Industrial distribution logistics and its adjustment to Internet times

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Abstract: Now-a-days, the agility and flexibility of an operation is considered very important, because it provides it with the possibility to deliver products that are better adjusted to individual needs. Manufacturers have been developing and implementing production and logistics techniques and methods in that sense, for a long time. This paper reviews some of the tools that are available to the manufacturing field in order to reduce lead times, as the authors believe that this is a key issue in the attempt to provide fast delivery to customers who are getting used to customize, configure and purchase products by means of the Internet. The paper also brings a snap-shot of the level of knowledge and use of such methods and techniques by the Brazilian manufacturers, based on a survey that was carried out with over 650 participating companies.

Key-words: Internet, logistics, agility, flexibility.

1 INTRODUCTION

Information products and services can be produced anywhere, because their delivery through the Web is quick and almost costless, regardless of where the operation and the customers are located (SHAPIRO and VARIAN, 1998; GEOFFRION and KRISHNAN, 2001). On the other hand, for physical products, which represent the majority of the goods sold by industrial companies, the Internet doesn't provide a delivery solution. In those cases, it is important to develop a logistics strategy that minimizes cost and time involved in manufacturing and delivering the product for an each time more demanding customer, with respect to delivery lead times.

As typical Internet purchases (particularly in the B2C market) involve little volumes and great variety, the decision of location of the production and inventories is a complex one, which is essential for the success of the business. It depends on a good understanding of the level of service that the customers expect, according to what will be discussed on **item 2.1**.

In some situations, it is possible to virtualize stages of the manufacturing process or the product, itself, eliminating or at least reducing the limitations imposed by the physical location of operation and inventory, according to what will be discussed in **item 2.2**. In other instances, the decision about where to manufacture the product and how to organize production resources, taking into account the need of agility in the interaction with suppliers has great impact on the costs and the speed the company can support its customers. **Item 2.3** deals with ways to make production more agile by means of planned co-location of different operations of the supply chain.

Postponing the decision about where to keep inventory may help reduce distribution logistics costs, but it may also be responsible for a level of service that is unsatisfactory to the customers, with respect to delivery lead times. The decision maker has a dilemma to solve: should centralized or distributed stocks be kept? **Items 2.4** to **2.6** discuss the advantages and disadvantages of those alternatives.

One way to make distribution more agile, reducing the customer's waiting time and, therefore, improving the level of service that is provided may be achieved by means of *cross-docking* (see **item 2.7**) and by keeping a rigid control of the position of inventory along the value chain, in order to better adjust it to customers' needs, at each moment (see **item 2.8**).

After discussing all those possibilities in **section 2**, **section 3** presents the methodology that was used to obtain information about the awareness and competence of Brazilian manufacturers to deploy the techniques and logistics practices discussed in **section 2** and to analyze it. The results of the survey and the analysis that was carried out are presented in **section 4**. At last, the authors present their final considerations and managerial implications of the electronic commerce advance to industrial companies.

2 DISTRIBUTION LOGISTICS IN INTERNET TIMES

2.1 Identification of the service level expected by the customer

Companies need to develop a clear idea of the service level that is expected by the customers, in order to perform accordingly (GRAEML, GRAEML and STEIL, 2001b).

Sometimes, the convenience of fast delivery may be valued by customers to an extent that they are willing to pay a premium price for it. In such situations, the delivery of products that are sold through the Web needs to be even faster than a visit to a physical store for the customer to be pleased. Nobody would be willing to wait until a pizza delivery operation has two deliveries to make in the same block, in order to minimize distribution costs, for example.

In other cases, as highlighted by Graeml, Graeml and Steil (2001a), the customer is willing to wait a little longer, allowing the company to plan the delivery in a way that reduces its own costs. Most people wouldn't mind if their monthly supermarket purchase was scheduled to be delivered the next day, at an agreed specified time, if that helped keeping delivery costs down.

In addition to understanding the customer's urgency, Hintlian and Mann (2001) believe it is important for distributors to develop the following strategies to deal with orders:

- separate large and small items in different order picking points;
- use *cross-docking* warehouses (see **item 2.7**) in order to transfer products to smaller vehicles, in charge of delivering them to end customers;
- keep products that have a high inventory turn ratio in local distribution warehouses close to the customers and products that have a low inventory turn ratio in central warehouses, in spite of the resulting longer delivery lead times; and
- establish different delivery times and availability policies for different products.

Not many companies have enough scale or resources to develop their own logistics structure for a global operation, in the case of physical products that need to be delivered to the customers' door steps, after having been bought through the Web. Companies like DHL Expressways, Federal Express, United Parcel Service and the traditional postal service present themselves as potential partners for the distribution of packages and small products around the world. Those companies are not just transporting packages, anymore, they have become complete logistics service providers, according to Sweat (2001).

2.2 Virtualization of products and processes

Sometimes, it is possible to completely change the way one does something, in order to benefit from new technologies. When the product or process can be redesigned, so that at least part of it is virtualized, the company may find that the Internet can become an important tool to reduce costs or to add value.

One interesting example of virtualization is the creation of a Web site by a British publicity agency to give access to the first cut of a TV commercial to editors, directors and the development team responsible for it. The company was so successful with the venture that it ended up creating a spin-off firm just to commercialize the new service, also to its major competitors. The new company, named Beam TV, possibly recalling Star Trek's "beaming up, Scott", understood the potential of the Internet: it virtualized the product and changed the process (and even the business!) in order to benefit from the new situation. In the form of bits and bytes, video clips could be sent to anywhere in the world and made available in just a few seconds, instead of the two days that it used to take for a video-tape to be physically transported from New York to London (BURGOYNE, 2003).

In other situations, when virtualization of the product is impossible, companies may still explore the advantages offered by connectivity and the possibility of information sharing among partners, provided by the Internet, in order to improve their processes and develop original solutions for distribution logistics.

Although there aren't still many studies on the transformation of businesses as a result of the new possibilities offered by the Internet, there are quite a few innovative entrepreneurs that are testing new concepts in the field. Flower sellers and pizza delivery ventures throughout the Web, for example, which support much broader geographical areas than they could physically deliver their products to from a centralized distribution point are changing the way similar operations were used to do business. Some of those firms choose to develop local partners that, after being trained (if necessary), can provide local service to web customers, representing the web company and providing service according to the service level established by it.

When companies start operating that way, they are not responsible for the physical product, anymore. Instead, they specialize in providing leads to their local partners, based on their network of customers. The consumer may not know that there is a florist two blocks away from his/her home (or s/he may simply not want to go there). S/he just needs to know that there is a virtual flower seller that offers the service over the Web and it will take care of the order, by choosing, among its local partners, the one that is closer and better suited to support the customer. As the company doesn't deal with physical goods, anylonger, but with information about potential customers and their needs, which can flow through the Web, its new business is completely adjusted to the Internet.

This reasoning may not be easily transferred to other businesses – car assemblers, for example, will not find someone capable of producing cars at the corner of the street where their customers live – but at least part of any company's activities can surely be reviewed in order to take advantage of the possibilities of the new technology. It's a matter of breaking paradigms, as processes need to be changed, trust relationships with new partners need to be built, and, eventually, a completely new business process needs to be developed.

2.3 Determination of the proximity with suppliers

In order to benefit from *milk-run* inbound logistics schemes, as well as other advantages of being closer to the suppliers, many companies, when they decide to build a new plant from scrap, stimulate their suppliers to place their operations in the neighborhood. The automobile industry adopted this strategy in plants that were built around the world in early years, inviting suppliers to

build their plants at small distances – in some cases, in the same block of land used by the assembler – forming the so called industrial parks (CORRÊA, 2000). This trend of suppliers following the assemblers to new markets, building their own plants close to their customers' (the assemblers) in order to exclusively support their new plants is called *follow-sourcing* (FLEURY, 1999). This production capacity planning effort for the implantation of an operation in a specific region, which is carried out by several partners as a joint effort, usually coordinated by the strongest link of the supply chain, intends to reduce costs and material flow lead-times, increasing agility and production flexibility. Pries (2003) provides examples of German car assemblers that have used the strategy of *single sourcing* (single supplier) associated with the strategy of *follow sourcing*. This behavior seems to be the general trend for most car assemblers with global operations: they attempt to develop global partners, with whom they work in all of the company's plants around the globe, pressuring them to be physically present in the industrial parks that they build around their new plants. Thus, the concepts of *single sourcing* and *follow sourcing* cannot be separated from one another, leading to definitions of *follow sourcing* that take *single sourcing* for granted, as the one proposed by Humphrey: "parts are always supplied by the same supplier in different places" (2000, p. 250).

The proximity of suppliers makes it easier to deploy *just-in-time* provision of parts and modules. And that makes plants more flexible and agile, consequently reducing the lead time required for the production and delivery of made to order items, which has high impact on distribution logistics and the service level provided to customers.

2.4 Distributed inventory management, close to the consumer

To keep inventory close to potential customers makes sense, considering the reduction of delivery lead-time it provides. Smaller vehicles that are better fit to the delivery of small quantities directly to consumers can be used. However, that implies keeping higher levels of inventory in the system, considering that each local warehouse needs to have all items that customers may request.

Wanke (2000) recommends this approach to be used when a demand anticipation policy is a sound strategy. He gives the example of a gas station. Gas and diesel have a relatively inelastic demand, even in recession times, which makes it very predictable. There is no obsolescence risk, which means that wrong decisions about the location of the inventory don't cause great loss. The good is not going to get "stuck". It will only take a little longer to be sold, sometimes. Considering that the contribution margin is high, in spite of the product's low price, it's worth to keep inventory and not to risk leaving customers unattended.

2.5 Centralized inventory management (location postponement)

On the other hand, choosing to keep a central warehouse and deliver from there directly to customers reduces the required amount of inventory, but distribution costs are usually higher and, many times, the delivery lead-time isn't so good. Lower inventory costs relate to the fact that the range within which demand is expected to vary in a centralized warehouse, for a specific item, is narrower than the sum of the ranges within which local warehouse demands are expected to vary. Higher transportation costs, on the other hand, relate to the fact that longer distances need to be traveled to deliver each order, individually (distance between the central warehouse and the delivery destination), and that a premium modal may be required, in order to deliver the order in time.

According to Wanke (2000), inventory centralization combined to the use of a fast transportation modal may help developing a strategy of quick response from a single distribution point, even if it is located far from where the demand is detected.

2.6 Mixed inventory strategy

Characteristics of the product and the demand are strong factors in determining inventory location, as it can be depicted from what was stated above and according to **Tables 1** and **2**.

Table 1 Characteristics of the product and the inventory location decision

Characteristics of the product	Centralized inventory	Decentralized inventory
aggregate value	high	low
contribution margin	low	high
obsolescence	high	low
production flexibility*	?	?

Source: adapted from Wanke (2000).

* If it is economically feasible to postpone part of the production until the customer places his/her order (manufacturing postponement), the decision about decentralizing inventory will depend on if the final production stages can be carried out somewhere nearer the customer or not. If final configuration still needs to be performed in the factory, the inventory of semi-ready products will be kept in a centralized manner. Otherwise, if the "final touch" can be given in a warehouse near the customer, or directly in a retail shop, decentralized inventory may be a good strategy to ensure a better service level (faster delivery).

Table 2 Demand characteristics and the inventory location decision

Characteristics of the demand	Centralized inventory	Decentralized inventory
predictability	low	high
inventory turn ration	low	high
transport scale	low	high
demand information	in real time	slow
expected service level *	?	?

Source: adapted from Wanke (2000).

* Wanke (2000) considers that the expected service level presents two basic dimensions: delivery lead time and product availability. A higher level of service may be obtained by means of more decentralized inventory, closer to the customers or by means of faster transport modals. As each of those approaches has its own advantages and disadvantages, in terms of costs, an individualized analysis is required for each case.

One way of reducing the problem of inventory location, depending on the characteristics of the product and the demand is keeping inventories close to the customers for items that have high inventory turn rations, particularly if unit value is low (demand anticipation policy). On the other hand, for expensive and low inventory turn ration products, when adopting a mixed inventory policy, items should be kept in a centralized location, from where they can be delivered by means

of premium modals that can make them reach the customers fast (fast response to demand policy).

This is a compromise solution, by means of which some products are delivered by means of premium modals, after the company knows exactly what the customer wants (logistics postponement), while others are kept locally, in spite of the inefficiencies of redundant inventories, in order to ensure immediate access to them, without the need to use expensive transportation means.

2.7 Cross-docking

Distribution cross-docking is an operation of load consolidation to make delivery easier when delivery volumes to different locations are small. In warehouses that are built for that purpose, the ideal situation is never having any item in stock. On one side of the warehouse large volumes of single products arrive in heavy vehicles and, from the other side, smaller and more agile vehicles depart, to perform local deliveries of consolidated loads (comprising of different items in smaller quantities).

In an immediate cross-docking operation, which is perfectly synchronized and coordinated, the merchandize being handled doesn't even need to touch the floor of the warehouse, being directly transferred from the larger vehicle to the smaller one, by means of fork lifts or any other suitable process. Cross-docking relates to the warehouse the same way just-in-time relates to the factory shop (ATKINSON, 2003). Its adoption eliminates the need for warehousing and reduces handling, the two most costly activities in a warehouse operation (SCHAFFER, 1998; 2000), transforming it in a pass-through facility, where loads are quickly reconfigured in order to be delivered to final destinations (HARRINGTON, 1999). This reasoning for logistics activities is capable of imposing a different pace to the handling and transportation of products, reducing cycles and allowing for the adoption of a *quick response*[1] behavior, in which suppliers use the data they gather from the point of sale in order to synchronize their manufacturing operations to warehousing activities and the actual sales to customers, according to Wanke (2004).

In less synchronized operations, known as future cross-docking (or cross-docking with brief storage), the goods may be kept in the warehouse for a little while, usually not longer than a day. In such cases, the warehouse is usually used for separation and even for some sort of processing, before the products are transported to the customers.

Cross-docking is just an attempt to conciliate the use of the transportation means with best performance to transport large volumes to large distances (usually from the manufacturer to the central warehouse) with those better suited for low volume transportation to small distances (from local warehouses to the point where the customer wishes goods to be delivered). It works as the interface between two different worlds: the industrial one, of scale mass production, and the information one, of selective and personalized consumption, connecting heavy and slow transportation/logistics systems to fast and agile ones.

In some cases, companies choose to perform mass customization, which generates products for personalized consumption in a production line. In those cases, secondary warehousing facilities may be used in order to carry out cross-docking operations before final distribution (SACCOMANO, 1999). In other situations, the warehouses undertake production and assembly

tasks, performing the customization demanded by the end customer, which makes the line that separates production activities from warehousing ones even fuzzier (HARRINGTON, 1999).

The following requisites are essential for the implementation of cross-docking in an efficient manner (SCHAFFER, 1998; 2000; ATKINSON, 2003):

- establishing partnership with other members of the supply chain;
- establishing good (real time) communication with other members of the supply chain;
- establishing good (real time) communication and internal control of the operation;
- ensure good quality and availability of the product;
- having prepared staff, and suitable equipment and facilities;
- performing tactical management.

As the cross-docking operation takes place in real time, it demands that no interruptions take place in the flow of products. Therefore, it's essential that the right product is available at the right time. That requires no problems with the product, with its transportation (outside the operation) or its handling (within the operation). It is also necessary to have a precise information flow (internally and among external partners), in order to know what needs to be done at any time. Atkinson (2003) warns that the information infrastructure is, therefore, a key factor for the successful implementation of a cross-docking operation, demanding special attention to the selection of the warehouse management system. The use of bar coding or other mechanisms to track the physical movement of products is also required.

2.8 Monitoring, planning and controlling inventory

Companies use computer programs, in order to optimize the levels of inventory in each point of the supply chain, being able to provide the level of service the customers require, without incurring in excessive inventory costs. But just having a good inventory system is not enough, though. One also needs to have effective ways of feeding the system with the information about the physical inventory at all times. In order to do that, other technologies also have to be used, to capture the information to be fed to the inventory system and to share information with business partners. Next, a few of those technologies and approaches will be discussed that can be used to collect and to share information used in planning and controlling inventory levels along the supply chain.

2.8.1 Bar codes

For many activities related to the inbound logistics (milk-run, sequencing, just-in-time), the distribution logistics and even the logistics of returning products to the manufacturer (reverse logistics), as well as inventory management activities, to work effectively, it is necessary to quickly identify the items that are being processed. The most widely spread technology available in the market for that purpose is bar codes.

Bar codes are very simple to use. They consist on white and black stripes that are arranged according to a pattern that conveys specific information. When a scanner device is used, it emits light that is reflected (or not) on the bars of the bar code, being captured and interpreted by it.

There are several bar code standards in the market, among which the most popular ones are linear codes. But there are also bi-dimensional codes, which can include several lines of bars and matrix codes, capable of containing a significantly larger volume of information.

Bar codes are used in supermarkets, department stores, warehouses, factories and by logistics operators. When used together with EDI, a technology for sharing information with business partners, it halps tracking the product along the value chain (COYLE, BARDI and NOVACK, 1999).

2.8.2 Radio frequency identification – RFID

More recently, radio frequency identification has started to appear as a possible alternative to bar codes. The technology uses microchips that transmit the information contained on them by means of radio waves (REID and SANDERS, 2004).

One advantage of the use of radio-frequency is that the information can be captured without the item having to be placed in front of a scanner, in order to be read (AUTOMOTIVE answers the "made-to-order" call, 2004). Thus, RFID promises to offer inventory information in real time, along the several stages of the supply chain, allowing for better management of the product flow, from the producer of raw-materials until the end customer. It can provide full tracking of the components used in the production of a product, which is becoming more and more important to help companies comply with legal demands of being aware of the source and destination of each item they process, in case a recall is needed.

According to Mercado & Consumo (2004), the German retailer Metro, one of the largest in the world, installed an RFID self-checkout equipment in its Innovation Center, which reads bar codes and radiofrequency labels of products that are traded in the retail. In the configuration that was used, the check-out deactivates electronic labels automatically, after reading their information, so that the consumer can leave the shop without triggering safety devices.

If there is no perspective of immediate use of the new technology in the front-office, for back-office activities, some companies have very aggressive plans for its use in a short time. Wal-Mart intended its major suppliers to be capable of using the technology early in 2005, in order to control pallets and boxes of products sent to the retailer or returned to the distributor or manufacturer, according to Andel (2004). The company also imposed the challenge on itself, as it intended to have its 180 distribution centers and thousands of shops ready to process radio frequency labels by then.

Noticing the huge potential of the new technology, developers of software for supply chain management, such as Manugistics and Apriso, already provide support to the use of radio frequency solutions (BACHELDOR, 2003), although the cost of the technology still needs to be reduced for it to become a feasible alternative to traditional bar codes.

In spite of the higher costs, the combination of the use of information systems and radio frequency identification devices has the potential of improving data collection and inventory level follow-up, in addition to providing better visibility along the supply chain (AUTOMOTIVE answers the "made-to-order" call, 2004).

2.8.3 VMI (Vendor Managed Inventory)

Information from the point of sale may be shared with suppliers in order to eliminate the distortions and delays in the supply chain, according to Sterman (apud SAAB and CORRÊA, 2004). VMI goes beyond that, as its principle is to allow the manufacturer to manage the whole supply chain downstream, determining the volumes to be sent to each point of the distribution chain and eliminating the need of order placement by the customers. With VMI, instead of the company monitoring its inventory levels, in order to decide when to order next, this responsibility is transferred to the supplier. As demand forecasts can be performed in a more aggregate fashion upstream in the supply chain, it tends to be more stable, according to Saab and Corrêa (2004).

Those authors remind us that suppliers of VMI systems claim that their solutions are able to:

- improve the manufacturer's knowledge of the demand's behavior downstream along the supply chain;
- reduce inventory level along the supply chain;
- reduce Forrester effect[2]; and
- reduce product cost, allowing this advantage to be transferred to the customer or included in the product's contribution margin.

Gillette, for example, according to Cottrill (2003), has attempted to develop a replenishment model that reacts to information obtained directly from the retail points of sale (POS), in order to improve the integration of its value chain.

Supermarkets and other high inventory turn retail operations offer good conditions for the implementation of this type of initiative, which has motivated the investment in technology by retailers and their suppliers.

3 METHODOLOGICAL APPROACH

Companies that participated in the survey were contacted by means of an e-mail message, which contained an attached MS Word form. The electronic questionnaire in that form had *check-boxes* and *drop-down* menus with possible answers to be chosen. A scale was used that was inspired in Likert's scale and could be filled in by clicking the mouse on top of an alternative answer. That contributed to reduce the time required to complete the questionnaire. Ray and Tabor (2003) argue that, although *radio button* or *check box* questions make a questionnaire clearer, a list of alternatives in a *drop-down* menu reduces the physical size of the questionnaire, considering that the menu is only presented while the question is being answered. Figure 1 shows an example of a *drop-down* menu that was used in the survey, precisely with the intention of reducing the number of pages of the questionnaire, which could have a positive psychological effect on the respondents.

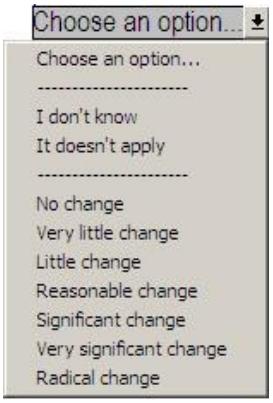

Figure 1 *Drop-down* menu used for questions about the level of change related to several value adding activities, resulting from the use of the Internet

The electronic questionnaire was sent to all industrial companies contained in FIESP's database[3] that had a valid e-mail address, which resulted in 655 filled in questionnaires being returned to the researchers, corresponding to a return rate of ca. 8%. The participants of the survey represented a convenience sample, as a result of the methodological approach that was used, which restricts the possibility to assume that results that are obtained for the sample are also valid for the whole population. However, the authors carried out comparisons of the existing demographic data for the companies that took part in the study and those comprising the population and didn't detect any evidence that the sample doesn't fit the population. On the contrary, χ^2 tests for the location of the companies and their size were very favorable.

A limitation of this study is that it represents a snap-shot of a particular moment. The authors will have to apply the same survey in the future, again, in order to evaluate the evolution of the participants' perception on the issues that were discussed here. It's like having a photograph, when what would really matter would be to have a movie.

4 ANALYSIS OF THE RESULTS

Companies that participated in the survey were separated according to their size. They were considered large companies when they had more than 500 employees, mid-size companies when the number of employees was higher than 100 and small, otherwise. This distinction is important because it was soon noticed that the adoption of the use of the Internet is influenced by this factor. Then, graphs were generated showing the behavior of each of the variables that were studied, taking into account the size of the company. Graphs relate to the perception of the participants with respect to the intensity of use of distribution logistics activities and techniques that the authors considered important, in order to provide the flexibility and agility demanded in Internet times. They also express the respondents' expectation for the next 3 years (one should keep in mind that the survey was applied late in 2003 and early in 2004).

Figures 2 to **7** present separate stack-bars for large, mid-size and small companies. Inside each rectangle that forms a vertical bar, appears the number of companies, in absolute terms, which provided a specific answer to the proposed question (according to the legend next to the graph). The vertical axis presents a percentage scale, used in order to provide a "relative" value for the absolute figures contained inside the rectangles. This scale is also useful to aggregate answers.

For example, **Figure 2** shows that 27,3% of the large companies consider that the change to distribution logistics that was caused by the Internet and other IT, along the last 3 years, was at least reasonable (this is the aggregate percentage for the one large company that considered that change was radical, the one company that considered it very significant, the one company that considered it significant and the 3 companies that considered it was reasonable).

4.1 Impacts of the Internet and other IT on the distribution logistics

The importance that is given to logistics issues has substantially increased along the last few years. To a great extent, this is due to the fact that companies have already improved their internal operations, in order to make them more efficient, so that additional gains are harder to achieve, now. Improvement opportunities still exist in the coordination of storage activities, handling and transportation. This section presents the results of the survey, which was carried out with Brazilian manufacturers, about their distribution logistics and techniques used for inventory and service level management, and the reduction of inventory turn. Most questions related to the impact of the Internet and other IT in logistics activities.

4.2 Changes in distribution logistics, related to the use of the Internet and other IT

More than one fourth of the large and mid-size companies (27.3% and 26.0%, respectively) believe that the impact of the Internet and other IT in distribution logistics was at least reasonable along the last three years. Among small companies, the impact was considered smaller: only 14.8% of them had the same perception. On the other hand, only 9.1% of large companies consider that the new technologies cannot contribute to their distribution logistics. Among mid-size companies, this percentage is 16.4% and among small ones, 14.4% (see **Figure 2**).

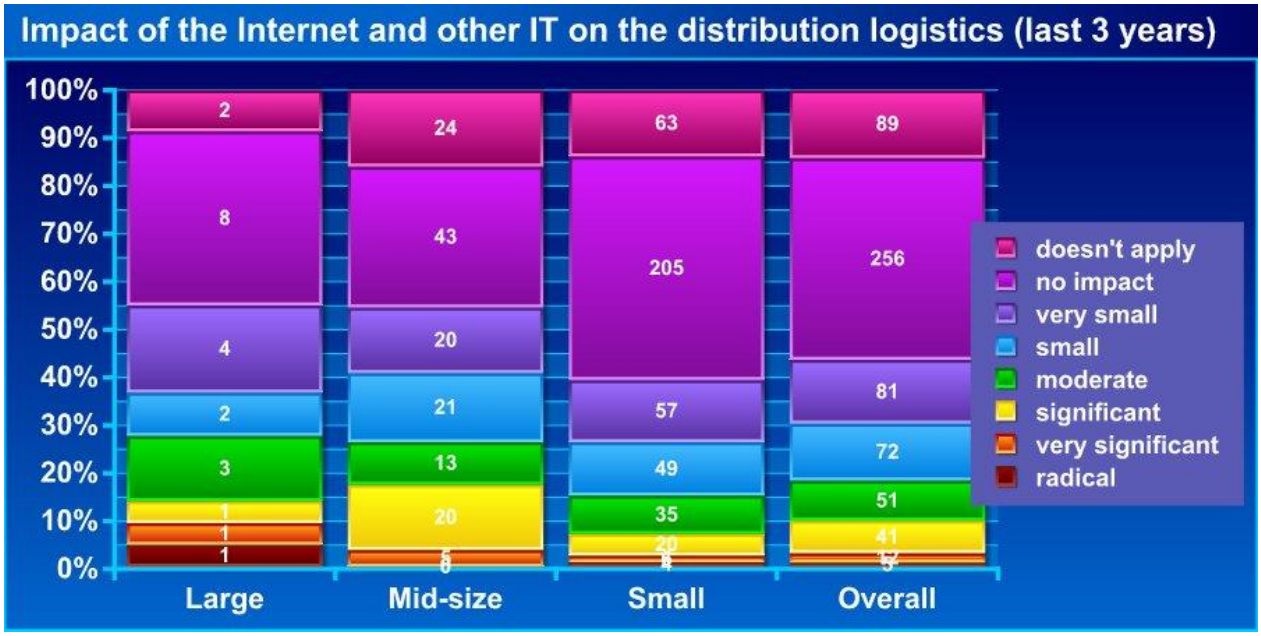

Figure 2 Impacts of the Internet and other IT on distribution logistics of manufacturers in Brazil, according to their size, along the last 3 years

4.3 Modularization and postponement

As it was mentioned before (**item 2.5**), postponement consists on only carrying out some steps of the production or logistics process after the customer has already set its preferences. In order to reduce the risk of producing something different to the customer's wish, the production may be organized in a way that it only takes place after a firm order is placed (pulled production). In order to reduce the risk of mistaken location of the inventory, one can choose only to send products to the distribution points when customers have already signaled the need of them. The problem is that cycle times involved may be too long, making it difficult for the opeartion to provide an acceptable level of service. Therefore, a strategy that is being used by some companies is to carry out part of the process in a traditional pulled fashion, specially those activities that are standardized, and wait until the customer "speaks" in order to complete the work, performing those tasks that allow for the personalization of the product.

It is easier to perform manufacturing postponement when the company's product is modular, because modularization makes it easier to determine the stage of the production process after which pulled activities will take place, i.e., the point where modules are attached to one another, in order to come up with a specific configuration of the final product. Thus, the authors included a question about modularization, in addition to the one about postponement, in the survey.

As it was expected, the graphs that were obtained for the use of modularization (see **Figure 3**) and postponement (see **Figure 4**) are very similar.

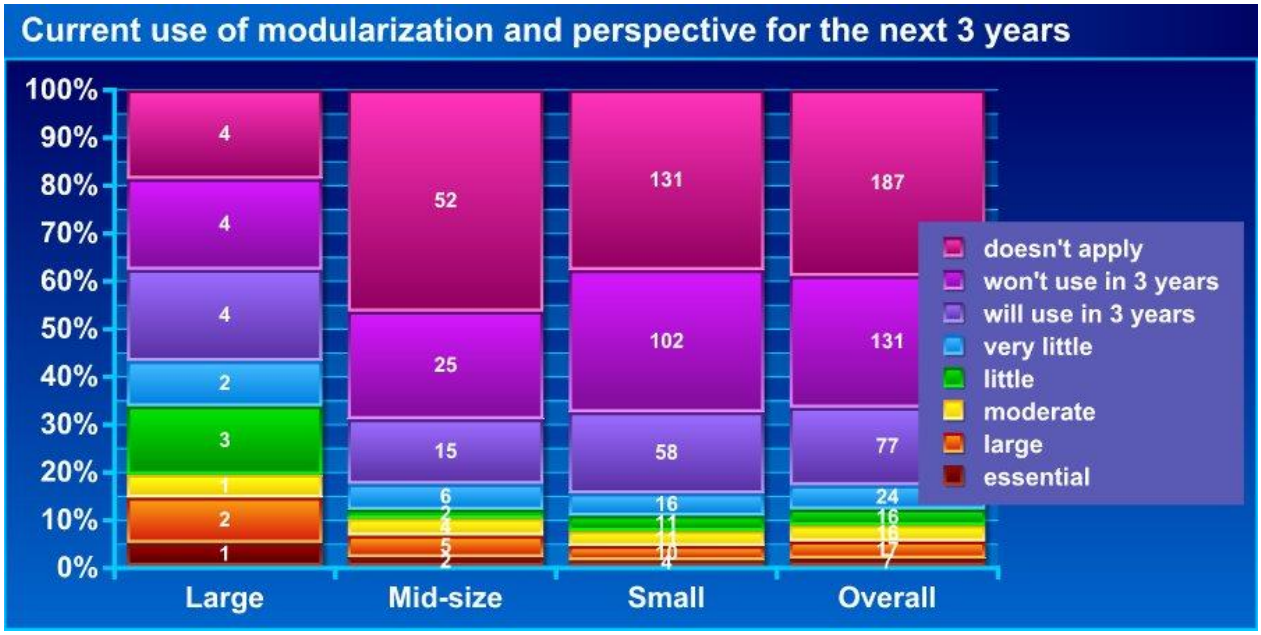

Figure 3 Current use and perspective of future use of modularization by manufacturers in Brazil, according to their size

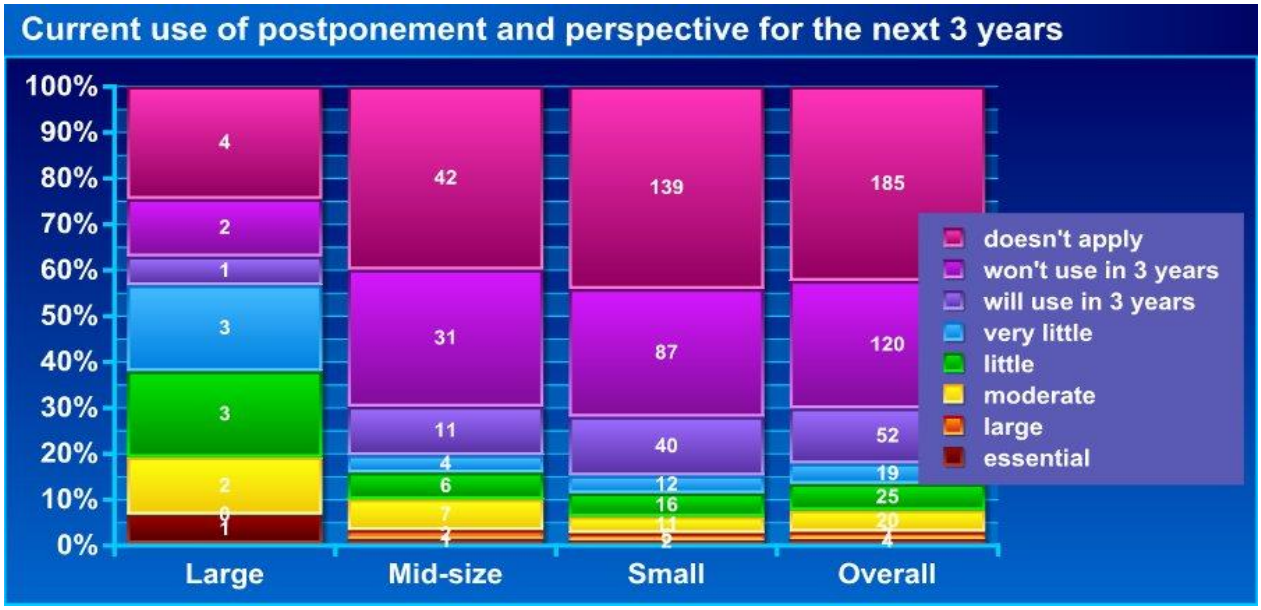

Figure 4 Current use and perspective of future use of postponement by manufacturers in Brazil, according to their size

4.4 Cross-docking

Analyzing the answers to the question about *cross-docking*, which was discussed on **item 2.7**, one realizes that small and mid-size companies do not pay much attention to the technique, differently to large companies. Only 1.8% of small companies use cross-docking at least to a moderate extent and only 9.6% of them intend to start using it within the next 3 years. 87.1% of small companies do not intend to use it or think it doesn't apply to their businesses.

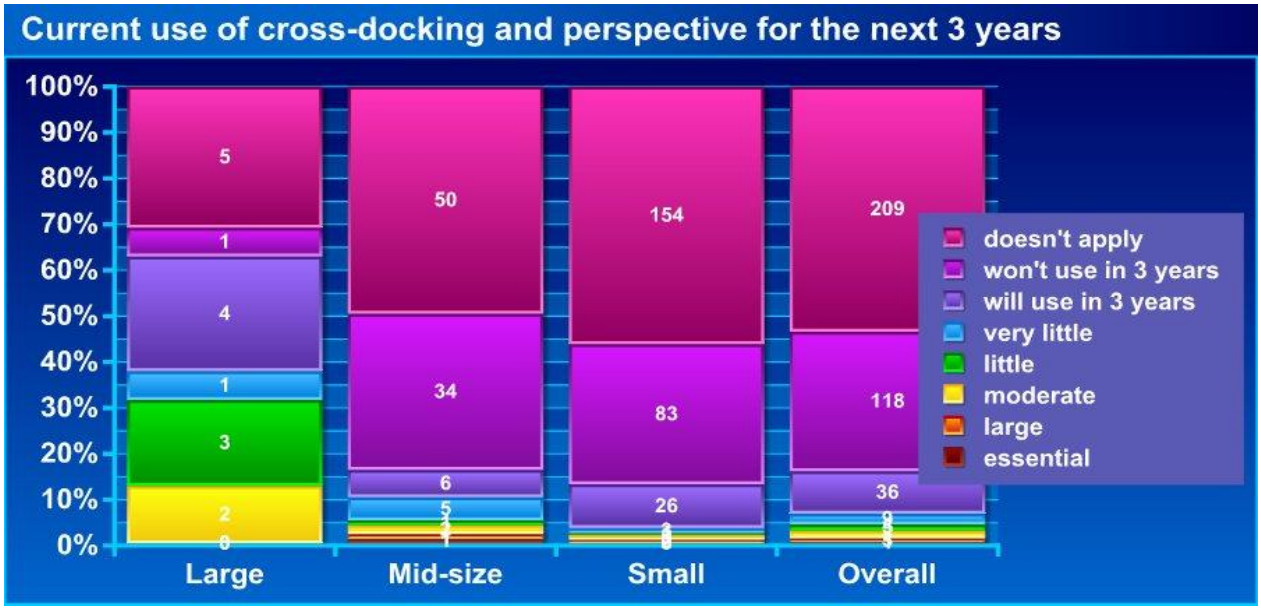

Figure 5 Current use and perspective of future use of cross-docking by manufacturers in Brazil, according to their size

For mid-size companies, figures are not much different: only 4.0% make moderate use of the technique and only some 6.0% say that they intend to use it in the near future. 84.0% are not going to use it soon or believe it doesn't apply. Large companies, on their turn, in spite of not using cross-docking very intensively (12.5% make moderate use of it), are more receptive to its use in the near future: 25.0% of them intend to use it in the next 3 years. Only 37.5% don't intend to use it soon or consider it doesn't apply. **Figure 5** shows the data referring to the answers that were obtained, from which the percentages mentioned above were calculated.

4.5 Bar codes

According to what was discussed in **items 2.8.1 and 2.8.2**, some technologies, as bar codes and RFID may be used to quickly identify items to be transported or stored, making it easier to track them within the value chain, at any time.

Companies were asked about the intensity of use of bar codes in their operations and the answers are presented in **Figure 6**.

Among large companies, 54.5% already use the technology at least to a moderate extent, while 27.3% intend to start using it within 3 years. Only 9.1% consider that bar codes are not useful to their businesses or do not intend to use the technology in the near future. For mid-size companies, the intensity of use was considered at least moderate by 43.3% of the respondents. 24.1% of them intend to use bar codes within the next 3 years. But the percentage of companies that do not intend to use the technology or consider it unnecessary is higher (21.3%). Only 20.7% of small companies use the technology at least to a moderate extent. 27.5% of them intend to start using it soon. However, 43.1% do not expect to use it in the near future or consider that it doesn't apply.

No question was proposed to the respondents about the use of RFID because, at the time the survey was applied, it was too "futuristic" in the Brazilian industrial scenario.

Figure 6 Current use and perspective of future use of bar codes by manufacturers in Brazil, according to their size

4.6 Direct management and replenishment of customer's inventory

The use of VMI, which was discussed in **item 2.8.3**, is more frequent among large companies than smaller ones. This probably relates to their capability of negotiating with customers the way inventories need to be managed. Wanke (2004) reminds us that the adoption of VMI depends on the bargaining power of the supplier, in order to convince the customer to accept this form of inventory management and replenishment, in which the customers give up their control over the inventory, handing it in to the supplier that starts replenishing goods without the need of any formal request by the customer in that sense.

20% of large companies use VMI at least to a moderate extent. Among mid-size companies, that percentage falls to half (9.8%) and among small ones, it falls to half, once again (4.9%).

One fourth of the large companies believe that VMI doesn't apply to their businesses, or they do not intend to use it in the near future. Among mid-size companies, this percentage is more than twice as high (55.3%). And among small ones, it reaches 62.1%, according to **Figure 7**.

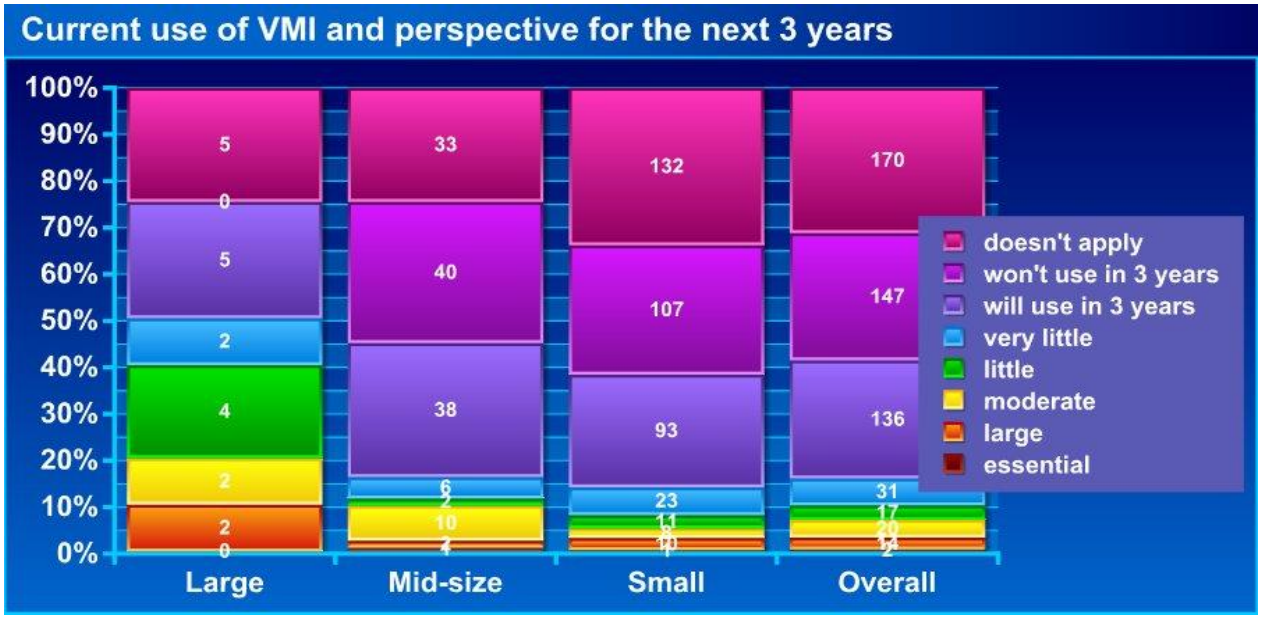

Figure 7 Current use and perspective of future use of VMI by manufacturers in Brazil, according to their size

CONCLUSIONS AND MANAGERIAL IMPLICATIONS

After NASDAQ's crash in April 2000, when *.com* companies lost in just one day all the gains they had accumulated during the whole previous year, investors became more conscious and conservative with respect to the projects they sponsored. The evaluation of Internet related projects started requiring going through the same conservative project approval procedures demanded from projects in other areas. It became more difficult to approve any Internet project without first linking it to traditional financial objectives, involving sound thinking on its cash flow and the return of the investment. Changes started happening in a different pace, apparently slower, but, as the authors of this paper believe, with deeper impacts to the businesses than just selling products over the Web, as proposed in the Internet original days. With a clearer idea of the

"miracles" that the Internet can achieve – and of those that shouldn't be expected –, companies now have the technological grounds on which to redesign their products, processes, structure and their supply chains, in order to benefit from the opportunities offered by the Web.

This paper discussed some methods and technologies that have been around for many years. Concepts like modularity and postponement have been around for decades. Starr (1965) first wrote about it in HBR in the 60's, arguing that if products were built from modules, the output would be optimized in quality and variety (product mix). However, those concepts are even more relevant now, because along with other more recent techniques also discussed in this paper, they provide the tools to make mass customization feasible, with short cycle times until the delivery of the product to the end customer's door steps.

The Internet's impact on the way companies perform their routine distribution activities or develop strategies to integrate their operations to their partners' in the supply chain is just starting to become noticeable.

The percentages of companies that use customization and postponement techniques weren't significantly large among the Brazilian manufacturers that participated in the survey, as it happened with respect to most of the issues discussed in this paper. However, it was interesting to find out that there was high correlation between the levels of adoption of customization and postponement practices. That indicates that modularization is not used just in order to facilitate the production process. Its users also realize the possibility of working as pizza men: they make the dough in advance and possibly only concern about the toppings in a later stage, when there is more information available about the actual demand for each product variation to be delivered.

The intensity of use of cross-docking and VMI was considered low. But then, one has to think that the participating companies, themselves, may not be so concerned with cross-docking, but maybe some other player in the supply chain (distributors or wholesalers) is. Of course, as both cross-docking and VMI rely on the existence of a good information and communication infrastructure, including computer programs and network connections, it may take a little longer for them to spread. The authors intend to monitor the evolution of the scenario of those two practices along the time, possibly by applying the survey again to the same respondents in the future. As mentioned in the methodology section of this paper, one of the limitations of the study is that it provides an idea of the current situation more than it depicts trends for the future, in spite of the questions about the company's plans for the next 3 years.

Current use of bar codes in the manufacturing industry was close to what the authors expected: ca. 50% of large and mid-size companies use the technology, to different extents. That provides logistics people with an effective way of tracking goods as they are stocked or transported along the supply chain, though new technologies promise to start replacing it in soon. The authors didn't even bother to include a question on the use of RFID in the survey (which was respondent late in 2003 and early in 2004), because they considered that logistics people in the field would find the question a bit "surreal", considering the challenges they already face to deploy even more stable technology as bar codes.

The "revolution" that may take place in the manufacturing field due to the adoption of the Internet, other IT, techniques and practices mentioned in this paper is silent, maybe slower than we would like, but steady. It is almost impossible to predict where this is all going to end.

Fortunately, it is not that difficult to figure out where it begins. Where we go from here will depend on the companies' willingness to break old paradigms and redesign their businesses around new concepts and demands of flexibility, agility and integration of the value chain.

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Notes

[1] *Quick response* was originally introduced in the textile and clothing sector in the USA, sith the purpose of reducing the response time of production flows and, as a consequence of that, the inventory levels that are kept along the value chain and, particularly, in the points of sale to the consumer. Usually, replenishment happens at regular intervals, but quantities vary according to demand data made available directly from the points of sale, ensuring that the floatation of the inventory level at the retail keeps within pre-defined tresholds (WANKE, 2004).

[2] Sterman (*apud* SAAB e CORRÊA, 2004) considers that, when orders are fulfilled more rapidly, the supply chain's response reduces the number of situations in which there are no products to fulfill the order, which, on its turn, reduces the occurrence of gost orders (those that are placed in a repetitive manner, as a result of a defensive reaction to the lack of business due to the lack of inventory). Gost orders are particularly disturbing in situations where the Forrester effect is already present.

[3] FIESP is the association of manufacturing companies in the state of Sao Paulo, Brazil. FIESP's database (from 2002), which was used in the survey, included 15,279 manufacturing companies. As companies would be contacted via e-mail, only those having an e-mail address in the database would, originally, be invited to participate in the survey. Such companies were 11,838. However, a previous survey that had been carried out by Cohen (2003) the year before, using the same set of data, had already found out that 1,247 of the e-mails in FIESP's database were wrong. Thus, target companies to the survey were reduced to those manufacturing companies contained in FIESP's database that had a valid e-mail account. During the application of the survey, approximately 30% of the messages that were sent didn't reach the addressee, as a result of wrong e-mail addresses. The increase in the number of invalid e-mail addresses from 1,247 to 3,547 was not interpreted as companies giving up the use of e-mail. Although no scientific verification was made for the significant increase of invalid e-mail addresses, the authors speculate that it was the result of Internet provider replacement, or the creation of the company's own domain and, therefore, the change of the e-mail address, in order to use the company's own e-mail server. This suspicion is supported by the great number of companies that, even having received the message in the e-mail address contained in FIESP's database, requested that future contacts took place by means of a different e-mail address.