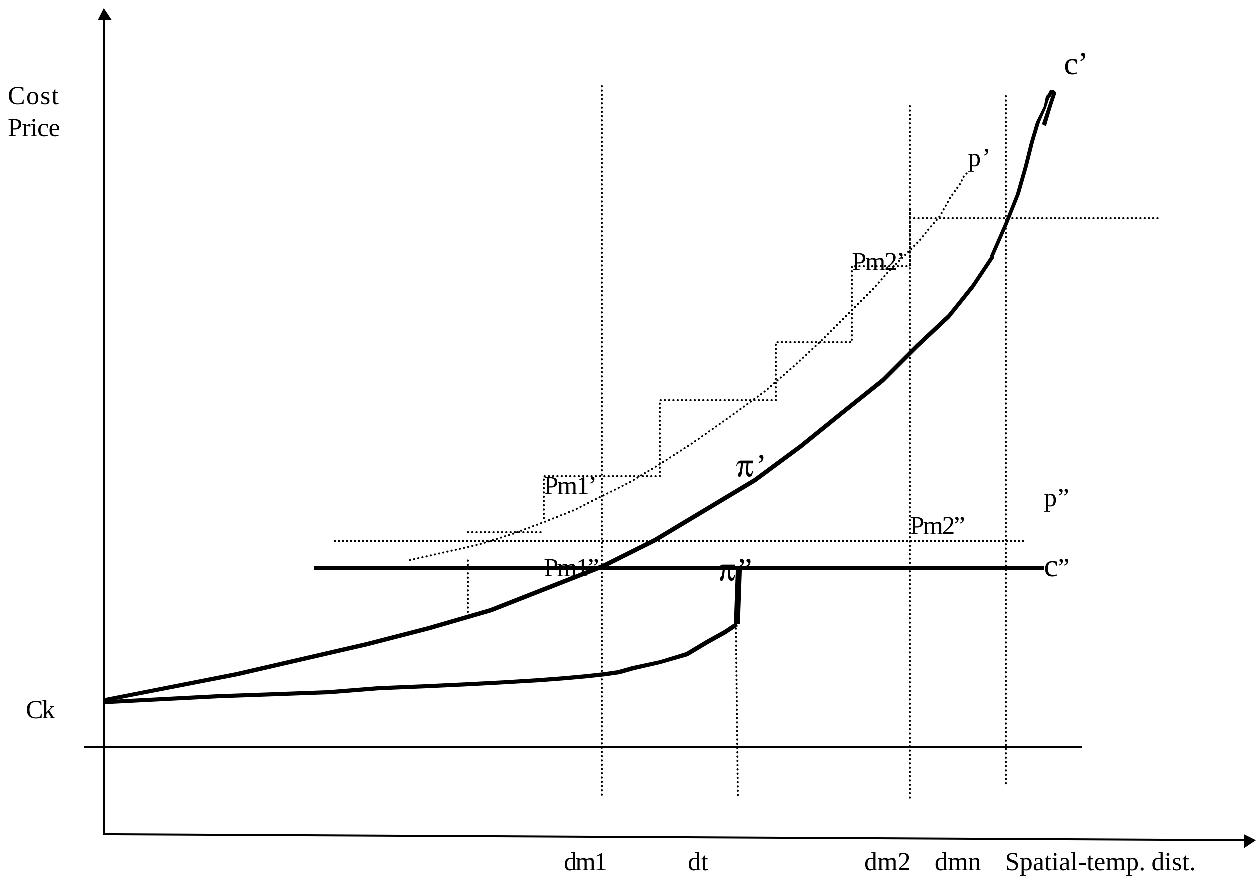
A PROPOSAL FOR FORMALIZATION: POSSIBLE APPLICATIONS OF THE PROPOSED MODEL

At this point, if we eliminate the simplifying hypotheses made hitherto, we can prepare a new graphical representation of the economics of the two distribution alternatives in consideration here. This new situation is summarized by the curves shown in Figure 3, where the price curves (p' and p") are placed next to the cost curves for the two distribution alternatives. As appears in this figure, the curves describing the costs of transporting the products from distribution point k to the generic customer m and the generic shop t, respectively, do not have a linear but rather accelerating trend. The underlying assumptions for this representation stem from well-known logistical inefficiencies that penalize door-to-door delivery with respect to store delivery, such as the greater amount of time needed for unloading and delivering orders, more problematic saturation of transport vehicles due to the configuration of the orders and the need to respect a certain loading order (to avoid lengthening stop times for unloading delivery merchandise). Furthermore, when the same type of service is requested, expressed by the capacity of satisfying customers located at steadily increasing spatial-temporal distances from distribution point k with the same lead-times, it is possible to imagine the use of faster, and thus more costly vehicles as the distance to be covered increases. The curve expressing the price for direct delivery is analogous to that for a curve parallel to that for costs, if the distributing firm decides to maintain a constant return for each delivery to customers located within the shop's territory when determining its rates. It is also assumed that the price curve reflects economic rationality only when it exceeds the cost curve (p'>c') and continues above the latter, probably in step-wise fashion (rate increases according to increasing spatial-temporal distances), to the point where the need to cover exponential increases in costs would result in rates that are unacceptable to the customer (c'>p'). On the other hand, in regard to the alternative of store delivery, where the supplier cost (c") is invariable with respect to the spatial-temporal distance between the t-nth shop and the m-th customer,

[6] In theoretical terms, the area in question would be comprised by the triangle Cm2', Cm2", and Cm3; however, given the working hypotheses, in regard to the location of the two customers at the minimum spatial-temporal distance dm1 and the maximum distance dm2 from the distribution point k, in the case examined here, the area is limited by the polygon described in the text.

price p” is constant (with p”>c”). In this case, the willingness to choose the alternative of brokered distribution is desirable for those customers for whom the marginal cost incurred to pick up the merchandise (Ppc) is less than the difference of the distance between p’ and p”, for each point on the x-axis between dm1 and dm2, or, as already pointed out, for values that can be placed inside the polygon pm1’, pm2’, pm1”, and pm2”.
The comparison of the cost curves (c’ and c”) associated with the two distribution alternatives and the associated price curves (p’ e p”) enables us to identify the areas defining the margins associated with the different distribution methods (π’ and π”), as illustrated in Figure 3.

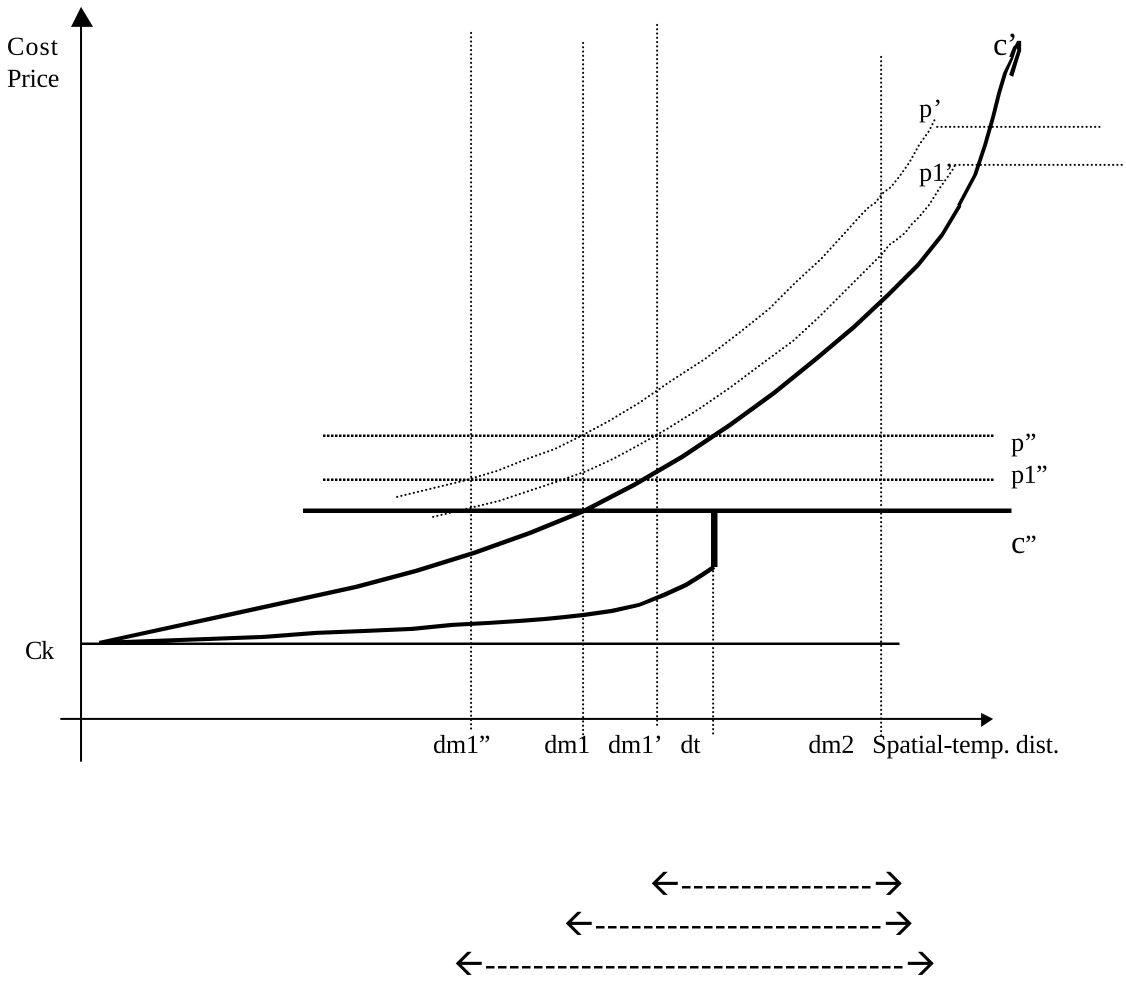
Figure 3. Costs, prices, and margins for the two logistical alternatives



The price movements illustrated in Figure 4 show how a reduction in p’, with all other conditions remaining equal, limits the area in which the customers will find it economical to visit the shop (from dm1 to dm1’), making home delivery economical for them, even in the assumed case of zero pick-up cost (Ppc = 0); in contrast, with a reduction in p”, the willingness to request home delivery will obviously fall off, thereby expanding the area where brokered delivery is economical (from dm1 to dm1”).

These observations, based on the intersections of price curves, cannot be extended to customers residing at a spatial-temporal distance greater than dm1’ (in the graph, to the right of dm1); for these latter customers, in fact, the willingness to choose alternative delivery solutions necessarily involves an estimate of the shop product pick-up cost Ppc.

Figure 4. Price movements and the most economical choice

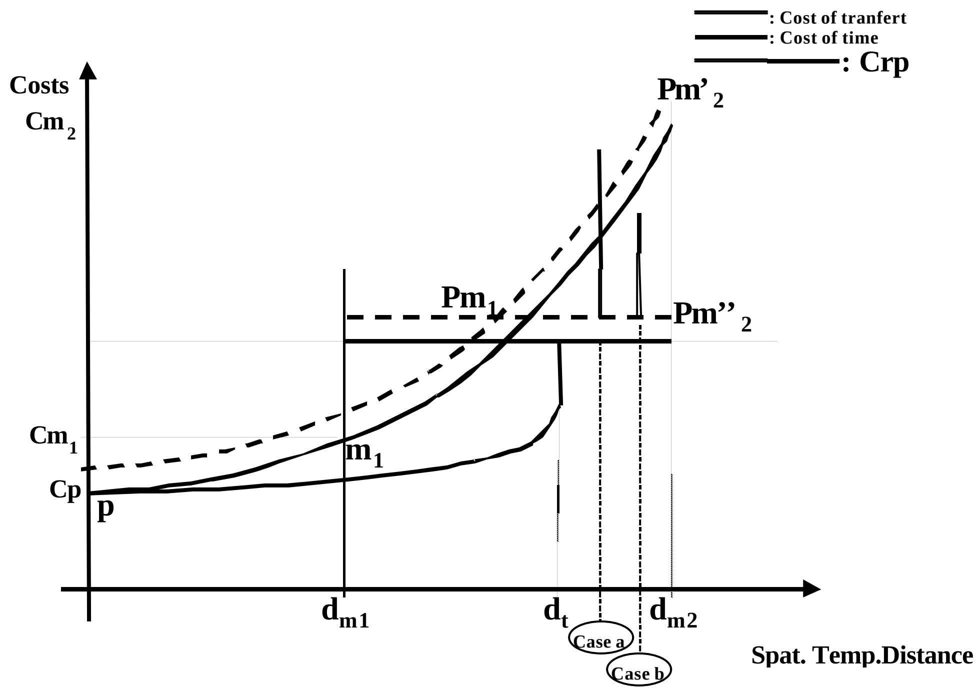


In this case, we can imagine that the cost incurred by a hypothetical customer m to pick up the products ordered from shop t varies linearly according to the distance between the customer's residence and the selected shop and is conditioned by the subjective value assigned by the customer to his own available time. Therefore, in the diagram the segment representing the cost Ppc incurred by each customer may vary in length according to the combination of the two components mentioned above (spatial-temporal distance of the customer's home from the shop considered and the value assigned by the customer to his own time). By way of example, compare the two cases illustrated in Figure 5. Even in the same scenario expressing the distribution dilemma, the first (case a) refers to customers who attribute a high value to their own time, while the second (case b) represents the opposite situation.

These examples illustrate how attribution of increasing value by customers to their own time causes the area of economical home delivery to grow and with it, where other conditions are equal, the overall profitability associated with this distribution alternative.

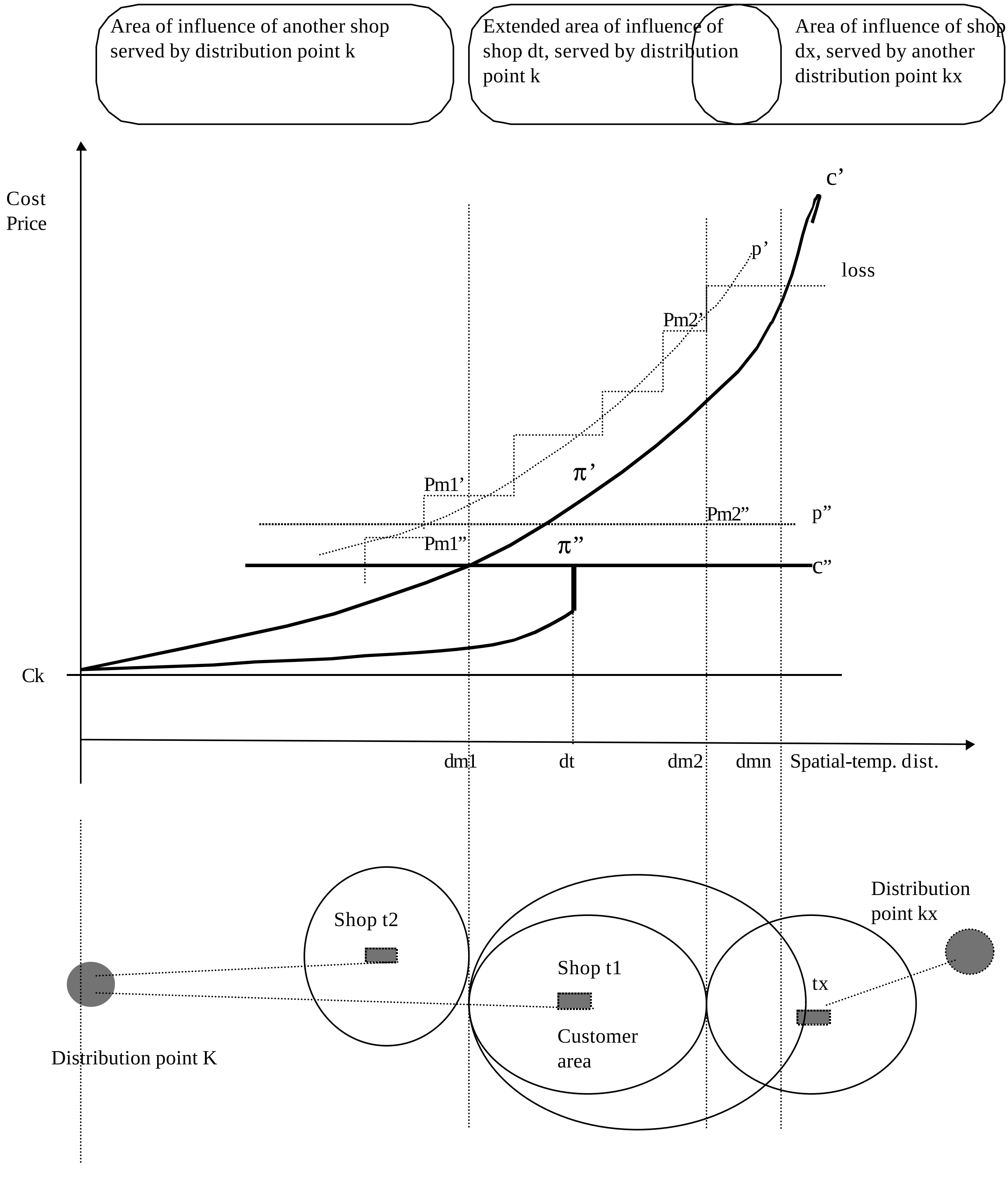
On the other hand, the less value customers assign to their own time, the greater the appeal of brokered solutions, and thus the margins from said solutions is assured. Our purpose here is to point out that all those customers who are characterized by an ordered product pick-up cost at the shop (Ppc), represented by a point that can be placed on the diagram inside the area defined by points pm1, pm2', pm2" and the curves p' and p'', will prefer product delivery at shops, while all the others will prefer home delivery. Furthermore, since the area delimiting the alternative choice is the result not only of the costs but also the rate policies applied by the firm selling the product, a simple variation in prices can heavily influence and/or condition customer preferences for the two distribution alternatives, as well as the overall margin that the firm can realize.

Figure 5. Choice of delivery and value of customer pick-up time.



These considerations lead us to make further considerations about the possibilities of using the proposed model. The variability of costs and prices, represented by the trend of the curves in question, offer us another angle of interpretation that can identify the area of influence that can be reasonably attributed to a shop and a distribution point. For the initial hypotheses illustrated in Figure 6, the area served by the shop dt is represented by the customers residing within the extremes dm1 and dm2, respectively located, in terms of spatial-temporal distance, at the closest and farthest points from distribution point k. In other words, this means that all customers located between k and dm1 will be served by another shop that is a satellite of the same distribution point k, while all the customers who reside at a distance greater than dm2 will be served by shop dx, which belongs to a different distribution point kx, or by home delivery directly from distribution point kx. Finally, those customers located between dm2 and dmn must decide whether to ask for home delivery, to visit shop dt, belonging to distribution point k, or visit shop dx, a node of distribution point kx. This option will obviously influence the price policies adopted by the distribution firm, especially if the second distribution point belongs to a competing logistics network.

Figure 6. Significant variables and logistical structure



In any event, the firm in question will not find it economical to serve customers residing farther than dmn – in other words, at an "inconvenient" distance – with home delivery; on account of the cost and price curve trends, it would start losing money. Consequently, it becomes increasingly likely that those customers will need to be offered delivery, either directly at home or through shops, from a second distribution point.

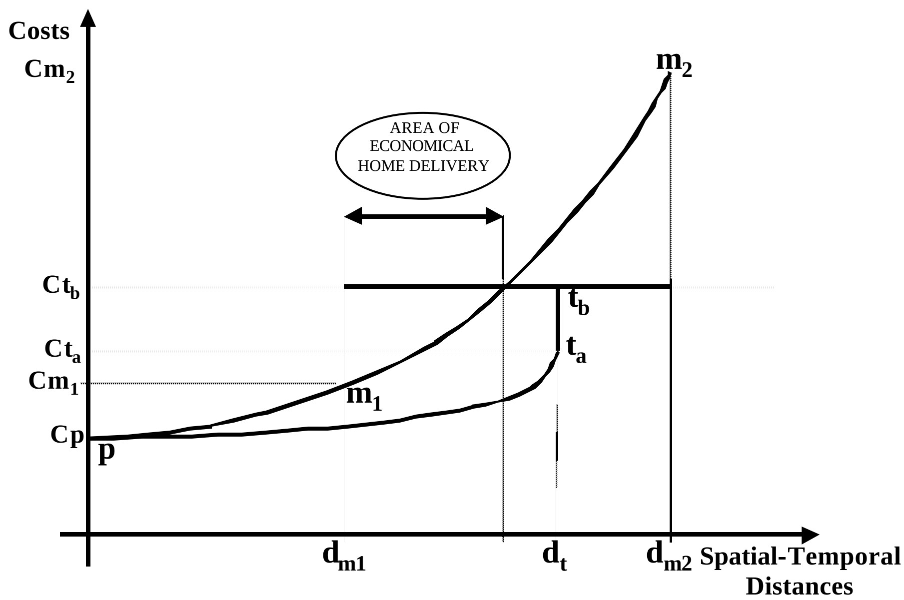
This stems from the fact that the territory of shop dt1 is defined on the basis of a reasonable estimate of the customer pick-up cost; however, the customer, aside from the value he places on his own time, will tend to prefer the closest of the areas served by the two logistic nodes if he lives in the area formed by their intersection.

Analogous considerations made for each area served will thus lead to a determination of the territories for each shop, as well as any overlapping of the areas served by different distribution points.

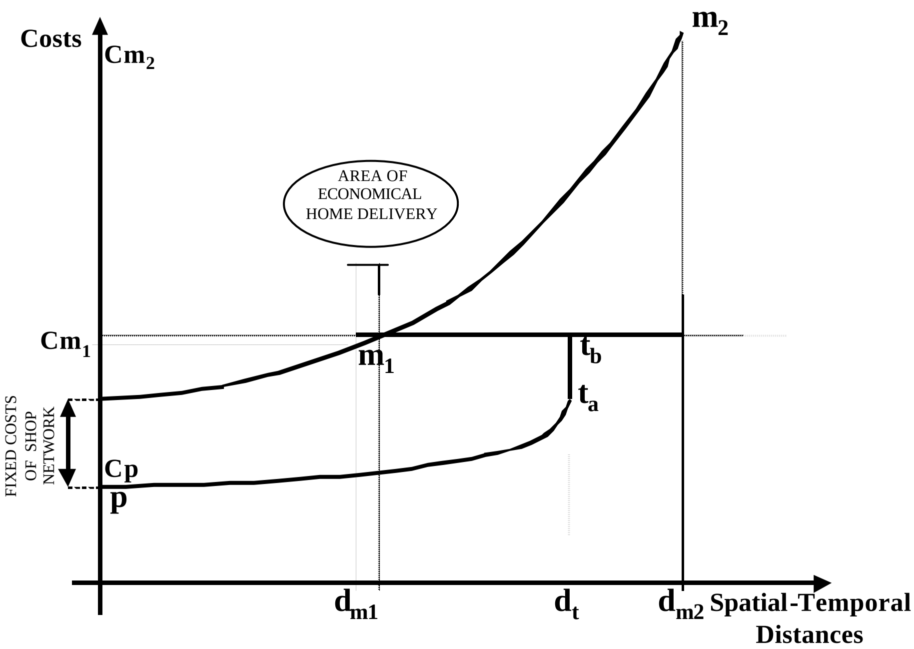
Finally, it is worth considering that the organizational alternative of home delivery of products ordered by customers can be adopted in the scenarios outlined thus far only on condition that the fixed costs be eliminated for the intermediate logistical distribution network that permits the other type of delivery to be offered on the market. However, this radical choice may place all those customers whose shop product pick-up cost (Ppc) is low in a position of economic imbalance, as illustrated in Figure 7. In the contrary case, if the intermediate logistical points (shops or distribution points) scattered throughout the territory and their associated fixed costs are not eliminated, interest in home delivery would be further eroded (there would be a shift towards the upper end of the cost curve in an amount equal to the sum of the fixed costs for the shops kept open). 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 7. The e-commerce trap

Case1: Alternative organizational solutions (network of shops or home delivery)



Case 2: Complementary organizational solutions (network of shops and 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[7].

THE CRITICAL VARIABLES IN PLANNING AN OPTIMUM LOGISTICAL 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; we shall then proceed to illustrate how these variables can affect the intensity of logistical costs, as articulated according to the different types analyzed before, and how these latter can condition the choice of the best logistical structure, in terms of its specific structural and operating components.

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

1. variables related to the order;
2. variables related to the offered range and the product;
3. variables related to demand and the market;
4. variables related to the logistical structure;
5. variables related to the infrastructure.

As we shall explain below, the advent of electronic commerce appears to have directly influenced the

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

variables related to the order, demand, and market (items 1 and 3), has had only a marginal or neutral effect on variables related to the product and how it is used (item 2), and has been subjected to limits while also conditioning the variables related to the logistical structure and infrastructure context (items 4 and 5).

The variables belonging to the five proposed categories can in turn be further broken down into **external** variables **(E.V.)**, which are difficult to measure and control – and thus only marginally susceptible to managerial manipulation, given the limited range of discretion available to the supplier – 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. As has already been pointed out in the preceding sections, when other conditions remain equal, home delivery will be preferred when the cost of making home delivery from the local distribution point is less than the sum of the costs of delivering the products from that distribution point to the shop in question, the fixed and variable costs incurred to manage the logistical activities of the shop, and the costs incurred by the final user to pick up the product purchased at the shop.

1) The variables related to the order consist of the following:

- **density of value of order. (E.V.)**

  The density of value of the order is given by the ratio between the value of the products comprising an individual order and the quantity that has the single greatest impact on order transport costs ($/cubic meter, $/100 kg, $/trip, etc.[8]. This variable influences the costs to make deliveries or pick up the products considered. In fact, as the density of value of the order increases, the importance of the transport cost declines with respect to the other logistical costs (stocking cost, stock carrying cost, obsolescence risk cost, etc.). The density of value of the order belongs to the category of external variables, being related to the choices made by the customer, and appears to be marginally susceptible to influence by the supplier. Accordingly, the spread of e-commerce tends to reduce the average density of the order, shifting the weight of logistical variables to the transport component.

- **average size of order. (E.V.)**

  The average size of the order refers to the quantity (expressed in terms of the order lines and number of pieces per line) of products, either all the same or different, indicated on an individual customer order. This variable influences the ratio between transport costs and delivery stop costs that comprise the overall cost of distribution. When the overall quantity delivered remains equal, as the average size of the orders decreases, the impact of these cost components increases, and thus the impact of the overall cost of distribution on total logistical costs (Lambert D.M., Stock J.R., 1993, pg. 45 and pg. 310). Analogously to the previous category, the ability of the supplier to influence this quantity appears to be extremely limited; the e-commerce development depresses this variable and increases the fragmentation of deliveries, leading to net increases in distribution costs.

- **ancillary delivery services. (E.V. – I.V.)**

  Ancillary on-site services refer to all those services that are adjunct to the product, such as installation, shelf placement, testing, and other services that are requested by the customer upon delivery of the

[8] The quantities most commonly used to determine the density of value of the order are the unit of volume and the unit of weight. The choice of the most appropriate quantity is influenced by the intrinsic characteristics of the products comprising the individual order.

product[9]. This variable influences both the distribution costs, especially the delivery stop costs, and the variable shop operating costs. Accordingly, this variable forces choices at a low level of discretion if the intrinsic nature of the product and the competitive environment impose rigid behavioral stereotypes. However, in some cases this stimulus can be effectively manipulated by seeking out innovative ancillary services aimed at enhancing the perceived value of the expanded or "total" product. This variable does not seem to be specifically influenced by e-commerce, although it must be given due consideration to ensure full customer satisfaction after sale (after sale service, spare parts, etc.).

- **degree of urgency of order. (E.V.-I.V.)**

  The degree of urgency of the order expresses the time limits imposed on delivery by the perishability (e.g. fresh foods) or obsolescence (e.g. newspapers) of the considered product, in addition to the costs connected with unavailability of said product (e.g. spare parts for plants and equipment, life-saving medicines). This variable has a great impact on all cost components. The urgency of the order determines the willingness of the end customer to accept higher than normal costs in exchange for a reduction in the order waiting time. It seems clear that this attribute, which is associated with the characteristics of the product or the consumption context, is generally difficult to manage. On the other hand, exceptions are made where residual shelf life values (typical of products such as drugs, diagnostics, some foods, etc.) are an integral part of company logistical policies. As previously mentioned, the relative urgency stems from some characteristics of the product and, in general, is not influenced by how the transaction is carried out; nevertheless, in the eyes of the customer who makes purchases through e-commerce, the speed characterizing the purchase phase translates into increased expectations of service, which occasionally translate in turn into expectations of a delivery speed analogous to those connected with urgent orders.

- **handling of returns. (I.V.)**

  The handling of returns consists of the procedures for pick-up of some types of products at the end of their useful life or when they are replaced. This variable has a major influence on distribution costs. However much the handling of returns depends on common customer relations, operating practices, or legal requirements (such as the Ronchi Decree regulating recovery of packaging materials[10]), we have preferred to categorize this variable amongst the controllable choices, since it is one of the variables that can significantly affect logistical decisions, such as the search for "returns," the study of routes, "rounds," etc. In general, we must note that the development of on line purchases will make this variable even more important; for many classes of merchandise, clauses of contract referring specifically to refusals, returns, and replacement of merchandise will have to be provided (pursuant to already applicable law) in the face of probable discrepancies in perception between the characteristics of the goods selected and purchased on line and the features perceived upon physical inspection when the good is delivered or used. The discontinuity between the time the product is chosen and the time it is physically inspected significantly increases the problem of returns, thereby entailing the design of reverse logistics systems (Dekker et al., 1998, pg.141); this problem does not arise in the majority of traditional purchases, since the times of purchase and availability of the product are the same.

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[9] In the perspective of an expanded product, these services could be placed in the category of variables related to the offered range and the product; by categorizing them as variables related to the order, we preferred to emphasize the key role played by the customer in the process of interaction with the supplier, while highlighting the fact that the supplier must set up logistical systems that are highly responsive, including to the variables in question here.

[10] Decree Law no. 22 of 5 February 1997.

2) The variables related to the offered range and the product are:

- **breadth and depth of the range of products offered (I.V.).**
  The breadth and depth of the range of products offered express the number of product families placed on the market by a specific supplier and the number of individual items contained in each family[11]. They essentially influence the operating costs of peripheral inventories (shop stocks). As for the impact of e-commerce, it is highly likely that the offer must be expanded, since the role of concentrating supply will be increasingly assigned to and supported by the establishment of "portal" solutions.
- **density of value of product. (E.V. – I.V.)**
  The density of value of the product refers to the ratio between the unit value of the product in question and the single greatest quantity that affects transport and stocking costs of the product itself. For example, imagine the modest impact that transport costs have on the distribution of pharmaceutical products. The density of value is a product attribute that cannot be easily changed by the firm or logistics operator over the short term. Nevertheless, it is becoming more and more common to find logistics plans aimed at manipulating this factor, such as Design for Logistics measures or designs for simplification of packaging. The density of value of the product is also related to certain aspects of the maturation process during the life cycle of the product. For example, certain hi-tech products (cellular telephones, hi-fi systems, compact disc players, etc.) suffer a dramatic loss in value, due to changes in production and to the widespread consumption, that does not correspond to a proportional reduction in dimensions, creating easily imaginable impacts on the logistical variables in question.
- **weight and volume characteristics of the product. (I.V.)**
  The weight and volume characteristics of the product directly influence its transportability. In fact, the various means of transport have an optimum transportable weight/volume ratio. Transportation of products with weight/volume ratios in excess of the optimum level means not fully saturating the useful capacity of the vehicle. Vice-versa, when products with a weight/volume ratio lower than the optimum level are transported, the useful load of the vehicle is under-utilized. The need to perform numerous, widespread deliveries makes it necessary to use single-product packages and packing materials that can affect streamlining of loading and unloading activities, increasing the complexity and associated costs of order preparation activities and vehicle loading.

[11] Here too, the sole purpose of categorizing this variable with those characterizing the product is to underscore the importance of offering a range of products that can be easily modified. This is especially true for the distributor, who must constantly update his catalogue by rearranging his vendor portfolio and endeavoring to maintain a "sustainable" average density of delivery value.

3) The variables related to demand and the market are:

- **predictability of demand (E.V. – I.V.).**
  The predictability of demand expresses the facility of determining consumption of a specific product by a specific customer at a specific time a priori. The predictability of demand makes it possible to streamline inventory carrying costs, with availability for customers remaining equal, and the cycle (and thus cost) of restocking sales outlets. However much the fragmentation of orders increases the predictability of demand, the rapid spread of purchasing habits and consumption models induced by e-commerce can be translated into sudden, poorly predictable crises throughout the supply chain, exposing the distribution logic to risks of unsaturation or major disservice.
- **geographic concentration of demand (E.V.).**
  The geographic concentration of demand expresses the average spatial-temporal distance between the local distribution point and the customers belonging to that area. This variable influences the transport costs from the distribution point to the shops and from the distribution point to the end customers. In the context of a market that is by definition global, the speed with which purchases are made on line jeopardizes those forms of distribution that underrate the dynamism of this phenomenon and that are unable to design and operate reconfigurable logistics systems.
- **density of customers (E.V. – I.V.).**
  The density of customers expresses the spatial/temporal distance between customers who are in the same area as a distribution point. As the distance increases, so do the costs for making home delivery (and, in particular, the cost component connected with transport). Amongst the precautions that must be addressed by a logistics system design, special attention must be devoted to this form of potential, as well as to sudden changes in trends that, for the reasons stated above, can produce rapid shifts of huge delivery volumes from areas with high customer densities to areas with less dense demand.
- **schedules for acceptance of ordered merchandise (E.V.).**
  The schedules for acceptance of ordered merchandise influence the efficiency and effectiveness of delivery rounds made by secondary distribution delivery vehicles. Specifically in regard to home delivery, particularly local distribution (e.g. downtown areas of cities), competition between sites is shifting to the ability to offer numerous "time windows" or slots for daily deliveries, characterized by an increasingly limited territory and planned in such a way as to minimize customer wait times. In strictly logistical terms, this translates into the ability to correctly balance several variables together, such as the number of customer orders that can be confirmed for each slot, the capacity of the vehicles used, the time taken by each reloading and delivery cycle, streamlining of the routes, etc. Furthermore, the minimum amount of time between the last possible order confirmation and the first delivery promised entails a careful study of the accumulated times and methods involved in logistical restocking operations at the vendors or distribution center location, composition of the order, loading on the vehicle, and transport that are duly redesigned in order to minimize stop and customer delivery times.
- **value assigned by customer to his own time (E.V.).**
  The value assigned by the customer to his own time has a substantial impact on the economic balance, that enables one to make the best choice between home delivery and shop pick-up. As has already been mentioned above, this variable is one of the most complicated ones to analyze: in fact, the value assigned by the customer to his own time is independent of the order, the ordered product, his geographical location, etc. In other words, this involves a largely subjective variable that can vary from

person to person, from time to time, modifying the opportunity cost of the time dedicated to picking up the merchandise, from significant values to practically insignificant values. Think of the previously mentioned example of mail box type shops, used as distribution points, in areas and quarters with a high concentration of students (university campuses), a population group that is little affected by time constraints.

4) The variables related to the logistical structure are:

- **shop characteristics (I.V.).**
  The shop characteristics (geographical location, ability to receive and stock products) 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. Shop location, structure, layout, and logistical technologies must be based on new design approaches: from a configuration for movement of small packages, to a guaranteed ability to trace customizable customer packages; from the possibility of managing packaging units that tend to be in unitary form in highly selective distribution points, to the ability of moving materials on a high frequency basis, etc.
- **characteristics of means of transport (I.V.).**
  The characteristics of the means of transport (maneuverability, ease of parking, hydraulic lift, merchandise movement equipment, etc.) largely affect transport costs (travel cost and stop cost). It is highly likely that in some cases transport vehicles will have to be completely reinvented, being equipped with easy external access on all sides, selective loading capacity designed for streamlining delivery turnover and fast removal and movement of packages. In other cases, the physical layout of the vehicle will have to be redesigned in order to handle groups of heterogeneous products, in terms of logistical requirements, that are bought together: fresh, dry, and frozen foods as well as non-perishables. The very approach to saturating loads must be based on information technology approaches and supports that can streamline elements mentioned above, such as the density of the value transported, the load conversion index, etc. In this sense, we are witnessing the spread of satellite monitoring systems for locating vehicles that, when combined with streamlining software[12], are used both to check the progress of deliveries on long routes, and to calculate standard delivery times, which are fundamental in the quest for the most effective saturation of the vehicle and maximum yield of the slot[13] on segments of the last mile.
- **location of intermediate operators (I.V.).**
  The location of intermediate operators refers to the geographical location of the consolidation hubs and the local collection and distribution points. This variable influences the cost of delivering the merchandise to the shops located in the area of the individual distribution point. The traditional design logic underlying location choices, which are typically sited in a central location according to the relative weight of the different areas of demand and the underlying logistical costs, certainly do not change the method but will be heavily influenced by the increased dynamics of the variables in play, as pointed out in this paper, stimulating the search for organizational structures and solutions (partnerships) that can be quickly modified.

5) The variables related to the infrastructure consist of the following:

[12] For an early look at the issue of streamlining transport segments, see Stevenson W.J., 1999, pg. 389 ff.
[13] Slot yield refers to the capacity for increases in the ratio of intermediation of the vehicle load.

- **quality of transportation network (E.V.).**

  The quality of the transportation network (roads, railways, etc.) directly influences the costs incurred in making shipments. In particular, high network density in the geographical area combined with the quality of the network itself promote more effective and efficient links between the origin and destination points. As already pointed out above, a fundamental feature of the Italian freight transportation system is its extreme dependence on truck transport over a highway network and through infrastructure nodes that are extremely backwards in comparison with other European countries. If the growth in business resulting from e-commerce is not accompanied by major, urgent infrastructure investments, the system will fall into a vicious circle where the increase in transported volumes and the volume of vehicles themselves will saturate an already decrepit road system, limiting both the logistical effectiveness of the new distribution method, due to the increase in transit times, and its efficiency, due to the inevitable increase in transport and inventory costs.
- **level of route segment congestion (E.V.).**

  The route segment congestion influences the speed, thus the time, and consequently also the cost incurred to link origin and destination points in a specific transportation network. Congestion directly affects transport costs. In regard to the impact of e-commerce on this delicate parameter, where infrastructure conditions are equal, it unfortunately seems inevitable that there will be a distinct worsening in the intensity of physical flows, and a consequent worsening of both city and highway traffic, which is already extremely chaotic.
- **cost differential between modes of transport (E.V.).**

  The cost differential between different modes of transport 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 regard to the present topic, delivery over the last mile, it is impossible to imagine alternatives to truck transport, with the result that this problem is going to influence the design of specific transports; in regard to the primary transport to the distribution point, the alternatives are severely limited by the location and infrastructure factors discussed above.

In Table 1, 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.

The correlation between the impact of an individual item of cost on the different variables considered has been conventionally expressed with the symbols listed in the legend.

Table 1. Relation between critical variables and delivery costs

VARIABLES (related to:)	COSTS	Ddc	Ccn	Cfn	Cvn	Cps	Ppc
ORDER							
	Density of value of order	- - -	-	=	=	=	- -
	Size of order	- -	-	=	-	=	-
	Ancillary delivery services	+ + +	=	=	+ +	=	+ +
	Urgency of order	+	+ +	=	+	=	+ + +
	Handling of returns	+ + +	+	=	+ +	+	=
RANGE/PRODUCT							
	Breadth/depth of range	=	=	=	+	+	=
	Density of value of product	- - -	-	=	=	+	- -
	Weight-volume of product	-	-	=	=	=	-
DEMAND/MARKET							
	Predictability of demand	-	- -	=	-	- -	-
	Geographic concentration of demand	- -	- -	=	=	=	-
	Density of customers	- - -	- -	=	=	=	- -
	Schedule of acceptance of merchandise[14]	++	+	=	+++	=	- -
	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.

[14] In regard to the correlation and symbolism used for the scheduling of merchandise acceptance, we must make a clarification: the length of time for the delivery period, up to a limit of 24 hours a day, undoubtedly has an impact on the cost of direct delivery (Ddc), since, in many cases, it is the only form of delivery possible. If, on the other hand, the 24-hour service could be extended to the shop opening hours, there would be an even greater impact on costs, specifically the variable operating costs (Cvn).

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.

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 appropriate 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.

CONCLUSIONS AND RESEARCH PROSPECTS

Although this paper is not addressed at a further investigation of the various aspects of e-commerce, it behooves us to mention a number of open problems connected with the issue of logistical structure design, in order to describe the most likely lines of evolution and offer useful points of reflection for those who, whether they be scholars or businessmen, are interested in studying the issue further.

- In regard to the logistics policies of industrial and commercial firms, it appears that the need/advantage of establishing alliances with providers of integrated logistics services is accelerating; the rise of specialized professionals, on the supply side, and the scant willingness to manage the dynamic nature of the phenomenon, on the demand side, are increasing the operating possibilities for outsourcing agreements that involve growing portions of the logistics system. However, the outsourcing of consolidation points, transit points, transports, and various logistical operations must be based on decision-making paradigms that are not limited to operating make or buy evaluations, such as those that have led many firms in the recent past to delegate acritically those logistical activities that they considered peripheral with respect to their assumed industrial core businesses[15] (Quinn J.B., Hilmer F.G., 1995, pg. 48). In many segments and markets, logistics has assumed a crucial role, becoming a genuine business stimulus that can have a significant impact on their competitive advantage; therefore, the options for partnership must be evaluated in the perspective of establishing relations with evolved operators that possess distinctive skills with high added value.

[15] In this regard, see Velo D., 1998, pg. 48, where we read "… the process (of outsourcing) has involved activities and functions that are ever closer to the core business of the enterprise…"; in some contexts, logistics must be included among these.

- Major changes are also underway in the supply of logistical services. Although we are witnessing a process of concentration and specialization that is hard to dispute, interesting competitive spaces seem to be emerging for aggressive newcomers that are capable of designing and managing flexible logistical structures that can be reconfigured, based on the principles of "agile logistics," "Virtual Logistics" (Crowley J.A., 1998, pg. 547; Clarke M.P., 1998, pg. 486) and "Supply Chain Management" (Christopher M., 1998, pg. 213 ff.); on the other hand, the logistics operators that have invested (or are investing) huge amounts of capital to achieve efficiency risk being overly rigid in the face of sudden changes in the variables at play; the need to propose versatile systems also offers maneuvering room to small operators (the small trucking firms that are so widespread in Italy) that, if appropriately oriented and coordinated, could enjoy revitalized operations, going against the frequent warnings of their extinction.
- More generally, there is a great risk of rapid congestion of the roadways and a collapse of logistical infrastructures that will force the public operator to take fast, decisive action for guidance, support, and direct investment to correct the neglect that many now consider irremediable.
- Furthermore, the impact of e-commerce on business operations appears to be far from insignificant. Just imagine the impact on some professionals, like some traders who, inevitably liberated from their role of order collectors, must now acquire more evolved and complex skills, assuming the "role of consultant" to the point of becoming, in some cases, sophisticated service promoters. The changes induced by the new way of operating also affect numerous aspects of the most complex productive-logistical system, such as the products (which are increasingly modular[16]), packing and packaging (unitary or designed to make breaking the load easier), ancillary services (pre- and post-sale services that can be rendered by other structures), manufacturing processes (with major modifications at the end of the pipeline to create configurations, kits, and postponements on order by the customer), and equipment (for transport, handling, movement, stocking), organization of flows (particularly in regard to refunds, returns, and more in general, reverse logistics), just to name a few examples.
- Finally, major work must be performed in the area of measurement of the services performed by the systems considered here in order to design effective reporting systems that can guide the processes of improvement in logistic activities; to take a simple example, think of the need for logistical measure reporting and processing performance indicators that have been specially designed to control the performance of these innovative delivery systems; in the context of logistics components, we note the following variables that can decree the success or failure of these initiatives:

  - optimization of the index of intermediation by the shop or carrier through a study of sites and routes;
  - evaluation of the sustainability of the average delivered density of value every time the catalogue is expanded;
  - measurement of the index of completeness of the order through identification of the missing items according to critical attributes;
  - measurement of indicators of stockout in the time slot and, in particular, the duration of the stockout;

[16] As set forth in Rullani E., 1997, pg. 162: "Developments towards modularization of production and virtual business are going in exactly this direction – realizing not only economies of replication (through recombined modules), but also economies of variety, thanks to the flexible nature of the combinations that are realized over time."

- etc.

In conclusion, although the impact of e-commerce today is most visible in the context of information system architectures (Kalakota R., Whinston A.B., 1997; Rajput W.E., 2000), in the context of its strategic and organizational impact and commercial policy, we are convinced that proper handling of the physical flow along the supply chain will play a key role in determining the success or failure of many business ventures. There is no dearth of planning alternatives, and the range of possible responses extends from a radical redesign of logistical structures, to selection of the operating technologies and approaches most suited to pursuing the aims of service and efficiency, to details that are insignificant only in appearance. Even those choices that once seemed to be of marginal importance, such as the type of packaging, assume major significance in the new perspective, given that the change involves a rethinking of all the components of the logistical system, in the context of general and organic innovation where little or nothing can be left to chance.

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