



Research agenda for e-business logistics based on professional opinions

Research agenda
for e-business
logistics

513

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Received May 2001

Revised February 2002

Accepted April 2002

Keywords *Logistics, Supply chain management, R&D, Supply, Networks, New product development*

Abstract *This study investigated what should be the major research and development areas regarding the logistics of electronic business. The method of study consisted of five elements: the creation of a preliminary e-logistics vision; focus interviews of e-business and logistics experts, identification and categorisation of the key R&D topics, a panel workshop to critically analyse the preliminary findings and prioritise the R&D topics, and formulation of a research agenda to guide future research work in the field of e-business logistics. The two-phased process, where the interviews were followed by the workshop, enabled the evaluation and prioritisation of the preliminary findings. The requirements of e-business on the national logistics infrastructure were found to be one of the focus research areas. According to the study, integrated supply network structure with suitable visibility and usage of real-time data transfer is another area of great importance. Research and development of new logistics service concepts should also be promoted as well as research on the effects and possibilities of using new product data management and product identification methods.*

Introduction

With the growth in new information and communication technologies, managing the flow of information has become as vital as managing the flow of material (Demkes *et al.*, 1999). It is now possible to separate the information flow from the physical material flow if necessary. Furthermore the Internet makes it possible to connect all of those working within a single supply chain, which creates new challenges for enterprises. New technologies are used to try to optimise the supply chain, with the final goal of planning all the enterprise's activities in as close a relationship to the demands of clients as possible. The outcome of the process should be profitable growth (Ranagan and Adner, 2001).

Appreciation is extended to the National Technology Agency of Finland for support of this project. The authors wish to thank Jan Holmström, Eila Järvenpää, Juha Luoma and John Sillincer for their helpful suggestions on the earlier drafts of this paper and Hanna Pajunen-Muhonen, Jarkko Lehtinen and Hannu Yrjölä for active participation during the project.



The Trilog-Europe project (Demkes *et al.*, 1999) states that the Internet can be seen as a supply chain management concept as well as a trading platform. Most concepts for improving supply chain efficiency are based on sharing information throughout the supply chain in order to improve transparency. It is clear from a functional perspective that there are benefits to the supply chain as a whole but the distribution of the benefits remains a difficult task.

It is difficult to define e-business logistics comprehensively because the potential impact of e-business on logistics and supply chain management is not yet fully understood. One possible definition is that e-business logistics simply means processes necessary to transfer the goods sold over the Internet to the customers. On the other hand it is also possible to define e-business logistics as a wide-ranging topic related to supply chain integration, which is the viewpoint taken in this paper.

Many companies are struggling with the question of how e-business impacts the supply chain. It could have the effect of eliminating some intermediaries (such as the wholesaler or retailers), but it also fosters the emergence of new players like logisticians, whose role is to adapt traditional logistics chains to take into account the requirements of e-business. Many companies are also struggling with internal change management processes when trying to make employees adapt to electronic business.

Two recent studies (CEST, 2000; Ferrari, 2000) have listed issues that should be addressed regarding e-business logistics:

- Where is the value proposition of e-business relative to the supply chain? Can e-business make the supply chain experience more valuable?
- What will e-business do to the supply chains?
- What are the uses for e-business in transportation and logistics specifically?
- Is there benchmarking information available on how to re-engineer for e-business?
- How does a company match its current operations to the e-future?
- How to harness information and link it to the company's operations?
- How will the dynamics of B2B (business to business) and B2C (business to consumer) supply change?
- What new, valued supply chain "e"-services are possible?
- Who are the right partners?
- How will different industry sectors look when e-business is the norm?

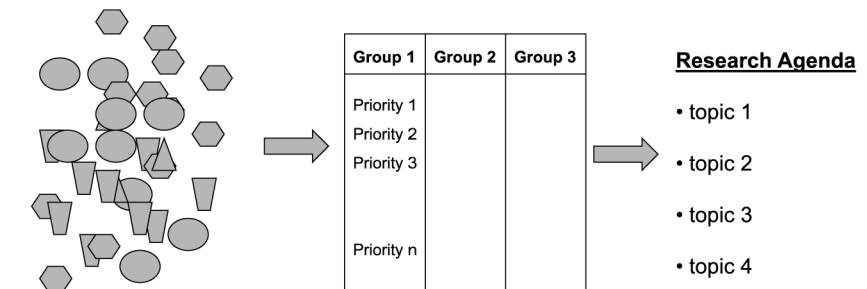
As we can see based on these selected references, the questions regarding the e-business logistics and supply chain management cover many overlapping themes. It is not always easy to see what is the interrelation of these different topics. The questions can be divided based on how concrete or abstract they are by nature. There are some very concrete (but still not simple) issues, like the

home delivery concepts related to e-commerce operations (Punakivi and Saranen, 2001) and a great variety of very abstract and large issues like the potential changes in the value chains of different industries that need to be studied further. Some of the questions can be considered as prerequisites for any future development and it is very important to realise what they are and quickly start initiatives to solve them.

The overall picture of e-business logistics needs categorising into different research and development themes. There also seem to be different opinions whether the IC technology is ready to redeem the vision of the e-business (Supply Chain Decisions, 2001). Guidelines are needed so that the resources can be allocated to the areas in the field of logistics and supply chain management, which mostly support development of profitable electronic business. Figure 1 illustrates how grouping and prioritisation of different R&D questions could be organised so that high quality research agendas can be formulated to guide the work (Auramo *et al.*, 2001).

This paper identifies, categorises and prioritises the most crucial research and development topics that should be dealt with in order to help enterprises to face the new logistics challenges of e-business. The study included an iterative process, where focus interviews of professionals were followed by the workshop. This iterative process enabled respondents' consensus views to be summarised and evaluated.

The categorisation and prioritisation of different but often interrelated e-business issues help people to see the overall picture of e-business logistics more clearly. However, there was a need to somehow pinpoint a few larger research themes to guide the future R&D work in research institutes and companies. Thus, as the final result of this study, we came forward with a proposal for the research agenda with four themes to support the development of e-business logistics.



Many different and sometimes overlapping R&D questions to be solved. Difficult to see their interrelationships.

Through analysis R&D topics are grouped and prioritised.

Finally a research agenda is presented.

Figure 1. Categorisation and prioritisation of R&D topics to formulate research agendas

Source: Auramo *et al.* (2001)

Method

Selected method

The method included aspects of the Delphi method (Linstone, 1975), which employs an iterative process of summarising and evaluating the respondents' views on a consensus view (McKinnon and Forster, 2000). The method consists of focus interviews, to be followed by a workshop. Ideally, the people interviewed should also attend the workshop. This kind of two-phased process enables the evaluation and prioritisation of the preliminary findings.

Face-to-face conversations foster interactive communication, which is a precondition for knowledge creation and new innovations (Nonaka and Takeuchi, 1995). Previous research has identified the task-orientated, interaction-centred focus groups (workshops) as an ideal methodology for exploring professionals' experiences and for describing that expedience. These professionals are often in a position to influence future events and, thus, make their forecasts come true (Belzowski, 2000).

Application of the method

The study consisted of five stages as illustrated in Figure 2. First, the preliminary E-Logistics Vision was created based on the literature study to be used as a discussion guideline during the interviews (Stage 1).

A total of 50 focus interview sessions were organised, with 65 people interviewed in total (Stage 2). The interviews can be divided into four categories: the leading edge companies (trade and manufacturing companies that have a reputation of being early adapters of new business trends), logistics service companies, IT-companies and consultants, and universities and research centres (Table I).

The objective of the interviews was to determine the key research and development topics in the field of e-business logistics. The preliminary vision was used as a discussion guideline, which became more defined during the interview process. However, the interview sessions were kept unstructured and

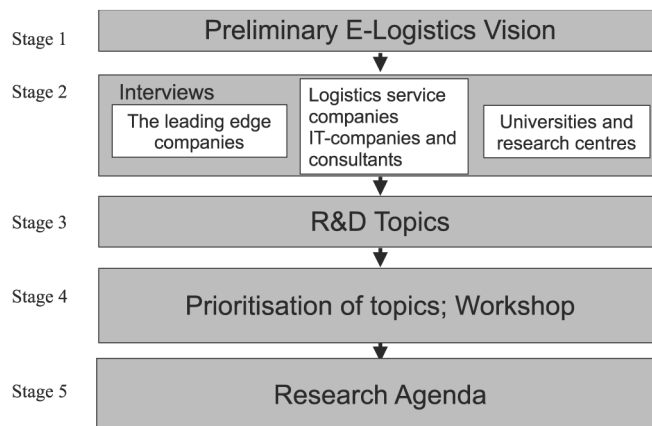


Figure 2.
The stages of the study

open to promote the free flow of ideas. The interviewees from industry, trade and service sectors were responsible for the development of e-business in their companies. Researchers and other professionals in the fields of logistics, supply chain management, e-business and future technologies were also interviewed.

In Stage 3, the data from the interviews was analysed. The key R&D topics identified during the interview phase were listed. Similar topics were divided into eight preliminary categories, which were formulated during the process. Preliminary categories and respective R&D topics were incorporated into three final categories.

In Stage 4, a workshop panel was organised and the findings from the interviews were prioritised, further evaluated and specified. The workshop was attended by a total of 45 people of which 30 were the same previously interviewed. The question: “What should be the key research and development topics in the field of e-business logistics?” was thoroughly discussed in five parallel groups. The group discussions were semi-structured based on categorised and listed topics. First, the categorisation was presented to the workshop and participants’ approval was sought. Second, the participants were encouraged to identify the most important research and development topics and prioritise them within each category in a consensus view. During the interview and workshop process a total of 80 professional opinions were analysed.

The objective of Stage 5 was to formulate a research and development agenda to guide future research work in the field of e-business logistics. The presented themes of the research agenda are combinations of prioritised R&D topics.

The key research and development areas

The framework

When analysing the results of the interviews and workshop discussions, we realised that the company’s level of integration in the supply network influenced how well the complexity of different interrelated e-business issues were understood. This formed the framework that helped us in the analysis processes (Figure 3).

	Companies	Experts
Industry	15	21
Trade	6	10
Logistics service companies	9	13
Consultants, IT companies	6	6
Universities, research centres	10	15
Total	46	65

Table I.
The background
information of
interview data

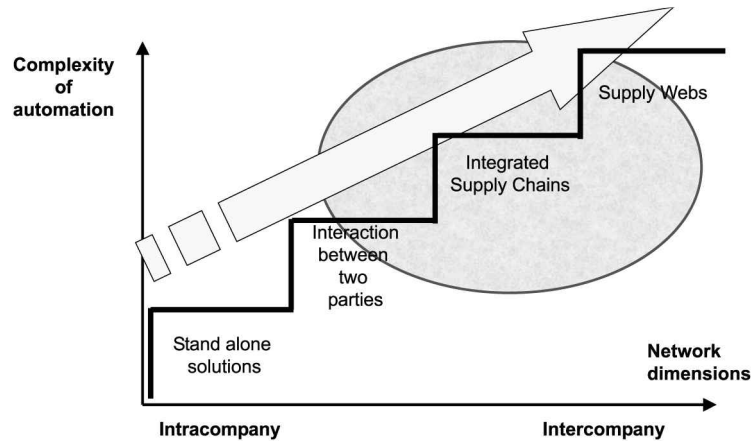


Figure 3.
The level of integration
in the supply network

Source: Adopted from Närhi (2000) and Demkes *et al.* (1999)

Figure 3 illustrates the development steps when moving from the traditional business practices towards the integrated supply and demand network. Most of the interviewed companies were located between the first and the second step or on the second step of the development curve. The companies have problems with the internal integration of information, as well as with integration with their suppliers and customers. Only very few companies were able to see what a fully developed e-collaboration could mean to their business.

Many interviewees paid a lot of attention to the readiness of individual companies to collaborate in the electronic supply network. Issues related to information management and internal capabilities of connecting to the other participants of the network were seen as critical prerequisites. However, it was concluded in the workshop discussions that they should be omitted from this study because the companies themselves are responsible for developing them.

As a result of the interview process it was concluded that the research and development topics in the field of e-business can be divided into three levels: strategic level; business level; and technology level (Tang, 2000). The prerequisites for the development of e-business and related logistics are created on the strategic level. The business level issues relate to the supply chain management processes that support the implementation of the selected strategies. The technology level deals with the actual order-delivery process.

Categorisation and prioritisation of R&D topics

After a thorough analysis of the interview results the R&D topics were divided into three categories as described in stage 3 in the methodology section. This division was presented to the workshop participants and their approval was sought. The three categories were:

- (1) *Information flow.* The research and development issues deal with the transparency of the information and its real-time distribution to the necessary parties in the supply-demand network.

- (2) *Supply network*. Research and development topics related to potential changes in value chains and new collaboration possibilities within networked companies.
- (3) *Physical material flow*. Utilisation of new technologies and their impact on distribution and logistical infrastructure, consolidation possibilities and emerging home delivery concepts.

The R&D topics were prioritised within each of the three categories in the workshop. The issues were discussed in five parallel sessions. The participants of each session were encouraged to identify the most important topics and to achieve a consensus view. The prioritisation of topics is presented in Tables II-IV. The numbers 0-5 in the columns headed "Importance" describe how many of the groups identified the topic as "very important". Each of three categories will be covered in more detail.

Information flow

Information and communication technology have played a key role in transforming logistics and supply chain planning (Demkes *et al.*, 1999). Increased visibility and the transfer of real-time information bring new effectiveness to supply chain management. For e-business to grow as fast as many expect it to,

The R&D topics	Importance (Σ)
Development of standards and interpreters	5
Integrated ERP (enterprise resource planning) – systems in the supply networks	4
PDM (product data management)	2
Development of POS (point of sales) – and forecasting data management	2
Information management in the supply network: responsibilities, correctness and rights	2
Centralised vs decentralised data management	1

Table II.
R&D topics related to the information flow and their importance according to the workshop

The R&D topics	Importance (Σ)
Changes in value chain	4
Evaluation and development of different e-business models	3
Modelling and optimising of the supply network	3
Management of outsourced resources	3
Logistics networks, 4 pl TM	2
Management of channel conflict	2
Responsibilities and role in the e-market places	2

Table III.
R&D topics related to the supply network and their importance according to the workshop

Table IV.
R&D topics related to
physical material flow
and their importance
according to the
workshop

The R&D topics	Importance (Σ)
National logistics infrastructure and requirements of e-business to it	4
Home delivery	3
Management of regional differences	3
Identification technologies	4
Mobile technologies	3
Consolidation of material flows, cross-docking	2
Improvement of order fulfilment accuracy	4
Service level variation	1
Physical logistics of e-market places	1
Material handling technologies	1
Positioning technologies	1
Reverse logistics, direct deliveries	0

trading partners must be able to more easily exchange data between their back-end databases and core business applications (Webster, 2001).

The most important R&D topics regarding the information flow within the supply network according to the workshop are presented in Table II. The numbers in the column headed "Important" describe how many of the five groups identified the topic as "very important".

Five groups found development of standards and interpreters as a very important R&D topic. During the interviews and workshop there was a lot of discussion about the transfer of information between company interfaces. There are different standards and interpreters being developed at the moment to overcome this problem (Cox, 2001; Webster, 2001). Standards-based Web services have the potential to solve the issue, but for most companies this is still a technology of the future. There were also differing opinions about the role of electronic data interchange (EDI) in the development of Internet based integration. It should, however, be kept in mind that the processes are being integrated across company boundaries and the IT development has just a supporting role. It is very challenging to try to integrate two different companies. Only after the integration can be optimised over the entire supply net can the full potential of new value-added integration be reached (Demkes *et al.*, 1999).

During the iterative process of interviews and workshops the information transfer within the supply chain or in the future within the supply net was seen as one of the key research and development areas. Here are a few comments from the workshop regarding the information transfer across the company interfaces:

- "Standards are seen as the key to solve the problem".
- "Modular information systems need to be able to communicate with each other".

- “The business processes need standards, not only the information transfer”.
- “Service providers can take the role of the standards”.
- “EDI systems should form a basis for the development”.
- “Attention should be paid also to the actual utilisation of the information; better to transfer less and ‘focused’ information than provide visibility that cannot be utilised”.

In relation to the development of standards for information transfer, companies need to study and understand the new role of enterprise resource planning (ERP) systems in the networked environment. ERP is viewed as the root from which data is pulled into a complex IT organism that links with customers’ and suppliers’ systems, or with clusters of trading partners in Internet hubs. It has been argued that in the new economy having ERP is not enough (Mullin, 2001). ARM Research (Boston) has coined a new term, enterprise commerce management (ECM), to describe multi-vendor IT systems (Mullin, 2001). Simultaneously there are solutions being developed where Web-based browsers allow companies without ERP systems (SME companies mostly) to complete transactions with other companies with ERP systems (D’Amico, 2001).

This whole development process, related to information sharing across company interfaces, is a very complicated issue from a single company’s point of view. As discussed earlier, a company’s level of integration in the supply network influenced how well the complexities of different e-business related issues were understood. Thus more research and development resources should be allocated to various fields in this area to help the enterprises fully benefit from emerging solutions, and of course to develop solutions that can foster integration and new innovative ways to collaborate.

Product data management (PDM), is one of the key elements when integrating the information flow across the entire supply net (Philpotts, 1996). Two groups identified it as a very important research and development topic. The product and the information related to it must be unambiguously described so that messages can be distributed to the network. Another potential benefit of PDM is the better management of the product portfolio throughout the life cycle of different products. There should be more research and development activities regarding the opportunities of product data management and different technologies available.

The development of e-business will create more tightly integrated supply nets where collaboration among different parties will play a key role (CPFR, 2001). According to the visions of e-business, forecasting and demand information is available to all the partners in the supply net in real time and without the Forrester or bullwhip effect, i.e. without the enlargement of demand variability as orders move up the supply chain (Forrester, 1958; Lee *et al.*, 1997). Sharing information and re-thinking responsibilities between companies are

topics receiving a lot of attention in supply chain management at the moment. Sharing demand information electronically more frequently or in real-time has become possible and, more recently, less costly (Kiely, 1998). According to the company interviews there is still a lot of work to be done before this vision can be realised. Collaborative planning and forecasting methods need to be developed and one should not forget the changes needed in the management processes when real-time information flows will be visible throughout the supply net. There is also a need for indicators that are capable of measuring the degree of transparency within the supply network.

When transferring information within the supply net the questions of who manages and owns the information and who guarantees the correctness of the information become vital issues. During the company interviews a lot of time was spent discussing whether the information management should be centralised or decentralised. A strong opinion was in favour of decentralised information management practices, but there is currently not enough knowledge about what this really means in practice.

The results of the prioritisation work done during the workshop focuses more on technological issues related to information transfer. The overall findings of the study suggest that it is at least as important to foster research and development initiatives that help to understand what information should be shared and how to use the shared information to add value to the supply network.

Supply network

Internet technology has dramatically altered the trade-off between vertical and virtual integration (Shah, 2001). The question, "Do the advantages of focusing on core competencies and outsourcing the rest outweigh the cost of managing added complexity", is very relevant.

The R&D topics that help to understand the integration processes and their importance according to the workshop are presented in Table III. The numbers 0-5 describe how many of the groups in the workshop identified the topic as "very important".

One of the major challenges of e-business is the potential change in the value chains of different industries. Four groups found it to be a very important research and development focus area. The Internet overturns the old rules about competition and strategy (Werbach, 2000). The changes will vary in different fields and will also depend on the role the companies play in the value chain. However, the value chain will only be changed if there is added value for the supply net. How to identify and measure the added value for the whole supply net or how to optimise the entire value chain were the key research and development areas according to the interviews. The analysis should be done separately for the different industries: electronics industry, forest industry, food industry, consumer goods industry, etc. It is, however, most likely that some general trends will also be revealed.

It was further noted that changes in value chains should also be analysed from an individual company's point of view: how one single company can understand

the changes it will be facing and how it can prepare itself for the new rules of the game. Knowledge about different e-business models was seen as important during the transfer process from the traditional supply chains to the networked business environment. What type of partners will have the key roles in the new value chains and whether there will be differences in the amount of decision-making authority when deciding how the future supply networks operate were also identified as topics of interest. A lot of attention was also paid to the requirements for SMEs to be able to integrate with the new value chains.

The channel conflict, which occurs when the traditional sales channels and the new electronic channels are servicing the same client base (Reda, 1999; Hanover, 2000), was identified as an important research topic. Managing outsourced logistics resources was another field to which new research and development initiatives should be directed.

The major challenges that affect the logistics infrastructure and the potential needs for new service providers in the networked business environment were also considered as significant topics to be studied further (Bauknight, 2001; Bade and Mueller, 1999; Timmers, 1999).

As B2B commerce shifts to the Internet, companies that control the on-line markets will exert enormous influence over the way transactions are carried out, relationships are formed, and how profits flow within the supply net (Kaplan and Sawhney, 2000). The roles and the responsibilities of the electronic marketplaces or electronic hubs as they are also called are not yet fully understood according to the workshop discussions. They were merely seen as trading platforms and not as integrated parts of supply networks. There should be more studies done regarding electronic marketplaces and their potential role as an information intermediary within the supply Web.

The main conclusion was that development of IC technology enables business process reengineering and fosters potential changes in the value chains. This creates requirements for new types of logistics services that are supporting new value chains. Research and development initiatives in this area should be focused so that they support the development of integrated and transparent supply network structures.

Physical material flow

The development of e-business will and has already set increased quality requirements on logistics services and on the logistics infrastructure as a whole. It will be important to be able to provide a different level of service to different customer segments or to individual clients at home. These services must create added value for the clients and at the same time optimise the overall cost structure of the supply net. The management of the physical material flow of the supply net has become one of the key development topics (Thomas and Griffin, 1996) especially in the e-business.

Table IV summarises the key research and development topics and their importance according to the workshop. The numbers 0-5 describe how many of the groups in the workshop identified the topic as “very important”.

More sophisticated customer demand chains and electronic business pose new challenges to supply chain management. Customers are demanding products and deliveries customised to their specific needs and flexible outsourcing of supply chain operations is a necessity in volatile business environments (Kärkkäinen and Holmström, 2001).

When moving towards electronic business the material flows are presumed to become narrower in the B2B environment due to increased visibility and the possibility to optimise the inventory levels in the different parts of the supply net. The material flows to the individual consumers in the B2C sector follow the same tendency when more and more goods will be transported directly to households and other delivery points (Witt, 1999). Forrester estimates that along with the growth of the market share, the number of residential deliveries will exceed 2.1 billion by 2003 (Brooksher, 1999).

R&D issues related to the supply network in the B2B environment are more globally valid; companies within the same industry sector or parallel players in the supply networks are struggling with similar issues. In the B2C sector, however, more country-specific elements have been reported (Demkes *et al.*, 1999). The logistics challenges when creating the home delivery concepts in the B2C environment are dependent on local infrastructure, the geographical distribution of the end users and the consumer habits rather than the line of business. Thus R&D initiatives need to be allocated to study the national logistics infrastructure and its suitability to meet the needs of e-business, both from B2B and B2C points of view.

It is necessary to offer different service levels and flexibility throughout the supply net. New evolving concepts like cross-docking terminals (Daugherty, 1994), direct deliveries, and office and home delivery solutions (Punakivi and Saranen, 2001) are processes that need to be researched and developed. There are also emerging consolidation possibilities, which should be further studied (Hall, 1987; Goolley, 2000). Reverse logistics, the reverse flow of products from customers back to suppliers, is another issue that faces new challenges. There is a trade-off between investing in the process of supporting reverse logistics activities versus investing in the process of prevention to ascertain why goods are coming back.

The development of electronic business will increase the importance of delivery accuracy, delivery frequency and delivery time in emerging new supply networks. This applies to logistics both in B2B and B2C segments. Research and development programmes are necessary in order to study how the required delivery patterns can be reached and how to measure their potential benefits.

New technologies, like product identification technologies, mobile technologies and applications that utilise satellite location technologies (GPS) are seen as enablers for the new logistical systems that will be necessary to fully benefit from e-business (Jedd, 2000; Shulman, 1999; Radding, 1994). According to the workshop opinion mobile data transfer together with RFID (radio frequency identification) may lead to great efficiency improvements in the logistics network. Use of wireless identification technology could be one of the keys to significantly speed up and increase accuracy in sorting and

distribution (Jones, 1999; Boxall, 2000; Lindström, 2000). Wireless product identification is already used with great benefits in the functional areas of innovative companies and there is potential for its use in supply chain wide solutions, i.e. item level supply chain management (Kärkkäinen and Holmström, 2001). But the current knowledge is still insufficient and further research should be supported in this field.

As a conclusion, research and development topics related to physical material flow should be divided into two major themes: technology related R&D to support the development of new logistics services to enable the necessary changes in the value chains; and analysis of potential changes in the national logistics infrastructure to support e-business development.

Further research agenda

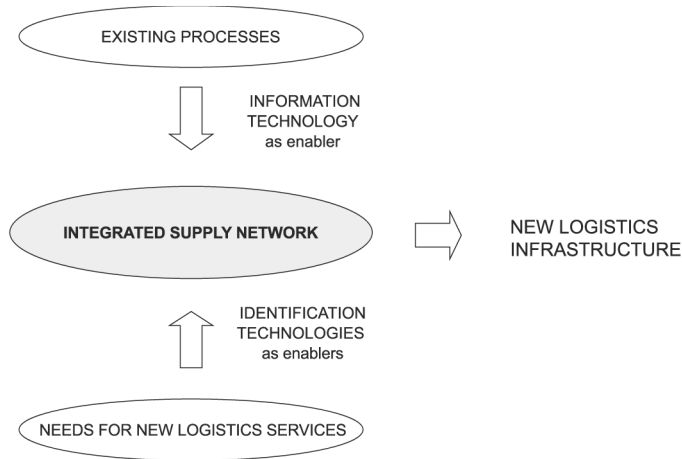
As discussed earlier in this article, many companies are struggling with the question of how e-business impacts their logistics operations and supply chain efficiency. The development processes related to information sharing and visibility across the company interfaces are very complicated issues. Also according to the interviews the emergence of new players in the field of logistics and information services and the potential changes in value chains are great challenges to overcome. The categorisation and prioritisation of these different but often interrelated e-business issues discussed earlier helped us to see the overall picture of e-business logistics more clearly. But there was still a need to somehow pinpoint a few larger research themes to guide the future R&D work in research institutes and companies.

As the final result of this study we came forward with a proposal for the research agenda with four themes to support the development of e-business logistics. These research and development themes are combinations of different R&D topics across the three categories supported with the findings from the international body of knowledge in the field. The proposed themes are:

- (1) integrated supply network structure with suitable visibility and usage of real-time data transfer possibilities, e-collaboration and CPFR (collaborative planning, forecasting and replenishment);
- (2) research and development of new logistics service concepts and their effect on the whole supply network;
- (3) research on the effects and possibilities of using new identification methods such as RFID (e.g. product, parcel or batch identity) in the supply network; and
- (4) the requirements of e-business for the national logistic infrastructure.

Although the R&D themes seem to be independent entities, there is a very strong interrelationship between them in the context of e-business logistics as described in Figure 4. Technology innovations are enablers to business process re-engineering aiming towards supply network integration.

Figure 4.
Interrelations of
research agenda themes

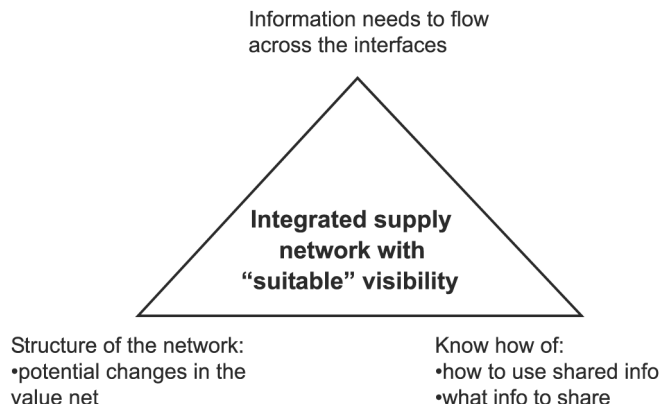


Integrated supply network structure with suitable visibility

Creating integrated supply networks with suitable visibility is a very complicated exercise. There are at least three major elements that need to be solved almost simultaneously as illustrated in Figure 5. Solutions are needed to enable information flow across company interfaces. There must also be know-how of what information should be shared and how to utilise the shared information. And last but not least there are potential changes in the structures of the value chains.

During the iterative process of interviews and workshops the information transfer within the supply chain or in the future within the supply net was seen as one of the key R&D areas. E-collaboration is one of the most promising areas related to information sharing. According to e-collaboration experts it is important to understand what information should be shared and how to add value to the information shared (CPFR, 2001; Cameron and Gormley, 1998; Holmström *et al.*, 2000).

Figure 5.
Building blocks of
integrated supply
network with suitable
visibility



There are also more strategic problems to be solved: new integration of the processes within the supply network and orchestration of the operations including the management of outsourced resources (Sawhney and Parikh, 2001).

R&D of new logistics services in the supply network

More sophisticated customer demand chains and e-business pose new challenges to logistics service providers. R&D of new logistics service concepts are required regardless of the line of business both in B2B and B2C environments. Unless the products are non-material, physical distribution logistics is one of the key challenges for the supply networks or e-marketplaces. According to the interviews the development of e-business will increase the importance of, especially, delivery accuracy, delivery frequency and delivery time (see Table IV). Thus a major challenge is to identify and develop new logistics service concepts, like 4PLTM (Bauknight, 2001; Bade and Mueller, 1999) or information intermediaries (Timmers, 1999), which could more efficiently manage, consolidate and optimise both information and material flows. This is especially important when different product group (Fisher, 1997) requirements, such as service levels, are to be created using the same resources. These new logistics services would enable companies to focus on their core competencies (Prahalad and Hamel, 1990) and added value could be created for both the network participants and customers.

Research on identification methods in the supply network

Development of e-business creates a need for new solutions for more efficient handling of lean material flows, efficient customisation of products and logistic services and information sharing across company limits. Research and development related to these topics can be approached from two perspectives:

- (1) *Technology perspective.* What are the possibilities that new technologies bring?
- (2) *Business need perspective.* Are there new technology demands when developing supply chain or network management?

Technological innovations and huge increases in efficiency are often connected together (Brynjolfsson and Hitt, 1998). According to the workshop opinion mobile data transfer together with RFID (radio frequency identification) may lead to great efficiency improvements in logistics networks. Applications using wireless product identification technologies have until now been mostly at the individual company level. However, making item level supply chain management solutions work across company limits could reap enormous benefits (Kärkkäinen and Holmström, 2001).

Requirements of e-business to the national logistic infrastructure

According to the prioritisation done in the workshop, one of the most important R&D initiatives is concerned with the national logistics infrastructure responding to the developing e-business. When trying to identify the requirements of

e-business on national and regional levels, current material flows and current logistics infrastructure need to be analysed. Additionally, various possible development directions ought to be analysed in respect of the requirements and challenges described, for example, in this article.

One of the most interesting research areas would be to analyse the logistics service concepts needed in B2B and B2C supply chains to enable profitable growth in e-business. Another challenge is to identify and define the responsible parties in the development and maintenance work for the physical logistics network infrastructure. In the development and maintenance of the Internet, the responsibilities are basically divided among all the actors who have Web sites. When creating the physical logistics network, where management of the information and material flows affects several parties, similar kinds of responsibility problems are faced.

Discussion and conclusions

In this study we have identified, categorised and prioritised the most crucial research and development topics that should be dealt with in order to help enterprises to face the new logistics challenges of electronic business.

The analysis was conducted through an iterative process, where focus interviews of professionals were followed by the workshop. One of the problems of the selected method is the difficulty in analysing the data obtained during the focus interviews when open questions are used. The researchers' role as an objective interpreter is very challenging. Another disadvantage of the method is that there is a possibility that, during the interview process, today's problems may hinder interviewees in seeing the future possibilities, problems and broader development issues. Despite the potential disadvantages, the selected method was found to be suitable to this study.

Inventing and developing new service concepts or business models to support the development of profitable e-business calls for an innovative and flexible attitude in the R&D and business operations. The rapid rate of change includes great possibilities but also threats. When implementing new technology to old processes there is a danger of creating only new, expensive and inefficient performance. To utilise the value of e-business efficiently, innovative new operating models have to be developed. However, development of e-business skills requires that the potential changes or modifications to existing business models and logistic processes can be identified and defined at the single company level.

In developing new service or business concepts for e-business, the logistics service infrastructure covering information flow, co-ordination of supply network and material flows is a crucial issue. Several of the most important R&D topics that were identified are related to logistics services, service providers or the overall logistics service structure. The R&D initiatives in these fields ought to be interdisciplinary and cover a wide range of business-related issues. Additionally, there ought to be space for development initiatives with both a shorter and longer time span, as shown in Figure 6.

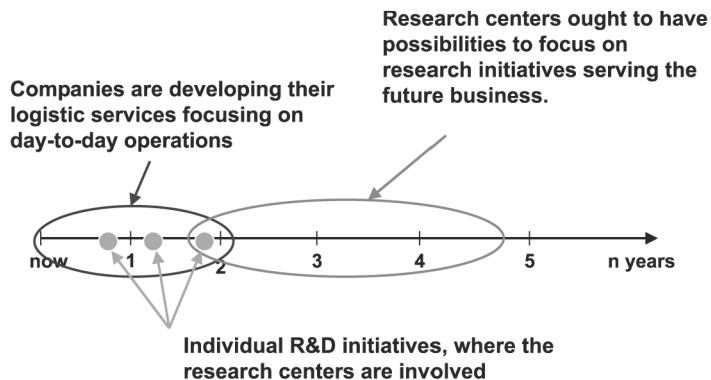


Figure 6.
Time span in the
research and
development

Although new technologies are enablers to network integration, successful integration requires confidence and excellent professional skills from the various supply network partners. Research and development resources should also be allocated to the areas that support the “soft” side of the integration process.

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