Ship & Chip
The importance of IT for logistics concepts

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Project code 64359

November 2000

Report 3.00.06

Agricultural Economics Research Institute (LEI), The Hague

The Agricultural Economics Research Institute (LEI) is active in a wide array of research which can be classified into various domains. This report reflects research within the following domain:

- ☐ Business development and competitive position
- ☐ Natural resources and the environment
- ☑ Competitive position and Dutch agribusiness; Trade and industry
- ☐ Land and economics
- ☐ Chains
- ☐ Policy
- ☐ Institutions, people and perceptions
- ☐ Models and data

Ship & Chip; The importance of IT for logistics concepts
Deneux, S.D.C. and J.J. de Vlieger
The Hague, Agricultural Economics Research Institute (LEI), 2000
Report 3.00.06; ISBN 90-5242-613-9 ; Price NLG 27.- (including 6% VAT)
51 p., fig., tab.

Mainly based on the currently available literature, this research describes the new logistics concepts and discusses the importance of IT for logistics.

After describing the drivers of change in the field of logistics, research focus zooms in on the new logistics concepts and enabling technologies. Just-in-Time (JIT), Quick-Response (QR), Efficient Customer response (ECR) and enabling technologies such as Electronic Data Interchange (EDI), Global Positioning System (GPS) or Electronic Fund Transfer (EFT) are briefly described. Critical Success factors of the logistics concepts are identified and a comparison with the integrated role of IT is proposed so that importance of IT for logistics is assessed. In addition, a case-scenario discusses the effect of IT contingency on an ECR chain. This research concludes with some recommendations to enhance integration of IT with regards to logistics reliability.

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Foreword

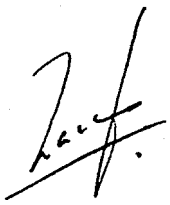
> 'We are standing on the verge, and for some it will be the precipice, of a revolution as profound as that which gave birth to modern industry. It will be the environmental revolution, the materials revolution, the digital revolution, and, most of all, the information revolution.'
>
> Source: Hamel and Prahalad, 1994

The fast evolving Information Technology industry receives an increasing place in today's business environment. Organisations allocate bigger budgets to IT infrastructure as they seek to differentiate themselves from their competitors. As part of the business activities, logistics has encompassed this tendency and IT is become an important issue in today's field of logistics. Real time communication, tracking and tracing of goods, forecasting consumer sales, planning and controlling, is nowadays achieved to a large extent by means of Information Technology.

To better understand this dynamic background, the Agricultural Economics Research Institute (LEI) decided to investigate the role of IT in today's logistics. Mainly based on the currently available logistics literature, this report discusses the importance of IT for logistics through an analysis of the new logistics concepts. Recommendations are also proposed with regards to the use of IT in logistics.

This research was carried out jointly by S.D.C. Deneux and J.J de Vlieger.

The Director,



Prof. Dr. L.C. Zachariasse

Summary

The world of business has been confronted with numerous changes. Driving forces - such as consumers, competition, and new technologies - have changed the face of the economy, introducing a new environment, keener and selective. Therefore, organisations had to reach challenges they were never designed to meet.

Driven by these new developments, the field of logistics had to introduce innovative concepts, including modern enabling technologies, in order to cope with today's business environment. Just-in-time, Quick-response and ECR are representative examples of these developments. The Just-in-time (JIT) concept focuses on the elimination of waste throughout the logistic and manufacturing system. This is done by delivering materials and components to the next stage of manufacturing just before they are to be processed and only in the quantity that will be used. JIT replaces the traditional push system by a pull system. In the quick-response concept, it is refers to a system of communication and co-ordination throughout an entire supply-chain. Essential within this concept is to share information about forecasts, sales, orders, production plan and inventories with others. Concerning the ECR concept, the main purpose relies on the increasing of efficiency and effectiveness of the entire chain by integrating marketing and logistics decisions and on the optimisation of the co-ordination of the different links throughout the chain. The ultimate goal is, in fact, the maximisation of customer satisfaction. This is done in four fields: Efficient replenishment, Category management, Efficient promotion and Efficient product introduction.

Logistics concepts rely on underlying sub-systems, so-called enabling tools, which contribute in a crucial measure to the success of the operations. EDI, Bar-coding, Cross Docking, participate actively to the achievement of the logistics concepts.

To understand the importance of IT in the modern logistics concepts, critical success factors have been extracted. The concept of JIT focuses on time and, in particular, on time synchronisation to eliminate waste. This is realised by a strict planning and standardisation of the different functions and tasks. The Quick-response system stresses on the need for co-ordination. Therefore sharing information to create transparency is encouraged. For the ECR system, the following points are essential: co-operation between all partners and information flow that leads to transparency in the whole chain and the use of market intelligence to better forecast consumer demand. In short, the modern logistics concepts relies on four critical success factors:

- precise scheduling and synchronisation of activities;
- information flows between trading partners;
- transparency along the chain;
- constitution of market intelligence.

In logistics planning, the place of Information technology is become central. Planning and scheduling activities are enhanced and enlarged by the settlement of an appropriate IT structure. Capacity to communicate has been also drastically extended by the integration of IT

systems in managing information flow, in terms of speed, quantity and reliability. Today's new technologies enables real time transfer of information, data file, programs, or other digital documents so that communication between distant places can be realised in real time. The electronic highway achieves better performance than traditional informative methods.

In enabling transparency along supply-chain, information technology plays also a critical role. It permits origin, location and flow of products to be easily traced and/or tracked, so that consumer possesses complete and accurate product information.

Information technology has provided the means to trace consumer behaviour, so that its action can be understood and forecasted. Information technology and POS scanners form the basis of customer intelligence developments.

Information technology appears to hold an important place in most current logistics systems. This place has increased along the last decades and is presumed to get even bigger as future technology is able to propose new possibilities. IT's technology not only holds and transmits data but can also exercise routine decision rules. In many today's global supply chain, the product flow is controlled and managed by automated technology. In such case, reliability of a whole chain flow relies on the operational safety of the underlying IT systems. In other words, logistics process reliability depends on IT performances.

Therefore, it is of crucial importance that organisations keep working on developing more reliable product. Also, regular verifications of the installations, control and frequent renewal of the elements will contribute to prevent eventual failure. Moreover, emphasising secondary systems (back-up systems) may also be a solution to minimise risk of logistics failure. Finally, as IT associates people, creates links, and modifies drastically the way of doing business and particularly the way of doing logistics, IT installation should be thought afresh strategically, taking into account the context of application (use, function, frequency, implementation…).

1. Project design

1.1 Introduction

Innovations in information technologies of the past two decades have radically reduced the time and cost of processing in communicating information. Such systems have proliferated as companies recognised the potential of these techniques to affect both inter- and intra-organisational interactions in terms of economic efficiency. Today's situation shows a strong integration of Information and Communication Technology (ICT/IT) within and between enterprises.

Taking advantage of these new growing possibilities, innovative logistics concepts have been introduced - such as Quick Response, Continuous Replenishment, Vendor Managed Inventory… etcetera -, adopting findings of Information Technology to enhance logistics efficiency and effectiveness.

Information Technology has been an important source of improvements in terms of new logistics concept developments. However, today's strong IT integration may also provide additional risks of eventual logistic collapse in case of ICT contingency. Y2K, viruses, bugs, or hackers constitute a potential threat for IT and indirectly for the reliability of the logistics systems.

To which extent does logistics rely on IT? Which function does it fulfil? To which extent will a supply-chain be affected by an IT breakdown? Many question on which the future strategy of carriers, warehouse managers and other executive staff of distributive enterprises rely.

1.2 Aim of the project

This project aims to give a descriptive overview of the new logistics concepts and to discuss the importance of IT for logistics. A case-scenario is also presented in order to assess the effect of IT contingency on supply-chain reliability. Points of improvements will be suggested.

1.3 Scope of the research

In this report, we will restrict our analysis to business logistics, leaving aside public-services logistics and military logistics. The definition stresses the physical aspects, the managerial, the financial and the informational aspects.

Furthermore, this research takes place in the program 'Chain and Logistics' of the LEI. Complementary research in the fields of Transport and Global Supply Chain Management formed a relevant basis when regarding how to approach the project. However, to avoid redundancy with running projects, the case of E-commerce has been removed from this study

and is voluntarily not elaborated here. Moreover, time and finance were complementary limiting constraints as well.

1.4 Research Design & Method

A framework has been designed to assess the dependency level of logistics on IT. After presenting an overview of the main logistics concepts, the heart (or Critical Success Factors) of the new concepts will be extracted and highlighted. The role of Information Technology in these particular areas will be then assessed and discussed. Dependency of the new logistics concepts on IT will be assessed from there. A breakdown scenario at chain level will be considered as well.

Figure 1.1 proposes an illustration of the research design.

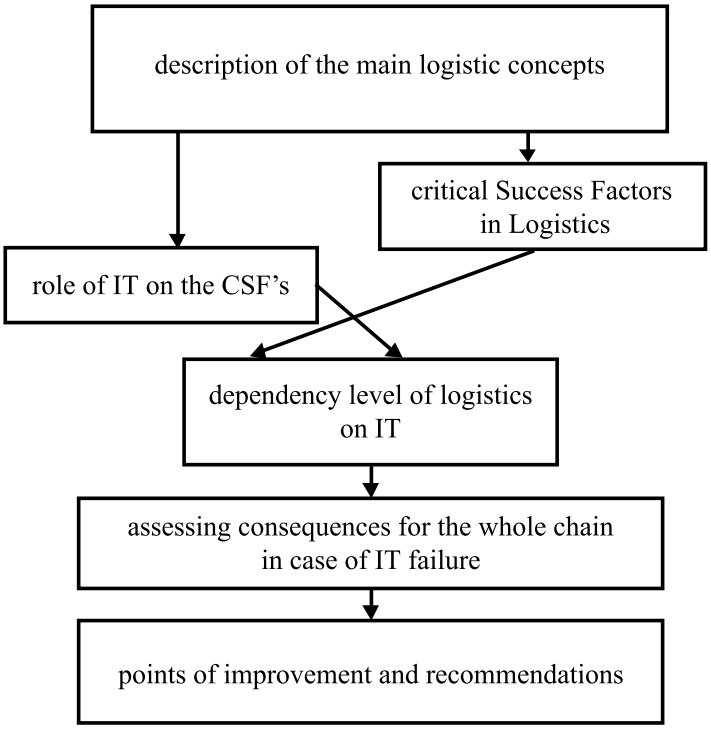


Figure 1.1 The research framework

Compiled information is mainly based on literature reviews and scientific articles. Both were extracted in several research fields such as Logistics, Supply-Chain Management, New technologies and Marketing.

Backstopping activities were conducted by LEI researchers experienced in the considered field to ensure consistency and coherence of the output.

1.5 Impact

This project extends the central discussion on logistics. Content and recommendations of this research will constitute an interesting basis for next studies.

Furthermore, the results of this research will provide to the professional of the sector a relevant overview of the current business practices in terms of logistics concepts and new developments in the field. Hence, the current project could be extended with eventual presentations to related firms.

1.6 Structure of the report

The first part of the project will aim to give an overview of the new logistics concepts with particular attention to the role of integrated Information Technology (chapter 2-3). Chapter 4 addresses the role of IT in the previous chapters, while chapter 5 discusses the level of dependency of logistics on IT. Consequences for the chain in case of IT failure will be discussed in chapter 6. Finally, points of improvements will be proposed to enhance reliability of supply-chain logistics in chapter 7.

2. Revolutionising logistics

During the last decades, the field of logistics has been confronted with numerous changes. Consumer and market environments have drastically evolved, revolutionising the way of conducting business. Organisations had to reach challenges they were never designed to meet.

2.1 An era of new challenges

Driving forces - such as consumers, competition, and new technologies - have changed the face of the economy, introducing a new environment, keener and selective.

Needs of the consumers have changed. Demographic developments, emergence of global marketing strategies, rapid dissemination of information through media, and government, have strongly influenced international consumer behaviour so that nowadays, firms have to deal with a capricious, impulsive, powerful and unpredictable consumer.
E.M Steenkamp (1997) has identified eight general major trends in international food consumer behaviour. They are not exhaustive but give a good overview of what faces agribusiness today. One trend is that a number of consumers gradually move from the quality/price ratio to the *shopping/enjoyment* ratio. Consumers seek to economise as much as possible on products that are less important to them, in order to allow themselves to enjoy pleasures. Therefore the demand for gourmet, exotic and ethnic food is increasing as well as the success of store brands. Another trend is the growing *fragmentation of the market*. Because in today's society everyone wants to distinguish himself from others, consumer variety and demand for a wide range of products have altered the clear-cut socio-demographic segmentation schemes. A third trend is growing *time-pressure***,** which obviously stimulates demand for convenience and already-made products. Related to this is also the increase of *female employment*. A fifth trend is the growing *health concerns*. Because of a lack of physical exercise, a life full of stress and time pressure, and the rapid ageing of the population, consumption of healthy products, such as low-calorie, light and 'natural' products has grown. A sixth trend is growing *environmental and ethical concerns*. Products that are harmful to the environment or are produced in an environmentally unfriendly way are encountering growing consumer resistance. Moreover, ethical issues related to production process, such as animal welfare, children labour, become more important. Another trend highlighted by Steenkamp is the shift away from home consumption to *food-away-from-home consumption*. The rapid emergence and acceptance of *Information Technology*, not only in the marketing channel, but also in the homes of consumers, is according Steenkamp also a trend in consumer behaviour. Virtual shopping is growing fast.

The increase of competition, the globalisation of the world market and technology enhancements have also contributed to the business revolution of the last decades.

Business competition is bigger, keener and more demanding than it has ever been. Getting and staying ahead of your competitors is today firms' main objectives. To compete in the

current world economy, business must develop and implement strategies to differentiate themselves from local and overseas competitors. Therefore, managers began to look to logistics systems as a potential source of competitive advantage. For example, product availability, timeliness and consistency of delivery, ease of placing orders and other elements of customer service can create customer extra-value.

The globalisation of the world market has become a major issue in business. Companies are examining the concept of global manufacturing more closely than ever. Products or parts are produced at different locations and shipped wherever a market exists. Such global strategy requires a 'world logistics system', in which responsibilities of a particular production location are determined by existing conditions, and centralised planning keeps company operations in line with overall goals.

> 'Boundaryless behaviour leads for example a medical business based in Milwaukee to empower a Swedish manager in Asia to use Japanese associate to make diagnostic equipment with component sourced from India and China for sale in Europe.'
>
> Source: Arthur D:Little International, Inc, 1998.

Forced to search globally for opportunities and resources, and focus in the mean time on core competencies, enterprises are rushed to outsource those activities that can be performed more quickly and at a lower costs by sub-contractors. Outsourcing logistics activities to third party providers is a growing trend in business logistics, addressing new relational and organisational issues to top-executives.

As business enterprises extend their boundaries and markets, they establish new alliances and partnerships with enterprises within and without chain. Networks become bigger and complex to maintain close links in every corner of the world in which they do business.

New technologies have during the past decade extremely evolved and clearly brilliant progresses have occurred in the way to communicate. Electronic transmissions, Internet, powerful processors, portable phone are concrete examples of today's means. These new technologies offer a broad span of opportunities from which the field of logistics could advantageously benefit. With timely connection between partners, scanners and barcodes, products and information flow much quicker along the chain. Planning and ordering becomes automated and replenishment automated and precise. These new technologies represent a real potential of development for business logistics.

Driven by factors as new consumer requirements, strong competition, globalisation of the world market, progress in new technologies, an era of new challenges is appeared, changing drastically the way to do business (figure 2.1).

2.2 Translation into business logistics

New market requirements have introduced new challenges to logistics performance. In a wide range of industries, product life cycles are shrinking -life cycles have declined over the last decade from years to month for certain products-. Companies have to face high frequency of new product introductions. As more and more product-line variety is needed to satisfy the

growing range of customer requirements, stock levels and inventory costs inevitably rise. The balance of power in the distribution chain is shifting from manufacturers to the trade. Since retailers can switch from one brand to another with ease, they have been able to cut their stock levels, place small orders, and demand speedy delivery. Many companies are restructuring their production facilities on a global basis.

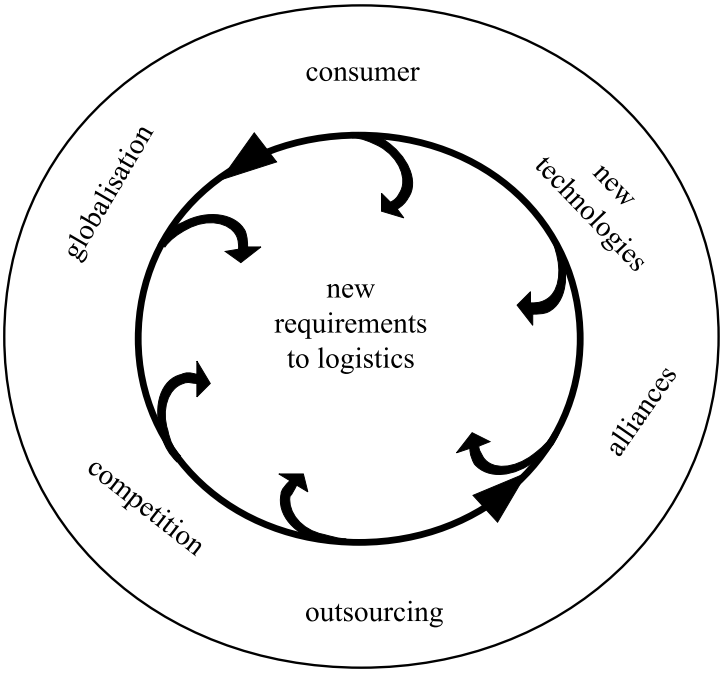


Figure 2.1 Driving logistics factors, Deneux, 2000

The ascension to shorter lead-time, larger assortment, global sourcing, higher responsiveness, flexibility, more frequency delivery has forced the logistics fields to find new solution in terms of concepts and organisation. Old concepts with infrequent store deliveries, a push-driven flow of goods with long lead times, high stock levels at several places in the supply chain are no longer sufficient.

2.3 Accepting the challenge

Driven by new challenges, the field of logistics had to introduce innovative concepts to cope with today's business environment (see figure 2.2).

The whole logistics function related to inventory management, transportation service, procurement, materials handling, inbound transportation, transportation operations management, warehousing management, customer service, order processing, logistics budget planning had to be reviewed.

Modern logistics concepts such as Cross Docking, Just in Time (JIT), Quick Response, Continual Replenishment, Bar Coding, Electronic Data Interchange (EDI), Enterprise Re-

source Planning (ERP), Efficient Consumer response (ECR), Vendor Managed Inventory (VMI) seek to enhance business logistics activities, in order to cope with a new environment.

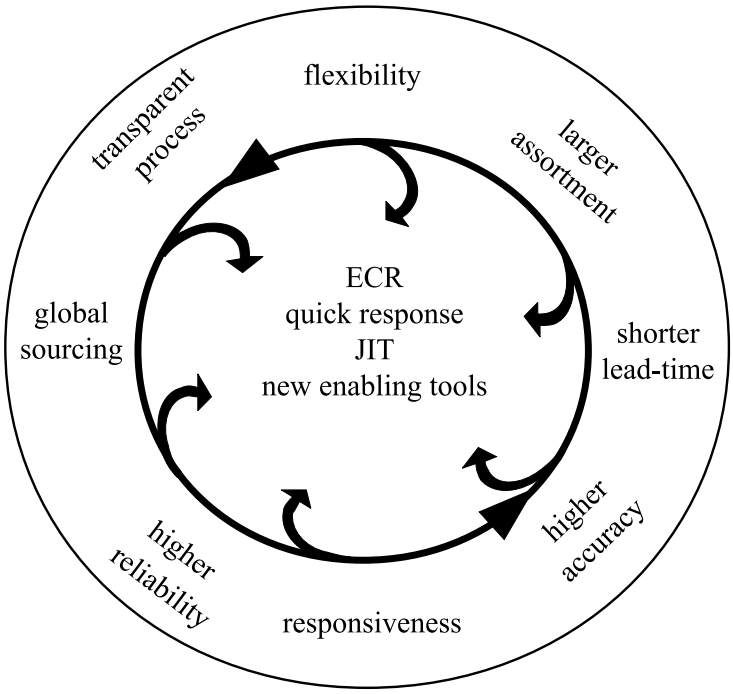


Figure 2.2 Birth of new logistics concepts, Deneux, 2000

2.4 Conclusion

A growing number of markets have seen the power of consumers continuously increased. Agribusiness companies have switched from the product-oriented approach to a consumer-oriented approach, removing 'cost minimisation and economies of scale' to 'identifying and meeting the needs of consumers'.

In the mean time, competition has increased, putting organisations under oppressive pressure. Organisations had to think afresh their organisation to adapt themselves to new consumer requirements. Consecutively, the field of logistics has introduced new concepts to serve the consumer as a 'king'.

3. New logistics concepts

In the world of logistics, ten years ago, the mission was clear: balancing inventories between both production capacity and the demands of customer service. Now all that has changed. The job of the logistics manager has begun to have an increasing significance for overall corporate performance. Over the last few years, perceptions about materials management have undergone a fundamental shift. The logistics concept has evolved to lead to today's contemporary physical distribution and logistics.

3.1 The evolution of the logistics concept

The 'logistics concept' has undergone many significant changes over the past decades and the term logistics in today's business vocabulary refers to a broad span of activities.

The significant changes can be divided in several important historical stages (as described by Langley, 86).

3.1.1 Past logistics

In the post-war years, product proliferation and scrambled merchandising forced the need for managers to look for new ways to help control distribution costs. The greatest challenge of this era was to gain top management awareness of the concept of physical distribution.

The 20-year leading up to the present was one of the most exciting and intense eras in the history of logistics and physical distribution. An integration of physical distribution and materials management took place. The need to co-ordinate both the inbound and the outbound movements of product and information was recognised. An emphasis on customer service also occurred. Logistics systems became more integrated toward development of partnership, arrangements with vendors, customers, and external third parties. More and more firms adopted a 'total channel' perspective on their business, and developed linkages with vendors and customers in an effort to make more 'win-win relationship[1]' (logistical decisions that benefit to both parties).

3.1.2 Today's logistics

Today's definition of logistics is given by the Council of Logistics Management.[2]

[1] ' Logistical decisions that benefit to both parties (see page 15).

[2] The Council of Logistics Management is the pre-eminent professional association of logistics personnel. It is primarily interested in furthering the understanding and development of logistics concepts and practices. It does this by providing a continuing program of formal activities, research, and informal discussions designed to develop the theory and understanding of the logistics process, promote the art and science of managing logistics systems, and foster professional dialogue and development about the profession.

'The process of planning, implementing, and controlling the efficient, flow and storage of goods, services, and related information from a point-of-origin to point-of-consumption for the purpose of conforming to customer requirements'

Definition of logistics, 1991, Council Logistics Management

This definition actually represents a revision of the Council's definition of logistics as approved by its executive committee in July 1991. It should be noted that the current definition specifically acknowledges the importance of 'services' to the logistics process, as well as product and information.

The logistics concept as defined in the Council's definition of logistics has several unique characteristics. First, it is extending from the original source of raw materials to the location of the final customer. In fact, the logistics process spans organisational boundaries in terms of encompassing industry-wide channels of supply and distribution. The second characteristic is that it pertains to the flows of both product and information and considers each as essential to the value-creating process. This acknowledges the critical role of logistics in the overall area of information processing and management. Third, logistics represents a viable means to satisfy and create value for the external customer(s) of the firm and/or the channel of distribution. It is this dimension that truly justifies the recent attention directed toward the new role of logistics management.

As shown by a study based on 100 American companies, today's logistics underlies broad activities. Table 3.1 shows the results of this study. Of particular note is that logistics activities converge around the 'move-store' functions of transportation, inventory and warehousing.

Table 3.1 Underlying logistics activities, 1987, CLM b)

Activities	Percentage a)
Outbound traffic	93
Finished goods warehousing	84
Inbound traffic	90
Plant Warehousing	73
Finished goods inventory management	68
Proprietary transportation	75
Customer service	64
Order processing	65
Purchasing	52
Production planning	50
Raw material in-process inventory management	36
Packaging	40
Sales forecasting	41

a) Percentages indicate the proportion of study respondents who included each activity in their firms' logistic functions; b) Council of Logistics Management.

Recently, however, there have been noticeable trends toward the greater involvement of logistics in the areas of production scheduling (evidencing a broader 'move-make-store' orientation), order processing and purchasing. Finally, as evidenced by the attention being directed to the area of customer service, it is clear that logistics is being recognised more and more as an essential element in the overall process of creating customer value.

3.1.3 Trends in Logistics

The first, and perhaps most significant trend, is the growing recognition of logistics as a middle of creating customer value. There are an increasing number of initiatives being taken by business firms to capitalise on the customer value created by logistics. Industries where considerable progress has been made include food and agri-products, chemicals, and pharmaceuticals.

A second observation is that firms are directing greater resources toward logistics and that the senior logistics executive is becoming more visible and involved on a firm-wide basis.

Third, considerable attention has been directed toward the integrative aspects of logistics with other business functions. Nowadays, it is become difficult to bound the field of logistics from other fields such as marketing or management, as they are deeply related.

The logistics concept has encompassed other business activities as it has evolved so that today's logistics managers work closely and consistently with their counterparts in such areas as marketing, manufacturing, finance and general management, as shown in figure 3.1.

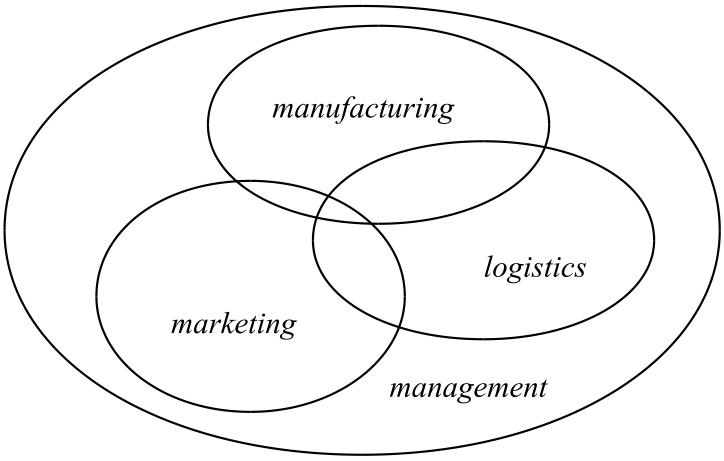


Figure 3.1 Interrelation of logistics and business functions adapted by Deneux, 2000

A fourth emerging trend is the development of partnership arrangements with suppliers, customers, other channel members and external third parties in the interest of achieving desired results in logistics. For instance, distribution centres were self-administrated in the past. Chain unity removed this individualisation to create centralised distribution centre per chain. A 'joint DC'[1] can handle different product and/or form various producers. Costs are then

[1] See logistics glossary.

minimised by economy of scale. It is also possible to let such large 'joint DC' under the control of specialised logistics companies ('Third-party logistics') which take care of the organisation and the management of such activities. Other companies can then focus on their own core business.

It is become apparent that a 'holistic' view must be adopted, one where the 'win-win' paradigm is recognised as being valid.

3.2 New concepts

During the last decades, numerous significant concepts have been introduced in the field of Logistics. Such concepts as Quick-Response, Just In Time, Efficient Consumer Response were introduced to respond to the challenging environment. They brought new ways of doing logistics.

3.2.1 Eliminating waste with Just in time (JIT)

Just in time, also called zero inventory and Kanban[1], is a concept of great importance to logistics and manufacturing. It was born in Japan, but the exact place of birth is up for speculation. Combination of ideas of Taiichi Ohno, his subordinates, and workers of TOYOTA produced the TOYOTA Production System of which JIT is the overriding process.

JIT is a company-wide philosophy, or culture, oriented towards the elimination of waste throughout the entire logistics and manufacturing functions. The concept of Just in time is simple: materials and components should be delivered to the next stage of manufacture just before they are to be processed and in only the quantity that will be used.

> ' Produce only necessary items in a necessary quantity at a necessary time'.
>
> TOYOTA's definition of JIT

Just in time is symbolised by low inventories and the highest levels of quality and customer service. The often-cited metaphor described JIT inventory as a river[2]. When the water is high, all the rocks are hidden. Rocks are only visible when the level of the water is low. Inventory similarly hides manufacturing problems. These problems become more visible when inventory is drained. In practice, Just in Time emphasises that any inventory that is not need immediately is waste, covering up possible problems in production. Fewer inventories results in less time in manufacturing, increases manufacturing flexibility and improves quality because less inventory allows problems to be identified faster and closer to the source of the problem.

In logistics, JIT creates totally new relationships with both vendors and carriers. It removes the traditional PUSH system to a PULL system, as shown in figure 3.2. Pushing system is the process of making schedules for production that may or not be feasible and then trying to 'push' (i.e., expedite, split orders, etcetera) the orders through the shop to meet the system specified due date.

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[1] See logistics glossary

[2] This metaphor was introduced by to illustrate the JIT concept.

JIT systems are pull systems in which a given level is produced only upon request from a higher level, so that inventory is pulled through the system. This process reduced the probability of producing either too many items or producing items for which there was no current demand.

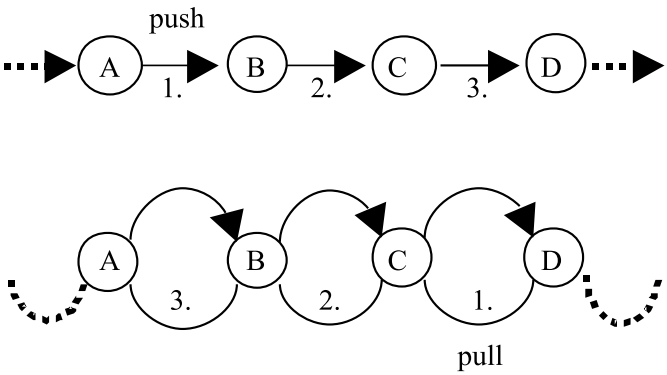

Figure 3.2 Push and pull systems, Deneux, 2000

Communication is essential for such systems. Consequently, Taiichi Ohno introduced the kanban card. It issued kanbans to its supplying work centres only for items it needed. Likewise, the supplying work centres issued kanbans to their supplying work centres only for the items they needed. Nowadays, new technologies replaced kanban's card and EDI system provides direct communication between computers of suppliers and customers for orders, production scheduling and purchasing.

Just in time principles look to internal process and immediate suppliers. Benefits from this concept mainly are inventory reduction, production process and management in general.

Based on JIT ideas but extended to the total supply chain, a new concept was developed, so-called Quick response.

3.2.2 Responsive chain with Quick-Response

The term Quick-Response concept is widely used in both Europe and the United States and refers to a system of communication and co-ordination through an entire supply-chain.

In the traditional approach of retail/supply relationship, the two parties are in conflict, competing for their own divergent interest. What one wins is what the other looses. Therefore, both retailer and supplier seek to increase their own power in order to get the biggest piece possible of the pie. Quick Response and Total Supply-Chain approaches consider supplier and retailer as partners of a same chain. Serving the consumer is the mutual interest of each partners of the chain. In this case there are large possibilities for both parties to benefit of the others (win-win) and increase this way its gain.

The two approaches are represented in figure 3.3. The situation where retailer and suppliers are competing with each other to get itself the biggest profit (to the detriment of the other) can be illustrated as 'pie-sharing'. The situation where retailer and supplier are co-operating to optimise the chain competitiveness can be illustrating as 'pie-growing'.

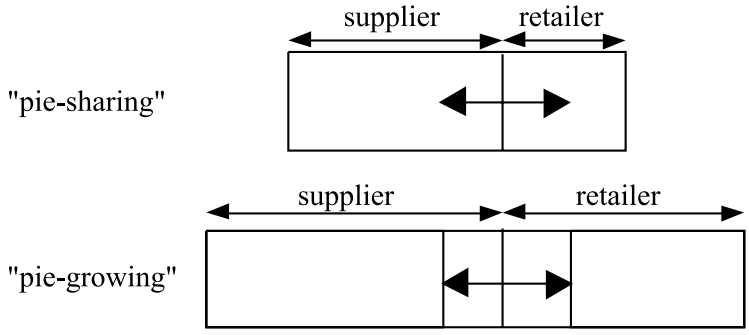

Figure 3.3 'pie-sharing' versus 'pie-growing', Veen, Robben

The underlying concept between Quick Response is that each link in the chain shares information about forecasts, sales, orders, production plans and inventories with others. Retailers transmit information about sales forecasts and actual sales, not only to distributors but also to manufacturers, who themselves are linked to suppliers of raw materials and components (see figure 3.4 below).

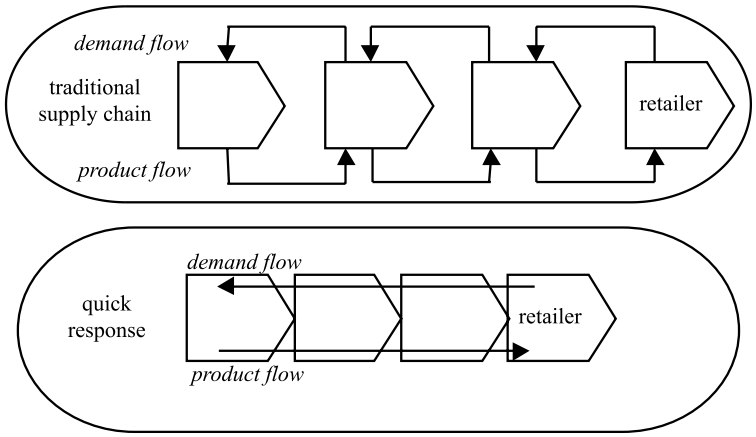

Figure 3.4 Responsive chain with Quick Response concept, adapted from FMI, 1993

To communicate through this entire supply chain, Quick Response systems utilise a combination of standard electronic data interchange messages and bar codes.

The main logistical objectives of Quick response are to reduce inventory, to increase service levels and to make the industry more responsive.

3.2.3 ECR and Efficient Replenishment

Quick response and Effective Customer Response are often used interchangeably, although there are differences in origin and application. Effective Customer Response (ECR) embraces the information characteristics of Quick-Response, but it also describes structural changes in the physical flow, such as cross docking.

The term 'Efficient Consumer Response' has been originally introduced in 1993 by the American Consulting bureau 'Kurt Salmon Associates' (KSA). It was introduced as a concept to strengthen the competitiveness of the American supermarket branch. The original definition of ECR has been formulated this way:

> 'ECR is a grocery industry strategy in which distributors, suppliers and brokers jointly commit to work closely together to bring greater value to the grocery consumer. This greater value is created by better products, better assortments, better in stock service, better convenience and better prices delivered through a leaner, faster, more responsive and less costly supply chain.'[1]

This definition has evolved with the years but the original idea of the concept is remained the same. The purpose of ECR is to increase the efficiency and effectiveness of the entire food chain by the integration of marketing and logistics decisions and optimal coordination between the different links throughout the chain. The ultimate goal is to maximise customer satisfaction by a maximally performing chain (Corstjens, Buxbaum, 1995).

The ECR concept can be divided into four main fields: Efficient replenishment, Category Management, Efficient promotion, and Efficient Product Introduction. We elaborate on the first element here[2].

The function of Efficient Replenishment is to *'Get the right product, at the right place, at the right time, with the just quantity, at minimal cost'*. Efficient Replenishment is defined as a value adding concept whereby the actors (producers, retailers) are working together in order to fulfil the uncertain actual consumer demand.

This is accomplished by more frequent and smaller deliveries between the trading partners, based on actual and forecasted consumer demand. By a continuous free flow of accurate, transparent and timely information, the trading partners are able to react quickly on the actual demand (see figure 3.5).

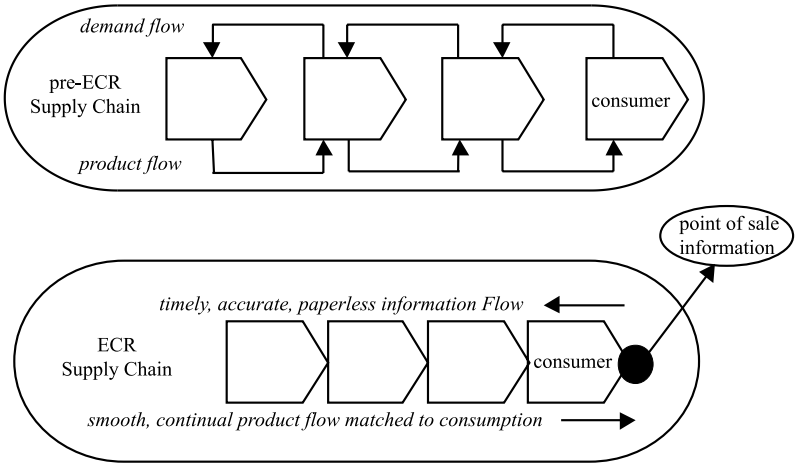

Figure 3.5 A new chain design, FMI, 1993

[1] ECR's definition (Source: KSA, 1993).

[2] Efficient Replenishment contains the essential logistics transformation proposed by the ECR concept. Other functions are more related with Channel Marketing concepts. Therefore, we have opted to highlight only the Efficient Replenishment field.

The POS' scanners (Point of sale) is the starting point of the Efficient Replenishment. Products are reordered at the moment consumers take them out of the shop via the scanned desk office. Direct information flow conducts day-to-day sales' results directly to suppliers' computers. According to these data and computer forecast frequent and small delivery matching with retail's day to day's needs will be made directly (see figure 3.6).

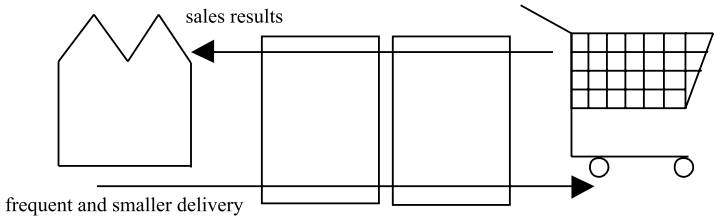

Figure 3.6 Efficient replenishment, Deneux, 2000

The main logistical objectives of Efficient Replenishment are 1) to meet required service level in order to minimise out of stock in the retail stores; 2) to lower stock levels; 3) to ensure freshness, quality and long shelf life of the products for the consumer; and 4) to reduce the logistical costs.

3.2.4 Conclusions

Quick response/ECR is an extension of Just-in-Time principles to the total supply-chain. Whereas just-in-time looks primarily inward to internal process and secondarily to immediate suppliers, Quick response/ECR is an effort to manage the supply-chain as a unit, evaluating the effects on other chain members.

Main characteristics of each concept are reviewed in table 3.2.

Table 3.2 Main logistics concepts

Concepts	*Principles*	*Benefits*	*Supported sub-concepts*
Just-in-Time	'Produce only necessary items in a necessary quantity at a necessary time.'	- Inventory reduction - Production process - Management in general	EDI
Quick Response	'Smaller order sizes with frequent deliveries.'	- Inventory reduction - Increase service levels - Make the industry more responsive	EDI Bar coding Scanning systems Total Supply Chain
Efficient Customer Response	'Get the right product at the right place at the right time with the just quantity, at minimal cost.'	- Meet required service level - Minimise out of stock in the retail stores - Lower stock levels - Ensure freshness, quality en long shelf life of the products for the consumer - Reduce the logistical costs	EDI Bar coding POS Scanners Cross Docking Computer Assisted Ordering Vendor Managed Inventory Total Supply Chain

3.3 Enabling tools

Logistics concepts rely on underlying sub-systems, which contribute in a crucial measure to the success of the operations. EDI, Bar-coding, Cross Docking, participate actively to the achievement of the logistics function. A description of the main 'enabling tools' is proposed[1]. in the field of business logistics.

3.3.1 Inventory control

AUTOMATED REPLENISHMENT WITH VENDOR MANAGED INVENTORY

Vendor Managed Inventory (VMI) plays an important role in the Efficient Replenishment schema of supply chain logistics. VMI predicts customers' orders on a daily basis, so that store inventories can be minimised. Since there is no manual data entry, the electronic systems also minimise clerical errors.

VMI system involves a supplier and its retailers. Data from the Point of Sale (POS) scanners are once a day downloaded to the supplier in-house computer. This computer has already the inventories for each store and it deducts the sales for that day to come up with inventory remaining at each store. It then takes into account an extensive list of factors to come up with the products to be delivered to the stores. In addition to products that have been sold, factors to be considered include sales history for that particular day, week and month, weather, store promotions and others. Stores conduct once a physical inventory of their stores once a week to reconcile the scanner data with actual consumption. Scanners only count what's sold and not products that is spilled or used in the in-store restaurant or inter-store transfers (see figure 3.7).

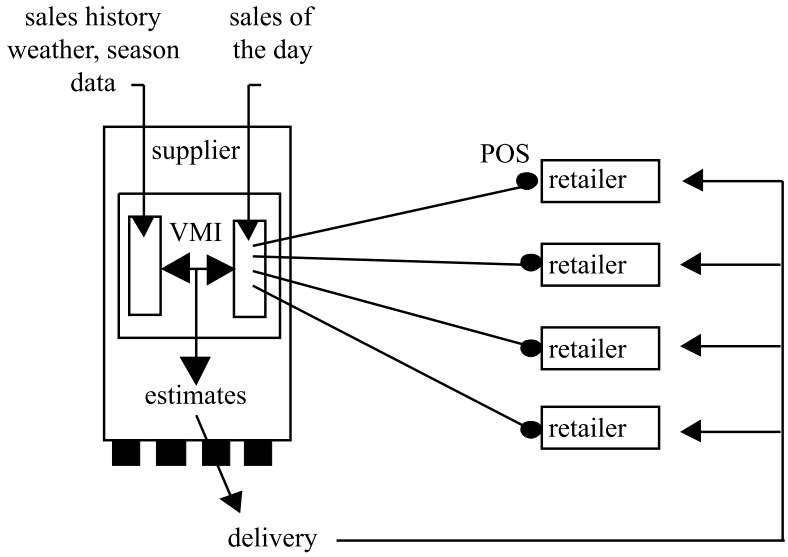

Figure 3.7 Vendor Managed Inventory system

[1] The list is not exhaustive but only seeks to overview new logistics technologies.

VMI reverses the normal trading relationship. Instead of the retailer managing its own stock and deciding when and how much more to buy, the supplier does it.

COMPUTER ASSISTED ORDERING (CAO)

Computer Assisted Ordering is a distributor system, which generates automatically a replenishment order when sales to the consumer reach a predetermined inventory level.

3.3.2 Warehousing

TRANSHIPMENT OR CROSS DOCKING

Cross Docking is an adaptation of Cycle Time Compression (La Londe and Masters, 1994). Cross-docking model illustrates a transfer of goods from one means of transport to another, during the course of one transport operation (transhipment), as shown in figure 3.8.

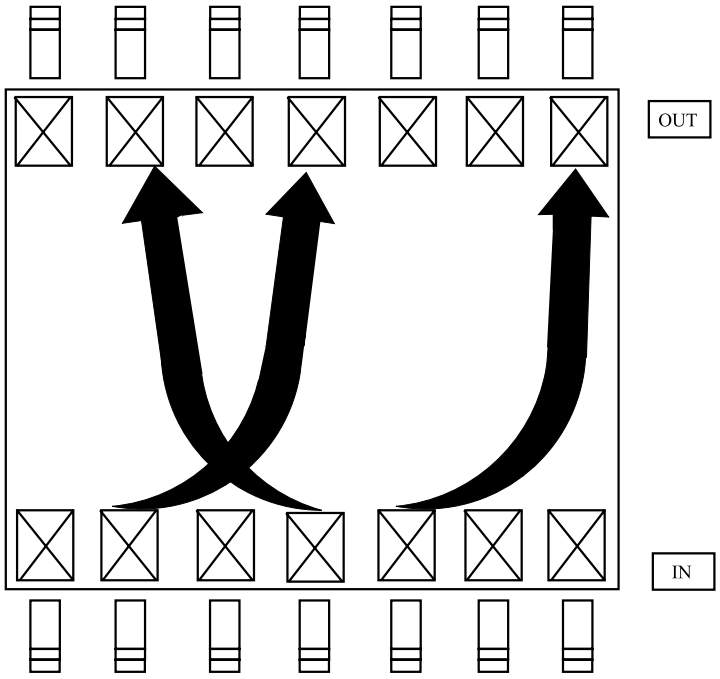

Figure 3.8 The Cross-docking model, Demsey

There are essentially three methods of cross docking. 1) The first- manufacturing cross docking- involves moving finished goods immediately from a production line into the back of a waiting truck for delivery. A variant of this occurs when products are manufactured, then staged- without going into storage- for later shipment. 2) The second cross docking method- distribution centre cross docking- has two variants. Current/active cross docking occurs when product from a receiving truck is dispatched immediately to another truck. Current/same day means that product is staged or held in a conveyor for re-lease later the same day. 3) The third

method-terminal cross docking- occurs where products are shipped from various distribution centres to a mixing terminal where it received combined and shipped to the customer.

Information systems are crucial to a successful operation. Cross docking generally requires fully integrated warehouse management systems, including bar-code technology, radio frequency (RF), advance shipping notification, along with EDI, to ensure that there is a full exchange of information along the entire supply chain purchasing to final sale. With appropriate information systems, cross docking operations can handle extremely large volumes of product in a relatively short space of time.

Cross Docking allows distribution centres to concentrate on flow of goods rather than storage.

3.3.3 Transportation

INTERMODAL TRANSPORTATION

Intermodal transportation characterises the aggregation of the various modes of transport to fulfil delivery of goods. Goods convey via a combination of at least two transport modes within the same transport chain, during which there is no change in the container used for transport and in which the major part of the journey is by rail, inland waterway or by sea, whereas the initial and final part of the journey is by road and is as short as possible.

The most common form of intermodal transport is unaccompanied railway transport. The long distance is covered by rail, whereas the distribution from the terminal to the final destination takes place by road.

This new concept in transportation has been increasing the recent years. It is characteristics in a large proportion of international traffic as carriers recognise its various advantages:

- door-to-door service;
- forwarding speed and flexibility;
- reliability and quality;
- compliance with regulations and environmental concerns logistics services.

However, to benefit of intermodal transport advantages, special criteria must be respected. Indeed, intermodal transport is appropriated to long distance transport, large goods and it requires an well-organised structure. In such conditions, intermodal transportation embodies the strategic function of low cost service creation, timely and flexible product delivery.

While offering transit times and equipment similar to road transport in terms of the equipment provided and transit times, intermodal freight transport brings substantial extra advantages such as reliability, added safety and punctuality.

GLOBAL POSITIONING SYSTEM-GPS

Global Positioning Systems (GPS) use satellites to track in real time the location of vehicles or equipment. The technology was developed by the US Department of Defense as a worldwide navigation and positioning resource for military and civilian use. Today its benefits are enjoyed by shipping companies, aircraft operators, trucking companies and others in freight and passenger transportation.

GPS is based on a constellation of 24 satellites orbiting the earth over twenty thousand kilometres high. These satellites act as reference points so that air, water and ground vehicles can 'triangulate' their position. DGPS (Differential GPS) is a further refinement on GPS, and enables greater location accuracy, up to +/- 10 m. It achieves this by filtering out the natural and man-made errors that creep into normal GPS measurements. DGPS receivers on board aircraft, boats, truck, survey vessels, etcetera enable operators to pinpoint their location very accurately.

3.3.4 Information logistics

COMMUNICATING WITH EDI

There are many definitions of electronic data interchange. One is typical:

> 'Electronic data interchange (EDI) is the exchange of business information electronically between business partners, intermediaries, public authorities, and others in a structured format, without any need for human interpretation or retyping'
>
> A definition of EDI, Bellago, 1991

EDI stresses data transmission across organisational boundaries between computer systems. It allows the exchange of standards documents from an interface to another with a minimum of manual intervention. It is now routinely used for transmission of transaction data including purchasing orders, invoices, shipping documents and information for monitoring the progress of orders.

There are two categories of applications: 1) General application, which are related to general business transactions such as purchase orders, invoices, waybills, customs entry and similar documents, and 2) specific applications, which are developed to meet one designated need such as the individual requirements of major customers. Both categories of applications require a communication standard, specifying the data transfer requirements between computers; a transaction message standard, which designates a uniform way to present data in a transaction; and translation software programs that convert message data for internal use or vice versa (figure 3.9).

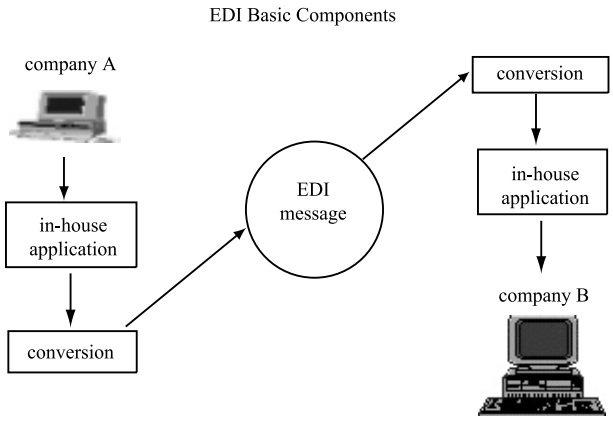

Figure 3.9 An EDI system

EDI helps reduce the amount of paper work required, the number of errors associated with manual transactions and the incremental cost of transaction. It increases the speed of communication and real time interaction between business partners. EDI enables short lead times, and allows more accurate and frequent ordering. In a broader perspective, EDI can be used in the creation of product databases, allowing buyers to find new products and new suppliers. Flexibility of such system is of course not maximal.

EDI enables shippers, carriers, and related parties to communicate efficiently via an electronic medium, enabling the operation of a seamless transportation system.

> 'In the past it took an average of 40 minutes and up to four people to process a single order. Now, with EDI, one person spends two minutes or less per order. Eliminating the manual processing of an order increases the quality and accuracy of that order when it hits our system.'
>
> (Debbie Bower, EDI coordinator at Dot Foods)

PRODUCT INFORMATION WITH PDI

PDI is derived from the EDI concept and focus on information exchange of product. PDI (Product Data Interchange) is a system that enables information about product to be at any moment consulted by any of the partners of the chain. Therefore retailers can check in the central database at which stage of process is the product they ordered, and the other way around, manufacturers can ensure whether its product is sold or not. Figure 3.10 proposes an illustration of the PDI system.

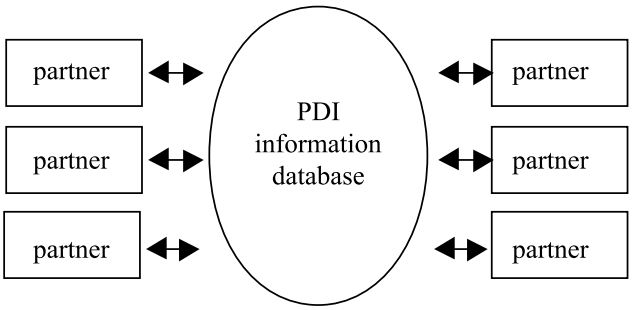

Figure 3.10 PDI-configuration, van Dorp, Jahae, Beers, 1996

This type of system offers interesting possibilities for tracking and tracing to the fields of logistics.

BAR-CODING

Bar coding extends tracking and tracing possibilities of products. From initial receipt to the warehouse through storage and picking to final delivery to a customer, products can be easily identified, controlled, counted or traced. It allows information to be captured immediately once the product is scanned, eliminating the need to manually read and key the information

into your systems. This information is not limited to just the identification of the product, but can include additional attributes of that product that are needed for a handler of that product. This is beneficial for members throughout the supply chain that physically handle the product. It also reduces all the labour associated with manually keying of the information and the time spent on errors caused by miskeying the data. With two-dimensional bar coding, additional data such as warnings, storage details and disposal instructions for medical goods, hazardous waste and perishable products can be hold. This improves the speed of moving goods.

A problem that prevents more widespread use of bar codes in Europe is the lack of a widely implemented coherent article numbering convention. Barcodes are often not unique, and so the same article from different manufacturers may have two different barcodes.

3.3.5 Financial logistics

ELECTRONIC FUND TRANSFER-EFT

Electronic Funds Transfer (EFT) enables the payment for goods or services electronically. With EFT, funds moves between banks and countries safely and securely. Time consuming and wasteful paper documentation is eliminated and the whole transfer process is speeded up.

EFT promotes increased speed of payment and documentation. This reduces administrative costs for all parties. Starting with the paperless invoice, or electronic request for transport services, the EFT process complements and closes the loop for commercial transactions in transportation.

EFT is currently being incorporated into communication via the Internet. While there are current concerns regarding the safety and confidentiality of the transfer process, new security procedures and encryption processes are being developed to fully utilise this communications corridor.

3.3.6 Management

ENTERPRISE RESOURCE PLANNING - ERP

Enterprise Resource Planning, or ERP, is a new business management system, which affects all functions across a company.

ERP attempts to integrate all departments into a single computer system that can serve all those different departments' particular needs. It serves the needs of people in finance as well as it does the people in human resources and in the warehouse. In a traditional approach, each of those departments typically has its own computer system, each optimised for the particular ways that the department does its work. But ERP combines them all together into a single, integrated software program that runs off a single database so that the various departments can more easily share information and communicate with each other.

ERP automates the tasks involved in performing a business process - such as order fulfilment, which involves taking an order from a customer, shipping it and billing for it. Everyone in the company sees the same computer screen and has access to the single database that holds the customer's new order. When one department finishes with the order it is automatically routed via the ERP system to the next department. To find out where the order is at

any point, one need only to log into the ERP system and track it down. ERP can apply that same process to the other major business processes, such as employee benefits or financial reporting.

3.4 Logistics of the future

Voice recognition technology has evolved during the past decade. As the technology becomes more sophisticated, keyboard data entry will be reduced. This will increase the speed and accuracy of electronic communication.

With the advent of bar-coding and point-of-sale information, massive quantities of data are available to customers and carriers. This data is now being warehoused and analysed to identify product flows, trade patterns, container routings, performance analysis, etcetera.

Sophisticated bar coding will enable containers and vehicles to be tracked, not just packages. The key is to develop internationally recognisable bar code standards to facilitate world-wide tracking and tracing. Initial package tracking systems consisted of a simple bar-code containing a waybill number. Recent barcode systems are significantly more sophisticated, and able to convey the weight, number of parcels in the shipment, and other elements of the waybill.

The 'smart stamp' concept is also expected to revolutionise tracking systems. 'Smart stamp' packs some 256 bytes of data, a battery and an antenna into a casing the size of a large postage stamp. Information on each shipment is loaded onto a reusable, affordable stamp, which is attached to the package. The stamp transmits the information, which can be picked by a scanner up to a few meters away. The results are impressive as the high labour cost of package scanning is eliminated and package tracking can truly be considered real-time. The next wave of stamps will likely include a transponder onboard, enabling real-time exact position tracking.

Such new technologies find promising application in logistics systems. Therefore, future logistics is expected to incorporate more automated IT systems.

3.5 Conclusion

The previous chapter outlines briefly the new concepts and underlying 'enabling tools' that appeared in the emerging field of logistics. General principles and main outputs of the particular concepts have been described. Information Technology appears to hold an important place in most current logistics systems. This place has increased along the last decades and is presumed to get even bigger as future technology is able to propose new possibilities.

4. At heart of logistics concepts

In order to assess the real place of IT in logistics concepts, particular emphasis will be given to the core of the particular logistics concepts, seeking to embody the critical success factors related to the concepts. The role of IT on these particular factors will be discussed in chapter 5 in order to gauge the dependency level of IT on the reviewed logistics concepts.

4.1 'Ship one, make one' with Just in time system

As it is suggested, the concept of Just in time focuses on time, and more precisely, time synchronisation in order to achieve the elimination of waste. As stated, materials and components should be delivered to the next stage of manufacture just before they are to be processed. This imposes on different business activities to be correctly synchronised. In other words, JIT success can be stated as ' ship one, make one'.

To enable easy flows of product in a JIT environment, a strict planning must be settled along the different business functions. Therefore, based on the anticipated shipping rate to customers, JIT computes a takt time: the time between completion of each piece. Then one redesigns every operation step so that it takes exactly the takt time. This is done through development of standard work - every aspect of each task is carefully optimised and standardised-. If there is a change in demand, the takt time needs to be redefined and tasks or equipment to be re-optimised. Control process can be simple, such as the Toyota KANBAN[1] (in the 80th), which is literally a card system. When processing of a production quantity begins, a card is returned to the preceding stage, which pulls a replacement unit forward in the production system. The entire system operates in synchronised movement. When such synchronisation of product flow is achieved, the amount of inventory in the system diminished, manufacturing flexibility increased and quality improves because fewer inventories allows problems to be identified faster and closer to the source of the problem. However, JIT introduces strong intra-dependency between lines. The low level of inventory in the system does not allow collapse to be easily buffered. As dependencies among level increase, the tolerance for errors decreases. For example, a manufacturing facility that schedules materials to arrive in Just in time environment may have to shut its assembly line down if weather conditions prevent the materials from arriving on time. On the other hand, the JIT environment normally enables the manufacturer to continuously deliver desired product at lower cost to the consumer, so the advantages outweigh the challenges.

The core of the JIT concept relies on the pertinence of the scheduling of the different activities with each other. Therefore, the computed calculation of the takt time, based on anticipated shipping rate to customers, must cope with the reality of the demand, so that activities can be kept synchronised.

[1] See glossary of logistics terms for complementary information.

4.2 Co-operation in Quick-response system

The Quick-Response system is an enlargement of the JIT concept to the whole supply-chain. It considers the supply chain as a unique unit, in which Quick response systems aim to create a faster and more responsive flow of products.

Therefore, Quick-response systems encourage the shares of information along a chain. Each link in the chain shares information about forecasts, sales, orders, production plans and inventories with others. Retailers communicate information about sales forecasts and actual sales, not only to distributors but also to manufacturers, who themselves are linked to suppliers of raw materials and components. Such exchange of information/data along a chain speeds the product flow, increases responsiveness, and creates transparency within the channel, which in term enables tracking and tracing facilities.

To insure the success of a Quick response system, there needs to be trustful relationships, and therefore a certain level of transparency within each activity performed by the partners. Flows of products, exchanges of information, financial transactions must be kept see-through in order to support trust, commitment and cohesion between partners. The buyer must trust that the information they share with vendors is kept confidential from the marketplace and competitors. If any element of the relationship is missing or breaks down, the Quick-response system can be adversely affected. Improving relationships with supply-chain partners requires the settlement of an efficient communication network. In a QR systems, information flow must be quick and reliable to transmit stock levels and usage rates from the purchaser to the vendor, or to inform the purchaser of shipping schedules, lead times, and quantities shipped. Information exchange is critical to the success of the Quick response concept.

4.3 Maximising customer satisfaction with ECR

ECR is a consumer focused process which starts from the management of consumer demand, working backward through retailers, manufacturers, and suppliers to increase the efficiency and effectiveness of the entire chain. The global purpose of ECR is to serve the consumer better, faster and at even lower cost. In a larger extent, ECR contributes to the maximisation of the chain, and consequently maximise customer satisfaction.

This is accomplished by more frequent and smaller deliveries between the trading partners, based on actual and forecasted consumer demand. Up-to-date and detailed information about customers' purchasing behaviour is hence essential to such systems. Once the information is captured, it needs to be communicated effectively and rapidly within the chain to keep partners connected with the actual demand. By a continuous free flow of accurate, transparent and timely information, the trading partners are able to react quickly on the actual demand. Quality of the information flow constitutes a crucial issue for the success of such systems.

Additionally, transparency along the chain must be kept optimal in order to ensure partner unity.

4.4 Summary

Logistics concepts have been investigated to extract per concept the critical success factors. Table 4.1, below, proposes a summary.

Table 4.1 Critical success factors per logistics concepts

	JIT	*Quick Response*	*ECR*
Critical Success Factors	- Scheduling of the activities - Synchronisation of the activities	- Transparency along the chain - Information flow - Co-operation between partners	- Transparency along the chain - Information flow - Market intelligence - Co-operation between partners

In a global extent, logistics concepts relies on 1) precise scheduling and synchronisation of the activities (JIT), 2) information flow between trading partners (Quick Response and ECR), 3) transparency along the chain (QR, ECR) and 4) constitution of a market intelligence (ECR).

5. What's the role of IT in there?

With regards to the critical success factors previously extracted, the place of IT in logistics is discussed in the following lines in order to derive the dependency of logistics on IT.

5.1 Scheduling and synchronising activities

Progress in information technologies over the last decades has brought new ways to do logistics.

Today, anticipated shipping rates to customers are assessed through automated programs, which integrate a large amount of driving factors. Specialised software's enables takt time to be calculated faster and with more precision than ever before. ERP databases relate planning activities with each other so as continuity and synchronisation within chains and organisations remains. The design of manufacturing lines is optimised by the help of suitable software's which integrates in their computing frame durability and planning of each activity. Scenarios are virtually comparable so those best alternatives in term of efficiency and effectiveness easily are recognisable. Electronic Data Interchange ensures communication and cohesion support. It connects computer and information systems, and thereby shares specific data along several point of a system in real time. Synchronisation of a JIT system can this way be controlled and kept into line, for example.

Clearly, the place of Information technology in logistics planning is become central. Therefore, the settlement of an appropriate IT structure is essential. When the whole structure is in place, planning and scheduling activities are enhanced and enlarged, and synchronisation is maximised so that in term the whole logistics function has been strengthened.

In such infrastructure, technology not only holds data but also contributes in a large measure to the organisational decision process of the entire logistics functions. That is why, maybe, sometimes, experts call those systems: Intelligent Planning systems.

5.2 Enhancing information flow

Information systems are become indispensable as inter- and intra-organisational transactions play a central role in today's economic system. As described in the previous chapter, information flow efficiency is become a critical success factor for most of the logistics systems (such as QR and ECR).

Information technology constitutes the essence of both systems - and information flow in general.

Growing ability to comprehend information technology has lead to drastic progress in term of information system efficiency so that information technology has improved the effi-

ciency of gathering and communicating information inside and across organisations (IOS)[1]. For example, information technology has improved co-ordination at the interface between a customer and its suppliers, creating efficiencies such as better management of inventory levels or improved data exchanged between the organisations involved.

The use of IT in modern information system has results in reduced response time and increased capacity of a communication channel. The first impact comes from the ability of such technology to speed up the information processing required before the system can respond, as well as the ability to set up a connection faster than conventional systems, such the mail or telephone systems. Information not only holds message, but also embraces computer files, data, selling results, shipping rates or digital documents, which in IT system can directly be used once received. The second impact comes from the superior capabilities to transmit large amounts of information with speed and accuracy.

Capacity to communicate has been drastically extended, in terms of speed, quantity and reliability by the integration of IT systems in managing information flow. Today's new technologies enables real time transfer of information, data file, programs, or other digital documents so that communication between distant places can be realised in real time.

The electronic highway achieves better performance than traditional informative methods.

5.3 Enabling transparency along a chain

Transparency along chains has been a growing concern over the last decades, as consumers have asked for more guaranties. These new requirements have conducted the field of logistics to find new ways of handling products, enabling tracking and tracing along the supply-chain.

Bar-coding, positioning systems, satellite-tracking systems are concrete examples of such technological developments.

For example, satellite-tracking systems permit carriers, intermediaries and shippers to know precisely where their goods are physically located, often in real-time and the systems are used extensively in trucking industry. The systems consist of onboard terminals and PC-based communications software.

Bar coding systems offer also interesting perspectives in term of tracking and tracing of products. It is used by most courier companies and LTL carriers. When combined with tracking and positioning systems, it enables containers, packages and shipments to be tracked through the distribution systems. Shipments are scanned when received, delivered, and at key handling points. Data is uploaded on PC, minicomputer or mainframe based systems, which enable shippers to access and/or receive the information via their communication systems. Standard technology includes hand-held reading devices with communications links to central computing systems. Such system enables final product to be traced from the raw material stage.

[1] Intra-organisational systems different departments within a same organisation with each other whether inter-organisational system focus on linkages between partner organisations.

Information technology plays a critical role in enabling such transparency along chain. It permits origin, location and flow of products to be easily traced and/or tracked, so that consumer possesses complete and accurate product information.

5.4 Enabling market intelligence

As described in the previous chapter, the consumer of today's market is impulsive, unexpected. Therefore, it is of critical importance to follow its behaviour in order to satisfy as much as possible its needs. Customer orientation is a new differentiation strategy leading to competitive advantage. For example, ECR concept, which seeks to maximise customer satisfaction by a maximally performing chain, requires such market intelligence, in order to couple demand and supply.

Thereby, new technologies proposed new growing possibilities in the field and numerous automated systems have been introduced over the last decades.

Bar coding in combination with scanners - POS scanners[1]- enables movement of products to be daily followed. Exact amount of a particular product can be computed from the POS scanners, and can be directly transmitted to the supplier database (VMI), speeding the information flow backward in the chain. Suppliers can adjust their supply with daily consumption.

Electronic consumer-cards have been also introduced in most of the retail shops (Cf. Albert Heijn supermarkets in the Netherlands). These cards enable retailers to identify each consumer so that customer purchase can be coupled with an individual name and address. What does he buy, how often, in which quantity can easily be computed out of such cards. For using the card, the consumer is rewarded with small gifts or occasional discounts. Retailer can segment its all clientele into small group type and thereby adjust upon its assortment and advertising campaign.

This essential market information can be coupled with some computerised model enabling forecasts of consumer behaviours and demands. Demand, trends, and tendencies can be then forecasted, providing to firms the basis to be pro-active.

Information technology has provided the means to trace consumer behaviour, so that its action can be understood and forecasted. Information technology holds an essential place in the development of such market intelligence.

5.5 Conclusions: the central place of IT

Communication and information technology is become the heart of logistics. Planning, scheduling and synchronisation of activities is in most organisations controlled by computer programs and specific software packages. Information flows to intra- and inter-organisation through electronic highways such as EDI, intra/internet, and electronic mails. Bar coding, satellites and various other automated systems permit complex supply-chain to be transparent. VMI and electronic cards keep companies in line with customer needs.

[1] POS scanners; Point of sale scanners.

IT's technology not only holds and transmits data but can also exercise routine decision rules. In many today's global supply chain, the product flow is controlled and managed by automated technology.

In such case, reliability of a whole chain flow relies on the operational safety of the underlying IT systems. In other word, logistics process reliability depends on IT performances.

6. In case of IT failure

The whole chain logistics is supported by IT systems and dependency of logistics systems on IT is obvious[1]. In order to assess real risk of such strong IT integration, consequences in case of IT contingency will be here developed. Therefore, an ECR failure scenario has been chosen as relevant case study as it incorporates newest logistics practices.

6.1 An ECR supply-chain scenario

6.1.1 A VMI breakdown in a standard ECR chain

Here we consider a standard ECR chain with VMI, EDI, CRT, as shown in figure 6.1. VMI and retailers scanners capture consumer data and determine new inventory level, which are electronically transmitted to the manufacturer. EDI ensures communication between members of the chain. Products are continually replenished with small and frequent delivery, matching consumer consumption. Cross Docking is used to optimise transport efficiency.

In case of an ECR chain, source of IT failure can be various: deregulation of the POS scanners, breakdown of the EDI system, collapse of the Computer Assisted Ordering, bugs in the software planning programs, or malfunction of the VMI system for example.

How often such failure may occur? This might be difficult to assess, as it is mainly dealing with hazardous prospect. However, overall the literature agrees with one other to mention that IT systems reduce human uncertainty and increase reliability of process. Strong IT integration seems to strengthen logistics concepts as it reduces human mistakes. However, real dangers rely on the low flexibility of such automated chain. Humans are not anymore able to perform the automated function of the IT systems, and, in case of failure, the chain is stuck until the breakdown is repaired. During this time, a large amount of employees are waiting inactive for the system recovery.

6.1.2 A chain reaction

For the scenario, we choose to consider the case of a VMI breakdown, as shown in figure 6.2.

The idea behind is to start from an extreme side of the chain to see how far the failure will be spread backward in the chain.

We consider the case of a breakdown at t+2 and repaired at t+4. Effects in term of product availability are assessed along t in figure 6.3.

[1] See previous chapters.

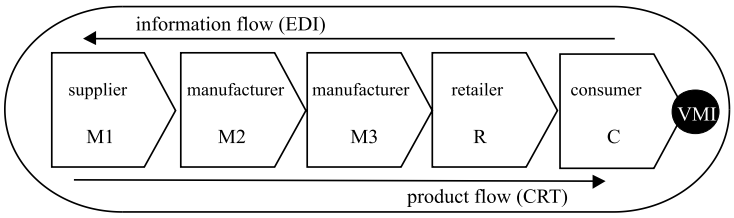

Figure 6.1 A standard ECR chain

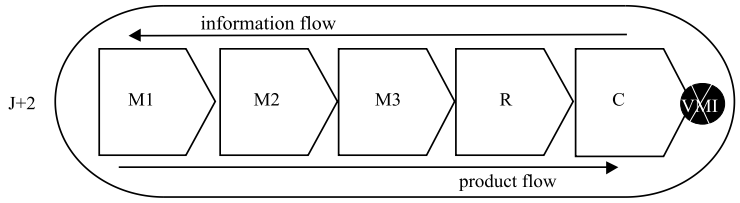

Figure 6.2 A VMI breakdown at t+2

At t+2, the VMI system breaks down. Manufacturer 1 does not get any consumption data on its central computer at t+2. Products to be delivered to the retailer cannot be computed.

In such case, the supplier is unable to manufacture any product at t+3. Consequently, manufacturer 2 does not receive material at t+4. He cannot manufacture any product at t+5, which means that the manufacturer 3 either will not receive material at t+6. Manufacturer 3 is unable to produce any final product. At t +7, retailer shelf can not be replenished. A bit later in the day, the shelf is empty and customers are dissatisfied.

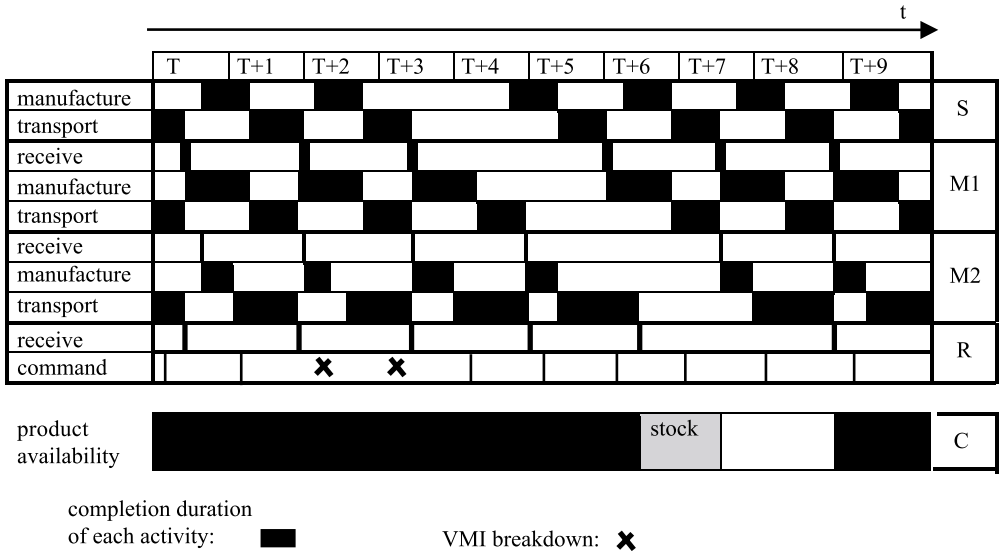

Figure 6.3 Breakdown consequences along t

On the other hand, the VMI is repaired at t+4, which means that M1 can start again its manufacturing line. At t+5, the supplier delivers material to M2, which can restart its manufacturing line. At t+6, products are shipped from M2 to M3. M3 can start again to manufacture final products at t+7. At t+8, the retailer receives the products and later in the day, consumers can find the product on the shelf.

6.1.3 Impact

From a customer point of view, the effect of the VMI breakdown is visible from t+7 to t+8. Between this period, replenishment of the product cannot be achieved and the level of stock available at retailer's level is not enough to be used as buffer. For a period of one day, the shelf is empty. As direct effect, customer satisfaction decreases. Additionally, fidelity of clients may be attenuated and in a larger extent, return rate to the shop may dangerously go down. This logically leads to direct financial shortfall as retailer's turnover is affected.

Other members of the chain are affected as the breakdown spreads progressively in the chain. For a determined period, manufacturers are not producing correctly. Because of the breakdown, manufacturer 1 can not function for a particular period. This timely non-productivity costs also to the manufacturer a certain sum. And the same occurs to each member of the chain. This timely non-productivity costs money, which actually is directly connected to the initial VMI breakdown at retailer's level. Moreover, trust is of critical importance in the success of such chain logistics. Breakdown might affect reliable relationships between partners and thereby reduce chain logistics efficiency. Impact of the breakdown is echoed all along the chain.

In practice, professionals find other alternatives to survive these disasters. In lack of forecasted command, professionals most of the time always turn to former methods, such as repeating delivery of the day/month/year before. These practices off course include a bias and are not completely matching the demand. But, at least, they contribute at avoiding the worst. The backward chain effect is also limited by these practices.

6.2 Conclusions

As firms understood the benefits of chain co-operation in the field of logistics, linkages between chain partners has significantly expanded. However, the current tied chain co-operation due to IT integration puts partners in an interdependency circle, where each actor depends on the other. Information technology represents today the vein of the chain logistics systems as it ensures the linkages along the chain. Therefore, IT failure at one point of the linkage affects the overall chain performance (figure 6.4).

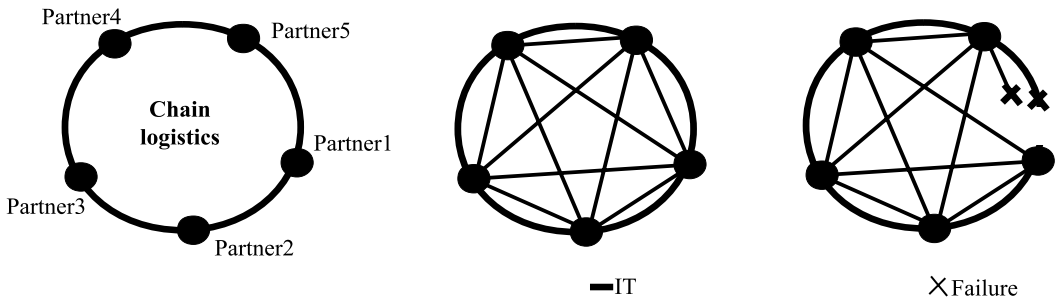

Figure 6.4 IT: the vein of the chain logistics

However, real practices reflect that other alternatives are available to minimise a potential global collapse in case of IT contingency. Such methods are far from optimum and most of the time not compatible with lately new practices. However, they only seek to minimise impact of calamity.

7. Conclusions and recommendations

Mainly based on the available current logistics literature, this paper assesses the dependency level of logistics on IT through an analysis of the new logistics concepts. Global conclusions of this research are summarised in the following lines. Recommendations with regards to the use of IT in logistics are also proposed in order to enhance chain logistics reliability.

7.1 Conclusions

7.1.1 Logistics concepts relies on IT reliability

Logistics concepts have been investigated in order to raise the dependence level of logistics on IT. After a brief description of the concepts, it is clear that IT systems are deeply integrated in today's logistics process. These IT systems not only hold and transmit data but can also exercise routine decisions. Today's situation is so that it is become non-viable to do logistics without IT. IT systems have become the core of logistics concepts.

7.1.2 IT: driver of improvement

The amount of IT systems raise in the field of logistics as managers recognised its benefits. As it is demonstrated in many illustrative examples, IT infrastructure has enabled logistics to be more effective and more efficient.

IT allows documents to be produced and transmitted instantaneously by digital transmission at fractions of their previous costs, reducing international barriers and transit times. Electronic data interchange permits computer and information systems to communicate directly with other computers, strengthening joint operations among organisations. This, in turn, permits closer control over product movement, production scheduling and inventories, leading to stronger and more effective logistics support of global marketing. Bar codes, which began on large scale with grocery products at the retail store, have given management the ability to gain precise control over individual product movements at every step on the path to the final customer.

However, dependency of logistics on IT raises dangerous issues as well.

7.1.3 IT: Introducing risk at chain scale

IT not only supports and changes business operations, it also introduces IT-enabled products and distribution chain and it allows individuals and organisations to work together effectively, while simultaneously weaving in the enabling IT applications and IT infrastructure. In other words, reliability of whole chain logistics relies on the integrated IT systems' reliability. Although IT integration minimises risk of human mistakes, it may be source of possible

technological breakdown. Risk of global chain collapse in case of IT breakdown becomes bigger as IT integration is strong.

Therefore, it is important to seek to minimise these risks in order to enhance chain logistics reliability.

7.2 Recommendations

As extracted from the previous conclusions, while IT is a fantastic motor of improvements in the field of logistics, it also introduces risk of contingency.

Possible ways of minimising this risk are suggested in the following paragraphs.

7.2.1 Improving technological reliability

That is what most of IT organisations tries to fulfil at the moment by continuously developing more reliable product. Progress in this area are quotidian and products always more and more reliable. New securing technologies are developed to protect systems and new products offer constant improvement in terms of capacity, performance and reliability. Moreover, overall costs are decreasing, as new systems become more powerful and adaptable. However, the risk of technological breakdown cannot be completely eliminated, only minimised.

Increasing reliability of supporting information systems encompasses the enhancement of the reliability of the information itself as well. Systems to transmit information should be reliable as well as the transmitted information. Therefore, attention should be given to information acquisition and data management.

7.2.2 Systems' compatibility

Hardware and software systems must be compatible in order to be effective.

There are numerous IT systems (hardware) in the marketplace and compatibility is a major barrier to the effective use of IT. When systems become more compatible in the future, the use of IT will be more effective and reliable.

Another possibility to enhance system's compatibility relies on the development of translating softwares. These programs authorise information to be transmitted from one system to another, even though they are not compatible. The primary information hold by one system can be treated by the software in such way that its language becomes readable by the other system. This type of software extends systems' compatibility and offers interesting perspectives with regards to enhancing logistics.

7.2.3 Better prevent than cure

Many technological sources can create IT breakdown. However in any case, regular verifications of the installations, check-ups and a frequent renewal of the elements will contribute to prevent eventual failure.

Moreover, emphasising secondary systems (back-up systems) may be also a solution to minimise risk of logistics failure. These types of systems fulfil a similar function than the

primary system and are there to relieve primary system in case of breakdowns. These systems are expanded in highly technologically integrated industry.

7.2.4 Needs for IT strategy

IT encourages supply chain to work together as it provides the source of linkages between partners. IT, hence, associates people, creates links, but also modify drastically the way of doing business and particularly the way of doing logistics. In fact, IT, and the way it is used, contribute in the overall strategy of a firm, as shown in figure 7.1.

Therefore, IT installation should be thought afresh strategically, taking into account the context of application (use, function, frequency, implementation…).

A well defined IT strategy will match business strategy and IT investments, minimising at the mean time IT contingency risk.

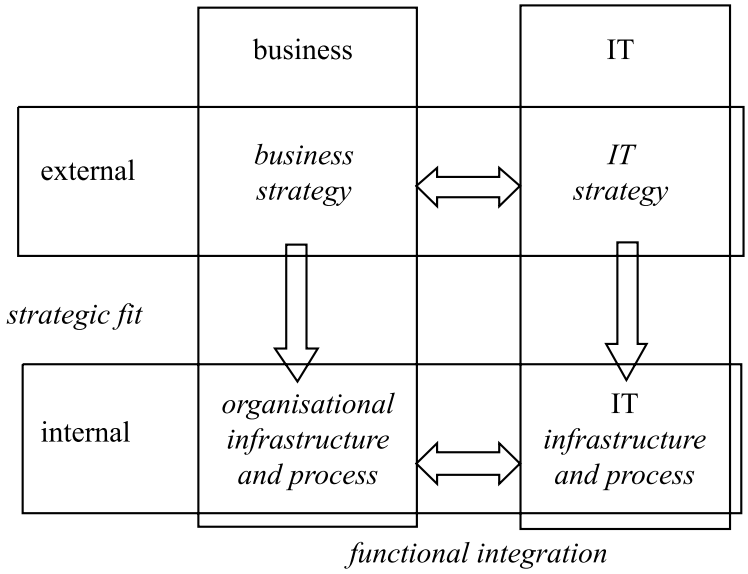

Figure 7.1 Strategic Alignement Model, Henderson & Venkatraman, 1993

7.3 Further research

This study focused on the importance of IT for logistics concepts and addresses recommendations to minimise risk of contingency. This work forms an interested basis for further research in the field. Other studies could discuss the importance of IT for all business functions. Issues as economic benefits of IT, IT and firm strategy, impact of IT on supply chain management, or IT as competitive advantage will be interesting follow-ups for this study.

Glossary of Logistics Terms

Business Logistics: The process of planning, implementing, and controlling the efficient, flow and storage of goods, services, and related information from a point-of-origin to point-of-consumption for the purpose of conforming to customer requirements.

Computer Assisted Ordering (CAO): It is a distributor system, which generates automatically a replenishment order when sales to the consumer reach a predetermined inventory level.

Continuous Replenishment: The inventory of the different actors of the supply chain is managed by more frequent and smaller deliveries, based on actual sales and forecasted demand

Cross Docking: Eliminating storing products at the (retailer) distribution centre by transferring, re-consolidating and distributing products directly to the retail stores.

Synchronised production; Keep production in space with consumer demand, combined with shorter lead times.

EDI (Information Data Exchange): it is the exchange of business information electronically between business partners, intermediaries, public authorities and other in a structured format, without any need for human interpretation or retyping.

Globalisation: the trend in which businesses cross international boundaries. Perhaps the most hackneyed of any buzzword, it even thrives in mainstream culture (think globally, act locally or whatever).

JIT: A production system in which materials and components are made available just at the point and time at which they are required.

Kanban: Kanban (card) is used in just-in-time production to convey information between the process and within the process. The kanban accompany every box of items that moves through the production system.

Outsource: to hire a third-party provider.

POS: Point of sale.

Point of sale register: Incorporates products normally associated with point of sale systems, i.e., computer, printer, monitor, keyboard and cash drawer, in one case.

Quick-response systems: A system of communication and co-ordination through the entire supply chain with the purpose of reduce inventory costs and increase service levels. Each links in the chain shares information about forecasts, orders, production plans and inventories

with others. Quick response systems rely on information technology (EDI, bar-coding, scanning systems) but also on partnerships among the chain members.

Supply Chain: the material and informational interchanges in the logistical process stretching from acquisition of raw materials to delivery of finished products to the end user. All vendors, service providers and customers are links in the supply chain.

Supply Chain Management (SCM): the practice of controlling all the interchanges in the logistics process from acquisition of raw materials to delivery to end user. Ideally, a network of firms interact to deliver the product or service. Although the term supply chain management has been used for years, only a handful of companies excel in SCM.

Third party Logistics: Third party logistics involves the use of external companies to perform logistics functions that have traditionally been performed within an organisation. The function performed by the third party can encompass the entire logistics process or selected activities within that process.

Vendor Managed Inventories: Store orders are generated automatically based on scanning data, inventory levels, planned promotions, shelf characteristics, etcetera.

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