8th WCTR

TRACKING AND TRACING : STATUS IN THE LOGISTICS MANAGEMENT AND STRATEGIC STAKES FOR COMPANIES

NATHALIE FABBE-COSTES
CRET-LOG (Université de la Méditerranée - Aix-Marseille II)
Avenue Gaston Berger
13 625 AIX-en-Provence Cedex 1, FRANCE

Abstract

Companies that face drastic changes in their industry and try to reach a high level of quality in logistics management are increasingly developing tracking and tracing systems. Beyond this observation the status of tracking and tracing in logistics management and the managerial problems that it creates have been poorly studied up to now. This is why we decided to undertake a research on the managerial aspects of the implementation of tracking and tracing systems.

The present paper relates the first results of this research. First we clarify the status of tracking and tracing in the logistics management, in particular its informational dimension and its role in piloting flow. Then we examine the forces driving to « global » tracking and tracing. We analyze for each partner of the supply chain the strategic stakes linked to such systems. Finally, we identify the managerial difficulties of a global implementation of such systems, whether the origin of the difficulties is inside a company or in the management of the logistics interfaces between companies. Two examples issued from our case-studies illustrate our discussion. In a conclusion we try to present the main lessons drawn from this research and the opened perspectives.

INTRODUCTION

Because increasing competition within most industries, companies look for cost reduction, differentiation and/or innovation concerning products, services or management methods. Since the beginning of the 80's logistics has been giving evidence that it could help to reach those objectives. When companies try to reach a high level of quality in logistics management they develop tracking and tracing systems if possible all over the supply chain, from source material up to the end consumer or user, sometimes including the recycling process. This is particularly true for manufacturers and retailers, it is also true for logistics service providers that want to participate to highly qualified logistics chains. Beyond this observation the status of tracking and tracing -of both goods and documents- in logistics management and the managerial problems that it creates have been poorly studied up to now. Most research works dealing with tracking and tracing are technical ones and concern problems such as : identification and codification of goods and logistics units, automatic localization and identification of goods, etc. Those problems are very important and more complicate that most people think but according to us a managerial perspective of the implementation of tracking and tracing systems is also useful, even for those who focus on technical aspects. This is why we decided in 1997 to undertake a research on this topic. We intend first to enrich the modeling of logistics management and flow's piloting, in particular the linkage between physical and informational flow, second to provide logistics managers with elements useful for decision-making when tracking and tracing systems related to quality and performance of logistics are concerned, third to give new ideas in terms of strategic options feasible thanks to traceability.

The research work consists in detailed case studies of companies or organizations that have implemented, or are implementing, tracking and tracing systems. Most systems are not limited to the border of a unique company but spread (or try to spread) all over the logistics partners involved in the chain. To avoid a too contingent analysis and to find out regular factors, we choose companies or organizations belonging to very different sectors : food industry, distribution, logistics industry, car industry, health sector, etc. For some of them, the tracking and tracing project is an aspect of a more global logistics project, for others, the development of the tracking and tracing system is a project in itself, at least at the moment when companies take the decision. The present paper relates the first results of this research that is currently still in process. First we clarify the status of tracking and tracing in the logistics management, in particular its informational dimension and its role in piloting flow. Then we examine the forces driving to « global » tracking and tracing. We analyze for each partner of the supply chain the strategic stakes linked to tracking and tracing systems and further the strategic potentiality of such systems. Finally, we identify the managerial difficulties of a global implementation of such systems (all along the supply chain and up to the consumer or the end user), whether the origin of the difficulties is inside a company or in the management of the logistics interfaces between companies. Two examples issued from our case-studies illustrate our discussion. In a conclusion we try to present the main lessons drawn from this research and the opened perspectives.

STATUS OF TRACKING AND TRACING IN THE LOGISTICS MANAGEMENT

Flow's management : the key-capability of logistics management

During the past decade, logistics has been and still is one of the most significant driving force for organizational change. The process-oriented perspective of the logistics management that cut across the traditional vertical functions of the organization has been a powerful stimulator for change. This movement participated to a global trend called *process-based management*

(Hammer, 1990) (Davenport & Short, 1990) that was in line with other notions like *lean management* (Womack *et al*, 1990) and *time-based competition* (Stalk & Hout, 1990). For many companies, in many sectors, the logistics process became a *key-process* and logistics a *strategic capability* (Stalk *et al*, 1992). Logistics was not only a tool for the global strategy of a company, but also the source of innovative *logistics strategies* (Fabbe-Costes & Colin, 1994). With logistics, most companies are looking for ways to respond to competitive pressures and to reach new performance levels by redesigning and continuously improving their production and operational processes. They are challenged with balancing multiple potential contradictory goals: reduce cost, enhance logistics service, meet changing consumer needs, meet global society's requirements, develop new technology, etc. In most cases they desire to establish a sustainable competitive advantage through cost and/or service differentiation and need to keep pace with rapidly changing business environment.

For a long time, people have been thinking that logistics abilities were essentially founded on operational activities like transport or stock inventory. It has rapidly been obvious that the key logistics' capability was more globally « flow management ». Now logistics managers are considered to be the architects and conductors of a multi-technology system involving multi-competence personnel, and logisticians undertake cross-function decisions. In this perspective logistics managers now consider that information management is the most important part of their job. For them, it is impossible to pilot flow, to evaluate and forecast activity and take satisfying strategic, organizational and operational decisions without an « adequate » information and communication system. *Logistics competence consists in piloting closely information and communication systems that are the nervous system of physical flow network* (Colin & Paché, 1988). The attention paid to logistics management rapidly focused on the information process all along the supply chain, both to improve it and to take a better advantage of it. The process-oriented perspective of the logistics management combined with dramatic innovations in information and communication technologies explains the trend for information system redesign.

The importance of the linkage between *real* flow and LICS

The main role of information and communication system (ICS) that became the core unit of the logistics process is to support the coordination of logistics activities, even if they are scattered throughout organizations. Supply chain management (SCM) *is when all individually governed entities of a generic supply chain are, in all the critical processes of business making, managed as one coordinated entity* (Berglund, 1997). Logistics has indeed become a multi-actor, multi-operation, multi-time and multi-place system, all the more so complex that flow is more tensed. According to us, one of the most important aspects of SCM is to achieve both *the global coordination* of the many parts involved in SCM and the *local responsiveness* of each actor. Juga (1996, p.19 and 30-31) emphasizes on 3 factors for coordination: *standardization* that *increases the compatibility of resources and adds to the transparency between the constituent parts of the network, formalization* that *brings about organizational integration, mutual adjustment* that *allows flexible coordination in accordance with changing situational requirement* [...] and *improves the flexibility and interconnectivity of the units.* He also insists on the importance of the *cultural cohesion* of the organization. The logistics information and communication systems (LICS) can be helpful tools to achieve coordination and cohesion if some principles are respected. We have identified (Fabbe-Costes, 1997a, pp. 127-131) 4 main principles for LICS design: direct linkage of LICS with physical flow, ability to pilot chain even when hazards occur, coupling of operational applications with management decision support modules, communication between the LICS of different partners. The challenge lies in using various information and communication technologies to organize, store, and present information in a timely and efficient manner for effective logistics decision-making. This entails capturing, storing, retrieving, transmitting and manipulating data concerning physical, administrative, and financial flows. The most important data, according to logistics managers, are those related to *real* circulation of goods and documents and to be useful they must absolutely be *real-time* and *detailed.* The purpose of tracking and tracing systems is to provide

this kind of information. Moreover you cannot increase quality service by increasing reactivity, reducing logistics cycles and stretching flow if you ignore risks and if there is no way to identify and analyze them. Traceability can support this kind of analysis. It is therefore a condition to obtain sustainable performance. It can provide data to resolve quickly problems and support continuous improvement efforts. This is all the more so important as logistics is subcontracted. As Tilanus says (1997, p.15) *in external logistics, a great amount of effort must be spent on maintaining the relation between the information system and the physical goods. Goods' identification, tracking and tracing systems are the key issue.* Close tracking and tracing should then be the basis of any LICS. Let us examine what it consists in.

Global tracking and tracing : the basis of LICS and logistics management

As we indicated (Fabbe-Costes & Sirjean, 1997), *tracking and tracing means that the system can follow through every piece of flow in any place, under any responsibility, during any operation.* To be more precise we must make the distinction between tracking and tracing. For Tilanus (1997, p.15), *tracking is to find back a shipment [...] and inform any party concerned about the whereabouts of a shipment at its request. Tracing is to follow a shipment as it proceeds [...] and have available information about its whereabouts continuously.* Let us complete these definitions. Tracking consists in localizing. It gives the response to the question « what is currently happening? ». It supposes first the identification of things, second to have a system to observe where things are. Tracing consists in giving a continuous image of the overall flow. It gives the response to the question « what has happened until now? ». Tracking is thus a necessary condition to tracing. On-line tracking provides the historical record for tracing. Tracing supposes first to memorize tracking data, second to have a system that enables to « reconstruct the history ». To ensure tracing, information about products and documents must be accessible for a period of time after the related « events » have occurred. The main objective of the first developments was the control of goods' flow. In fact, tracking and tracing systems should permit traceability of every « thing » whether things are logistics units, documents or information. This is all the more so important that many problems occur because physical flow, paper documents flow and electronic information flow are not coherent. If we adapt Lesca's definition (Lesca H. & E., 1995, p.143) the traceability of a « thing » *concerns the fact that we can go back to its origin to control every step of its trip and of its elaboration.* Traceability supposes that traces exist in order to make this kind of research. An efficient ICS is able to go through operations and from an operation to another without losing any flow's track. It supposes to capture information directly from operations *where it is generated, when it is generated, in the time and place where it appears* (Le Moigne, 1973, p.101). The purpose is not only *ex post* analysis, but also *on-line* observation and analysis to ensure direct piloting of flow. It can also support *ex ante* forecasting and planning.

The evolution of information and communication technologies has been a powerful stimulator to develop tracking and tracing systems with an increasing part of automatic and electronic tools. Most organizations are looking for ways to handle better their logistics process by electronically capturing information at its source. Basically, tracking and tracing system needs : *identification* for each piece of flow (source material, components, products, logistics units, documents, etc.) throughout the supply chain, systems that *observe* or detect where each piece of flow is, *memorization* of « captured » information, *computation* systems that help to reconstruct history and support analysis. The problem is that a logistics chain involves many actors with different information systems. Each actor « observes » a small part of the chain, the part he is in charge of. The reconstruction of the global history of the chain demands *communication* between the different systems. A *global* tracking and tracing system will then need additional communication modules to exchange information between *local* tracking and tracing systems. Identification and communication standards must be defined and accepted by every party to accomplish a global tracking and tracing system. Beyond the benefits for logistics management, what are the strategic stakes associated to tracking and tracing systems that explain why so many companies and organizations focus on them ?

FORCES DRIVING TO GLOBAL TRACKING AND TRACING AND RELATED STRATEGIC STAKES

Stakes for manufacturers and retailers

Tracking and tracing systems are becoming absolutely necessary to face the drastic changes in most industry. The most sensitive ones are those where consumers' or users' security and health are concerned. Three of them are really aware of the potentiality of tracking and tracing systems. The *food industry* has been upset by two problematic events : first in 1993 the contamination of some Perrier boxes with benzene that sets up the problem of knowing where could infected products be and sets up the problem of their call back, second the « mad cow » crisis that demands to secure chain and guaranty the origin of products. The *car industry*, in particular car-markers, must offer cars with total safety and quality, they need to call back every car suspected not to be absolutely safe (for example the recent Mercedes Class A), they also need to upgrade cars if any abnormal default or any maintenance problem is detected. *The health industry* (hospitals, pharmaceutics manufacturers and retailers, etc.) is directly in charge of the health of people with an increasing demand for high quality medical care and medicines but is also facing a difficult economic challenge. Those industries are at present the most active for developing tracking and tracing systems. We could have added the *military* and *nuclear* industries which have developed traceability earlier for « high » strategic and safety reasons. We could also have added *luxury goods* manufacturers that need to ensure high quality products and must defend against counterfeiting. To cope with the drastic changes in most industry, partners need to work in 3 directions : enhance quality and safety of *products*, enhance quality and security of *services*, then of every process, reduce *costs*. In each case, the quality, reliability, security and performance of the logistics process are concerned and a tracking and tracing system can offer accurate information to react against any problem and to progress in a long-time perspective.

Concerning products, the main problem is consumer / user's safety. Only traceability can ensure a global quality process that enables both producers and retailers to guaranty the origin of materials, ensure an adequate level of quality of the overall process (manufacturing and logistics process) and help to react against any quality problem. Traceability of products' flow concerns not only finished goods but also components (raw material, work-in-process and packs). If any quality problem is detected, it is possible to track potentially defective products, stop them and if necessary call them back for testing, destruction or reprocessing before they cause disasters. The objective is to avoid that defective products arrive up to the consumer or the end-user. Another factor is also becoming important for consumers : the efforts to protect environment. A global tracking and tracing system can permit to call back for destruction or reprocessing all packs and/or products not fully consumed or out of use. To develop such a « total » approach of traceability, it is necessary to follow through the entire life cycle of the product. The consumer or the end-user must then be included in the traceability loop. Some examples of such global loop exist for long-lasting products that need logistics support during their life.

Concerning services, the main problem is to give a quick response to customers' and users' needs, which supposes flexibility, reactivity and reliability of logistics process. In most case, he company who has to be sure that consumers or users are « well served », designs the logistics chain but doesn't realize himself all logistics operations. The control and maintenance of an adequate service level are thus very difficult for the firm if it is « blind » when goods move out off its operational responsibility. Global traceability gives partners remote data about goods' delivery and forwarding, warehousing and inventories in the different places where goods move through. Aside the quality of the service in itself, we observe a demand for a better information about the service, which appears to be a *meta-service*. In today's information intensive society, consumers or end-users want to be better informed about the products and services that companies can offer and are, therefore, demanding easy access to relevant information, even about

when and how their order is actually served. Producers and distributors are trying to give more information to their clients about the ongoing delivery process and to give evidence about the authenticity of products and the quality of the overall production and delivery process.

Global traceability is particularly important for manufacturers or retailers that subcontract partly or totally logistics operations. It allows shippers to follow-up and sometimes to pilot flow process, to identify and solve problematic or critical situation, to know where and when problems happen, especially in just-in-time process where flow is tensed. Knowing the product history, they can re-create events or phenomena, analyze them, point out responsibilities and simulate better action. Logistics managers need such data not only to control quality, but also to build a representation of *real* operations. This operational knowledge that shippers can build thanks to traceability is very useful to improve their logistics' strategies.

Stakes for third party logistics

The responsiveness of third-party logistics vis-à-vis quality and security of services and products is obvious. They must ensure the required level of quality for the operations they perform on behalf of shippers. Because of competition in the logistics supply industry, shippers can now expect high standards when they contract out their logistic activities. Those standards relate both to physical operations and to the processing of information. When « sensitive » logistics operations are subcontracted, shippers often seek a high degree of transparency to be able to audit and control the operations closely. As previously stated (Fabbe-Costes, 1997b), *the quality of information support is vital as shippers need to exert tight control over their logistical* [subcontracted] *operations. Shippers also want detailed operational information to acquaint themselves with physical operations and maintain their expertise in this area. [...] LSPs* [Logistics Service Providers] *need an information and communication system directly linked to the physical flow of goods to forecast, plan, organize and follow the operational process and react against any disruption. Information management is thus a core activity and basic offering of LSPs. [...] Information management has therefore become a strategic factor for LSPs, especially those that wish to add value to the service offering.* This highlights the importance of tracking and tracing for third-party logistics (TPL) that want to participate to « qualified » logistics chains. A research about logistics alliances has also made this statement: *the shippers expect that the improvements in performance will mainly be achieved with the use of both EDI and tracking and tracing systems, and expertise/logistics skills* (Andersson, 1995, p. 95). Some recent studies confirm all that and give details.

In a recent thesis about the TPL industry (Berglund, 1997), the author made some interesting observations from an empirical study. Considering the importance of information for the TPL industry he maid (pp. 105-134) 6 statements. 1- *Shippers recognize information systems as one of the logistics providers' major services.* 2- *The most important skills for being a successful TPL provider are in the area of operations, analysis/engineering/design, and information system.* 3- *Most TPL consider their skill lack is related to logistics information system.* 4- *Information skills are highly ranked both as an important skill to operate successfully as a TPL and as a skill the TPL lack.* 5- *The main investments needed for the expected growth of the TPL industry are related to information systems and human resources.* 6- *The most important competence for achieving supply chain integration is related to information system.* A recent survey about the third party-logistics market presented at the 1997 Annual Conference of the Council of Logistics Management (UT, 1997) also gives useful elements to appreciate the importance of tracking and tracing for TPL. It indicates that the reliance of shipper on third-party suppliers for information capabilities concerns first *the shipment monitoring* (93%), second the *performance monitoring* (81%); both capabilities based on tracing and tracing. To the question « did you get what you pay for by subcontracting? », most shippers (i.e. 61,1%) respond « not as much » concerning the *improvement of information systems* and 66,7% respond « not as much » concerning the *more specialized logistics expertise*. This confirms the demand of shippers related to ICS when they

subcontract logistics activities and the demand for pooling expertise discussed in Fabbe-Costes (1997b). When speaking about barriers to long-term success, according to this study the *lack of IT/IS involvement in the selection / design process results in missed opportunities.*

To conclude, everyone is aware that IT/IS is fundamental, that tracking and tracing systems are necessary, but practice shows that it is not easy to achieve traceability. We assume that beyond technical problems and financial difficulties, the implementation of global information and communication systems including tracking and tracing systems arises unsuspected blocking managerial problems. Our purpose now is to analyze those difficulties.

IMPLEMENTING GLOBAL TRACKING AND TRACING : MANAGERIAL DIFFICULTIES

General approach of the difficulties encountered

Global traceability all along a supply chain can only be achieved by interchanging information between a wide range of applications from many functions inside a company, and from many companies. Most of these applications exist but they often belong to distant systems that have not been originally designed to share information. We have observed (Fabbe-Costes, 1993) that: *logistics is supported by various specialized modules (distribution, inventories, production, transportation, supplying...) that hardly communicate. Many LICS consist in interfaced old separated modules that weren't designed to share information. Then they don't guarantee coordination between functions and actors and only achieve local optimizations. It is frequent to observe sophisticated computerized sub-systems that are mostly isolated. There are very few examples of multi-actors' optimization. EDI connections when they exist only support administrative exchanges such as orders, delivery advice, invoice and payment advice. Above all, today's LICS don't adapt easily to significant changes, either internal or external ones.* The 1998 situation is unfortunately quite the same. Of course there are more logistics applications that are more sophisticated and involve « new » technologies... but in most cases the communication between the applications is still difficult. Some progress exists inside companies. Many databases have been recently reshaped and are now « common » to most internal applications. The problem still exists for communication between actors.

With today's technologies that overcome problems of distance, transmission speed and interconnection with acceptable installation costs, global traceability is feasible. It requires important changes of existing LICS such as : integrate hardware and software applications, create a informational network between all units involve in the supply chain, simplify communication between people and information systems, provide easy access to documents and information, improve availability and security of business information, support the development of expertise and knowledge among organizations, support a permanent improvement approach of the process. Many problems arise when trying to implement global tracking and tracing systems. As previously said, the most easy to observe are the technical ones : multiplicity of interfaces that have to be developed, time and cost necessary for their maintenance, problem of data base compatibility (nomenclature, coding, and structure of data), problem of language compatibility (definition and terminology), aversion to upgrade, even redesign the information and communication system... In fact those problems have two interrelated dimensions : a technical one quite well known now, and a managerial one much more difficult to solve. Companies have begun to pay attention to the technical dimensions of the problem : identification of physical flow (raw material batches, components' batches, products, pallets...), scanning of bar-codes or tags, electronic data interchange between geographically dispersed facilities inside a company, between companies... but the undertaken developments often were for themselves, i.e. inside their operational bounder. Problems have arisen when trying to develop *cross-boundary traceability.* Even if standards for identification, labelling and

communication exist, it is up to the partners in the supply chain to choose the information they mutually require. And it is not so simple to share information among related participants and distribute related flow of information. It does cause problems of confidentiality, of reliability, of user-friendly access... It has practical issues such as lack of standards for « specialized » messages or data, complexity of connections, extra costs, and risks (security of systems, confidentiality of some information). While information technologies now permit to limit access to confidential information, it also introduces some real vulnerability that may not be ignored.

Global traceability also raises questions that, according to us (Fabbe-Costes & Sirjean, 1997), reveal blocking problems. *Are partners ready to open their ICS to others? How will they make their information system compatible? Are they ready to build a reliable relationship and to share any logistics information? Are they ready to build a common language and a common identification system, either for goods or documents? Are they ready to accept that their partners become more autonomous thanks to the sharing of information?* Those questions are very important because each actor in a supply chain is potentially both provider and user of information. For many partners the information issued from tracking and tracing systems is the most strategic one because it describes exactly what happens in the supply. Another aspect of the problem is the confidence one can have in the shared information. If partners want to have a remote control of the supply chain, i.e. control operations they don't perform themselves, they must clearly define responsibilities towards information production and exchange. It is thus necessary to identify actors and their role vis-à-vis the global tracking and tracing process. Partners must be ready to « open » their information system. This decision has great technical and organizational impacts and also strategic issues. Sharing information demands a minimum level of cooperation between partners at least to define and agree on information management rules and organization rules, according to their individual and mutual objectives.

To complete our analysis of managerial difficulties we choose to present two case studies that are according to us good illustrations of issues discussed in this paper. In each case we focus on a company involved in a global tracking and tracing project. Company n°1 is a manufacturer and company n°2 is a wholesaler. Both of them belong to the food industry. For each case, we describe rapidly the logistics situation, the main partners of the chain, the driving forces for developing traceability, the main characteristics of the tracking and tracing system and the problems/success encountered with the tracking and tracing project.

Case study n°1

Company n°1 is a beverage manufacturer. The Perrier's problem has been a strong driving force for him to implement traceability. They began to work on the project in 1993. Today the project is also linked with other logistics and marketing projects such as ECR (efficient consumer response) and SRC (supplier-retailer collaboration). The physical flow management is quite simple. The upstream flow is mainly controlled by the company which manage directly every plant. In France the company operates the storage of finished products. The production planning and the sourcing of plants are designed to produce homogeneous pallets. The rule can be expressed by : in 1 pallet only 1 batch of product, i.e. the same product (unique EAN13), the same batches of source material. Each pallet is individually identified and labelled at the end of the production line. Because the products of this company have a high consumption level most clients -in particular retailers- order homogeneous pallets. 98% of the delivered pallets are homogeneous ones. The company sells « free of charge » that is to say it controls downstream flow, even if it doesn't perform the final transport. Two markets are delivered: the « home market » i.e. retailers (mass distribution), and the « cold drink » (restaurants, bars, etc.). The traceability project deals with the 2 markets, but the more difficult is the home market because delivery points are not always stores (it can be a logistic platform controlled by the retailer) and because cooperation is more difficult. The implemented tracking and tracing system only deals with pallets' traceability. Because of the structure of the market, the company considers that it is a satisfying level to perform a good quality of service, ensure the safety of consumers and have a

good level of accurate information. The driving forces to implement such a system were the following ones. 1- To have a *total quality management* of products inside the company that permits an easy call back of pallets in case of quality problem, and narrows the scope of a major quality spill. 2- To reduce *freight expense* related to returned products by stopping the defected products very soon and avoiding to return those that are not defective. 3- To improve the *quality of service* : fresher product thanks to a stock management with DLUO (deadline for optimal use) or DLC (deadline for consumption) and higher turnover of product. 4- To improve the *visibility* of downstream flow and the *control* of the delivery process. 5- To improve the *logistics management* of the company (less stocks, better reactivity, better productivity etc.) and manage more information more rapidly.

The system consists in the following points. Each pallet has an individual and standardized label with the EAN 128 standard, which is a worldwide standard for the labelling and identification of pallets, rolls, containers, etc. On each label the following data appear : SSCC code (serial shipping container code) which is the basic code for traceability of logistics units, EAN13 of the product content, N° of batch, DLUO / best before, variant for promotions), and « clear » information such as designation of the pallet and its content is associated to bar-codes to facilitate « manual » controls. Bar-codes of pallets are systematically scanned at each step of the chain (from the end of production lines, up to final delivery points). Captured data are automatically transferred to the ICS. Logistics, manufacturing and commercial applications share a common database. Each document (transfer forms, preparation form, delivery forms, transport orders etc.) exchanged inside the company (between plants and depots) and with other partners (TPL, retailers, clients, and industrial partners) uses the previously defined codes. Each document (transfer forms, preparation forms, delivery forms, transport orders etc.) has an identification code and the corresponding bar-code, the scanning of it speeds up and improves quality of control. At each step of the process automatic modules check the coherence between physical and information flow, between what is forecast and what happens, etc.

In 1997, the system was properly operating and on-line traceability is obtained from the end of production lines, up to final delivery points. The project is then a success for this company. Every unit of this company uses the system, which is a global one for the company. The use of worldwide standards facilitates the communication with partners. With the identification of pallets and the link with batch codes (i.e. a link with manufacturing process traceability) it is easy to stop and call back every « suspect » pallet. The company benefits from real improvements of its logistics and commercial performances : fewer errors in particular in preparation, less stock, fresher products delivered, less out-of-stocks, better logistics productivity in particular in depots. Success factors of this project seem to be 1- the methodology for the project, in particular the emphasize on information and training periods to help operational people to use correctly the system, 2- the tenacity to achieve 100% labelling and scanning both for physical flow and administrative documents, that demands almost 3 years, 3- the powerful and evolutive ICS that existed before the project and could easily integrate the necessary modifications and new modules, 4- the links between the applications of the ICS that permit to reconstruct easily the history of a product, of a pallet, and 5- the investments in technologies such as automatic label printers and stickers, portable scanners, automatic transfer between scanners and the ICS.

Some improvements can be made that correspond to the limits of the system. Today company n° 1 is able to send by EDI every document useful for the supply chain management in which appear all the codes useful for traceability. Each partner can then use them to continue the process and go on with tracking and tracing. The problem is that retailers don't seem much enthusiastic about this possibility. They probably will change their mind when a sufficient amount of manufacturers will adopt similar systems, with homogenous standards of identification and labelling. That would justify the investment in scanners and the modifications of their ICS to support « end-tracking and tracing » i.e. from delivery points up to the consumer. To summarize, in case of problem, company n°1 can only tell the delivered retailers that such and such pallet

must be stopped and/or called back ; it is then up to retailers to find out where they can be! Today company n°1 keeps « blind » at the moment when products are delivered. They would like first to be sure that retailers know how to find out pallets in their logistics process, second to have a possible trace up to points of sale, even if they deliver a retailer's logistics platform. The transparency of flow inside the partner's border seems to be a very difficult question. Perhaps negotiations and developments for ECR and SRC will soon make it possible.

Case study n°2

The company n°2 is the exclusive wholesaler of a chain of fast-food restaurants. Its business consists in delivering restaurants with everything they need. The mad cow crisis that has a real impact global on consumer's confidence towards food, has been the driving force that has triggered the movement for traceability off, in particular in France. At the beginning of 1997 the restaurant chain that wanted to reassure consumers has demanded his supplier (i.e. company n°2) to achieve traceability for 11 frozen products, more sensitive than others, among them beef. The first objective was to guaranty the origin of the food and to follow through homogeneous batches of products. In this case « homogeneous » means : unique origin (in particular for fish, beef, chicken, etc.), unique production batch, unique DLC. The second objective was to check that DLC is always respected. The third objective was to be able to stop and/or call back products if any problem is detected, whether a supplier or a restaurant detects it. Company n°2 was supposed to succeed in 6 months. Then the system would be enlarged to fresh products.

This project has encountered many difficulties that are very interesting to analyze. Some are technical, but most of them are organizational. To have a better understanding of the case, let us study briefly the supply chain. The chain restaurant is responsible for the choice of all the suppliers and negotiates prices for all the products. Then the chain restaurant gives the information to company n°2 that must manage the supply chain. Company n°2 buys products to the selected suppliers, organizes the shipments (composed by mono-product pallets) up to its depots. Company n°2 can then deliver the restaurants when they order products. Downstream flow is a mix of homogenous pallets and boxes. We must specify that Company n°2 doesn't participate to the commercial negotiation between the chain restaurant and the suppliers and it seems hard for company n°2 to have logistics requests against suppliers. It seems that the restaurant chain has not be very incentive vis-à-vis the suppliers concerning the traceability project, probably for two reasons : first to avoid higher prices due to extra costs related to the necessary investments that suppliers would have to do (identification, labelling, etc.), second because he had not a precise idea of how to « do » traceability and have a poor logistics know-how (the entire logistics chain is subcontracted to company n°2).

The project was then a great challenge for company n°2 that considers it as a powerful stimulator for change. When company n°2 has tried to implement the tracking and tracing system it faced (and still faces) many operational difficulties. Sometimes there is no codification of products by suppliers, there are very few suppliers that label pallets and put bar-codes on them. There is no normalization of codification, each supplier has his own way of identifying and codifying physical units (i.e. pallets, boxes, batches, products). Some pallets supposed to be homogeneous are not (2 or 3 batches on the pallet, sometimes with different DLC). There is no EDI communication between partners, and no project of this kind, then each code and DLC must be checked manually. Sometimes information given on delivery documents is not coherent with what is indicated on products, then systematic control must be done before warehousing pallets. Many documents don't indicate the DLC of products, it then must be directly checked and keyboarded when entering the products in the wharehouse. Some suppliers don't have an IS that permit to manage the needed information and put it on related documents.

For company n°2 this project has a great cost because of more time spent for extra controls, extra keyboarding, new computer developments, and this cost cannot pass on the restaurant chain. Like in case n°1, the tracking and tracing system interests partners of company n°2 but they

seem poorly motivated to invest in it. This problem of motivation seems to be the more difficult to solve. According to us, it can sign away at long term the global project. Restaurants seem to have no time to spend to achieve tracking and tracing inside the restaurant, despite the wish expressed by the chain managers to do it. They don't even control products when they are delivered. This aspect is important because there are buffer stocks inside restaurants and in case of emergency (if a restaurant is out-of-stock) restaurants can send products directly one to other. If they don't go on tracing flow there is no possible action in case of problem. Suppliers who don't offer the required conditions to perform tracing and tracing will probably do nothing until the restaurant chain demands them to fulfill traceability requirements. The chain restaurant managers want traceability but don't seem aware of its costs, its requirements, and don't seem willing to « put the pressure » on suppliers to succeed, despite their negotiation power. Inside company n°2 some problems were also raised. This company doesn't have a global ICS, and some depots have not a computerized warehousing system. This is obviously a blocking problem that the company is solving very rapidly. But if this new system will erase the extra costs associated to internal controls, it will not eliminate the inbound controls (i.e. the necessary controls when receiving products) and the lack of information from suppliers.

Today traceability is not 100% possible for this supply chain. Because of a lack of information and communication technologies, a lack of standardization, a lack of motivation of partners the project cannot be achieved. Thus, the risk of human errors is still high despite the many controls made at each handling and movement. According to company n°2, a lack of communication and expertise explains the poor implication of partners and the difficulties. The managers of the chain restaurant should have point out the driving forces for traceability, the risks if the project doesn't succeed. There are obviously risks : for consumers if it is not possible to stop suspect products, for the restaurant chain if such a problem occurs, for the suppliers, including for company n°2. The chain managers should have take time to think globally about the project before asking for it. They should have look for information about problems, difficulties that other companies were facing whilst implementing such projects. They should also have organized a copiloting for the project and work with their suppliers.

Although these two case studies are very different, they are good illustrations of practical issues to perform global traceability and of difficulties and conditions for success.

CONCLUSION

Tracking and tracing began to develop in response to a demand (secure quality of products and processes and guaranty origin of products) and with the perspective of competitive advantages (cost reduction and differentiation). Thanks to the experience that now exists in this domain, we thought it was worth to stabilize the concept, analyze its strategic stakes for each actor in the supply chain and think about the managerial problems of its global implementation. It was the objectives of the research and of this paper that presents the first obtained results. As a conclusion, we make a synthesis of what appear to us as the difficulties and conditions for success in global tracking and tracing projects, and indicate opened perspectives.

Lessons drawn by this first step of the research

If tracking and tracing has first developed inside companies, often to perform an internal optimization of the logistics flow, it is now spreading all over the supply chain. The management of interfaces with partners then becomes crucial if companies want to « see » flow outside their operational borders. To perform global traceability every actor in the chain must participate : manufacturers, industrial suppliers, third-party logistics, retailers, wholesalers, end-users, etc. They must adopt a common language for data, codification, labelling and communication, make tracking and tracing on the part of the chain they perform, give relevant information to other partners, in particular the next partner in the chain and the one that is

responsible for the chain. Each actor doesn't necessarily need to have in its LICS all the available information about traceability (that would suppose that every data would be systematically given to everyone in the chain). Actors must be able to gather information where it is available and reconstruct the flow's history in case of necessity. Then information must be available somewhere, the way to access or obtain information must have been defined. The design of a global tracking and tracing system is thus a collective project and must be discussed in common by partners. There must also be a test period before implementing the system to identify problems and discuss about technical and managerial solutions, extra costs' sharing out and benefits' distribution. Companies often stumble against these last two points.

To implement successfully a global tracking and tracing system, there are « obviously » basic conditions. Each piece of flow must be individually identified and labelled at the very beginning of its life, if possible since its design. Each « status' change » of each piece of flow (transport, production, packing or unpacking, loading or unloading, storage, etc.) must be tracked and any change in the « shape » of the considered piece of flow must be followed by a new codification. Links between « new » codes and « old » codes have to be closely memorized to trace properly the overall flow. To succeed, companies must have an « everything or nothing » approach. You cannot stop at the middle of the gate. In particular companies must take care of any breach in the informational process. Any « hole » in the tracking and tracing chain is a risk to lose products and then can destroy all the efforts done. To succeed, companies must have a global methodology to manage the project and think about all the impacts the project can have for the company and its partners. A basic condition to permit cross-boundary tracking and tracing is to use standards both for codification, labelling and for the communication between information systems.

It is sure that the global implementation of a tracking and tracing system, even if it doesn't encompass the entire supply chain, have great organizational impacts : on the information and communication systems of each partner, on cooperation between partners, on expertise development. The impacts on ICS are observable on databases' structure (what kind of data, the links between data), communication languages (exchange of messages and of data), connection with physical process and flow, management of « dynamic status » of products documents and process. The impacts on cooperation between partners are observable on : the ICS dimension of cooperation, the definition of « degrees » for autonomy, openness, transparency, confidence, confidentiality. Significant impacts on expertise development can be obtained thanks to a dynamic observation of flow but only if there is an investment to work on the memorized data.

Despite the improvements, some difficulties still exist and they correspond to really complex problems. Individual identification of each piece of flow is not so easy. For example, the EAN13 code is not an identifying code. The number of batch is the good level to have quality tracking and tracing but there is no way to scan it automatically. The links between the different levels of the « Russian dolls » of the identification process are difficult to design and maintain : batches of components or of source material are assembled to produce batches of products that are put in boxes then put on pallets and/or containers. The manufacturer is often the only one that manages this information. He doesn't always communicate it to its partners who often have the last code, it's to say the pallet's code. To this problem of « Russian dolls » codes, we must add the necessary links between the different codification that partners can use. For example, express delivery logistics suppliers (such as UPS, Chronopost, etc.) often have their own codification and bar-codes. When a shipper gives them a parcel, they immediately put their own bar-code that will be the only one used in their tracking and tracing system. If the parcel was also identified by the shipper, a « link » must be done to ensure the continuity of the trace. Consolidation of data collected by partners (TPL, industrial and commercial partners, retailers, etc.) is difficult. There are also problems of relative speed of information and physical flow. Information flow should go faster than the physical one. With express delivery services physical flow runs so rapidly that it becomes difficult to have connections between ICS that perform a quicker information flow.

When a company wants to develop a tracking and tracing system, it must think on both the internal and the external aspects, with a particular care for interfaces' problems. Traceability is obviously asking for cooperation between partners. Every partner must accept the remote control of the others on the part of the chain he performs. On the contrary, every partner must accept that others need information. Each partner must do efforts. Distribution of costs and benefits is an aspect that must be tackled at the very beginning of the project.

Opened perspectives

Development of global tracking and tracing is on the way. To have a better management of this kind of project it is necessary to have a clear view of the many related driving forces and strategic stakes. To summarize, the first class of objectives and the most important ones are related to consumers' satisfaction and safety. Consumers need to be sure that products are reliable and traceability is necessary to any company, or network of companies, that want to adopt total quality management principles. Traceability is the tool to know where a product comes from, where it is at the time « t », to check if it is following the right chain, and, if necessary, to stop it and call it back. It thus also permits to give accurate information to clients who want to now more about the running of their orders. Internet is becoming a « classic » tool with easy and friendly access to inform consumers or end-users.
The second class of objectives are logistics ones : ensure the performance of the entire process, its quality, reactivity, flexibility and reliability at the best cost. Some other benefits can also be globally obtained such as savings by reductions in shipping errors, pulls and returns, spills and overtime, narrowing the scope of a major quality spill, reduction of freight expense related to returned products by stopping the defected products very soon and avoiding to return those that are not defective, reduction in manpower required to unload, inspect and decide what must be done with quarantined products.
The third class of objectives deals with improvement in logistics and development of more global skills. The detailed information obtained thanks to tracking and tracing systems is useful to analyze the outcomes and costs of logistics chain and further reengineer it. It is also useful to improve the strategy in itself. The database obtained with traceability can give precious information concerning the market's evolution, the partners' performances, etc. This database is also important to feed control and evaluation systems and to enrich learning processes inside company and among chain partners. The information can also be very useful in case of disaster to have a clearer action during the crisis management.

As we can see, global tracking and tracing systems open many perspectives for companies at many levels and in many industries. It also opens perspective for research in many interrelated fields such as logistics, marketing, information systems and strategy. In the second step of our research, we will confirm the first results obtained about driving forces and difficulties when implementing global tracking and tracing systems, key-factors for success, and organizational impacts of such systems. We also would like to widen the approach and try to design new rules for piloting flow with achieved global tracking and systems. We will also enlarge the technology perspective (Intranet, Internet, ERP...) to look for information accuracy and timeliness improvements and to extend the benefits further.

REFERENCES

Andersson, D. (1995) **Logistics Alliances and Structural Change**, Thesis n°470, Linköping University, Sweden.

Berglund, M. (1997) **Third-Party Logistics Providers : Towards a Conceptual Strategic Model**. Dissertation from the IMIE, Linköping University, Sweden.

Colin, J. & Paché, G. (1988) **La logistique de distribution, l'avenir du Marketing**. Paris, Chotard et associés Editeurs.

Davenport, T. & Short, J. (1990) The New Industrial Engineering : Information Technology and Business Process Redesign. **Sloan Management Review**, Vol. 31, N°4 (Summer), 11-27.

Fabbe-Costes, N. (1993) Logistic Information and Communication Systems (LICS) are producing Organization Meanings. **Proceedings International Conference IEEE on Systems, Man and Cybernetics** (SMC), Le Touquet, France, 17-20 October, 1993. Vol 5, 300-305.

Fabbe-Costes, N. (1997a) Pilotage logistique : quel système d'information. In Aurifeille *et al* **Management Logistique : Une approche transversale**. LITEC / Éditions Management Société, Paris, 111-144.

Fabbe-Costes, N. (1997b) Information Management in the Logistics Service Industry : A Strategic Response to the Reintegration of Logistical Activities. **Transport Logistics**, Vol. 1, n°2, VSP Editor, The Netherlands, 115-127.

Fabbe-Costes, N. & Colin, J. (1994) Formulating logistics strategy. In Cooper, J. Coord, **Logistic and Distribution Planning : Strategies for Management**, Kogan Page, London, U.K., 36-50.

Fabbe-Costes, N. & Sirjean, S. (1997) Building an Information and Communication System (ICS) that ensures close Tracking and Tracing in Distribution Logistics. **Seventh International Special Conference of IFORS**, University of Gothenburg and Chalmers University of Technology, Gothenburg, Sweden, 16-18 June, 1997.

Hammer, M. (1990) Reengineering Work : Don't automate, Obliterate. **Harvard Business Review**, Vol. 68, N°4 (July-August), 104-112.

Juga, J. (1996) **Changing Logistics Organization**. Publication of the Turku School of Economics and Business Administration, Sarje / Series A-7: 1996, Finland.

Le Moigne, J.L. (1973) **Les systèmes d'information dans les organisations**. Presses Universitaires de France, Paris.

Lesca, H. & Lesca, E. (1995) **Gestion de l'information, qualité de l'information et performance de l'entreprise**. Paris, LITEC.

Stalk, G. & Hout, T. (1990) **Competing Against Time : How Time-based Competition is Reshaping Global Markets**. New York, The Free Press.

Stalk G., Evans, P., Shulman, L. (1992) Competing on Capabilities : The New Rules of Corporate Strategy. **Harvard Business Review**, March-April, 57-69.

Tilanus, B. (1997) Introduction to Information Systems in Logistics and Transportation. In Tilanus, B. Ed., **Information systems in Logistics and Transportation**, Pergamon, Elsevier Science, Oxford, U.K, 7-16.

Womack, J., Jones, D. & Roos, D. (1990) **The Machine that Changed the World**. New York, Harper Perennial.

UT (1997) **Third Party Logistics : Key Market / Key Customer Perspectives**. Research realized by the Center for Logistics Research, University of Tennessee for the Annual Conference of the Council of Logistics Management, Chicago, IL.