Jaana Auramo

IMPLICATIONS OF SUPPLY CHAIN VISIBILITY: BENEFITS IN TRANSACTION EXECUTION AND RESOURCE NETWORK MANAGEMENT

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© Jaana Auramo

jaana.auramo@tkk.fi

+358 40 773 5599

Abstract

The research context of this thesis is supply chain integration in manufacturing industry. This thesis examines how improved visibility in supply chain management can be exploited. The central proposition is that improved visibility brings new demands in supply chain management on the one hand, and gives rise to opportunities in innovative new business processes on the other.

The thesis consists of five individual studies and a summary. Three of these studies focus on the post-adoption usage of e-business solutions, investigating the challenges to be met and the deployment potential that companies can take advantage of when building visibility into the supply chain with the help of e-business and related integrative business processes. Two studies analyze the challenges and benefits related to the service integration that occurs when manufacturing companies move into downstream operations by offering high-value services related to the products they supply. This integration creates better visibility into customer processes and into actual products and their usage; the challenge is to create skills to take advantage of this visibility.

The thesis summary discusses the identified linkages between different perspectives of supply chain visibility. First, it identifies three different types of visibility as visibility of transactions, visibility of the process and visibility in use. Second, the results emphasize visibility as a concept with a dual role. From a tactical perspective, it is about visibility in transactions; from a strategic perspective, it is about the possibility of evaluating and re-shaping the resource network to better meet the demands of customers or changing business environments. The analysis indicates that, by approaching the problem situation from the two complimentary viewpoints of transaction and resource network management, new insight can be provided into how the attainable benefits of improved visibility are interrelated. Third, the thesis confirms that it is possible to exploit improved visibility at the three different levels of direct operative benefits, direct strategic benefits, and enhanced long-term strategic benefits. To be able to realize the long-term strategic benefits related to visibility, the resource

network perspective needs to be recognized and the problems related to coordination and collaboration addressed.

Overall, this thesis proposes that the three complementary perspectives of type of visibility, transaction vs. resource network, and level of attainable outcomes are all needed in order to understand the opportunities to exploit visibility in supply chain management. The thesis sets ground for a more normative analysis of the impact of visibility in supply chain management. Based on the empirical generalizations presented in this thesis, it is possible through further concept and proposition formulation to start building a theoretical model to describe the role of visibility in supply chain management.

Tiivistelmä (Finnish abstract)

Väitöskirja liittyy toimitusketjuintegraatioon ja näkyvyyden hyödyntämiseen toimitusketjujen ohjaamisessa ja hallinnassa. Aihetta käsitellään valmistavan teollisuuden näkökulmasta. Työn lähtökohtana on, että parantunut näkyvyys tuo toisaalta uusia haasteita toimitusketjujen ohjaukseen ja hallintaan, ja toisaalta mahdollistaa uusien, innovatiivisten toimintamallien toteuttamisen.

Väitöskirja on yhdistelmäväitöskirja, joka koostuu viidestä tieteellisestä julkaisusta ja niistä laaditusta yhteenvedosta. Kolmessa julkaisussa analysoidaan teollisuusyrityksissä toteutettuja e-liiketoiminnan ratkaisuja ja toimintamalleja. Julkaisut kuvaavat, miten parantunutta toimitusketjunäkyvyyttä voidaan hyödyntää asiakaspalvelussa ja ketjun operatiivisen toiminnan tehostamisessa. Niissä käsitellään myös näkyvyyden rakentamiseen liittyviä organisatorisia haasteita. Kaksi julkaisua liittyy teollisuudessa käynnissä olevaan muutokseen laitevalmistajasta palvelutarjoajaksi. Kyseessä oleva muutos integroi toimittajan tiiviimmin asiakkaiden toimintoihin ja siten mahdollistaa paremman näkyvyyden asiakkaan prosesseihin ja tuotteiden käyttöön. Toimitusketjun ohjaamisen ja hallinnan näkökulmasta haaste on osata hyödyntää tuota näkyvyyttä. Julkaisuissa analysoidaan, miten palveluintegraation myötä parantunutta näkyvyyttä voidaan hyödyntää teollisten palveluiden toimitusketjujen ohjauksessa ja hallinnassa.

Yhteenveto-osassa käsitellään toimitusketjunäkyvyyttä ilmiönä, jolla on erilaisia, toisiinsa liittyviä ulottuvuuksia. Ensiksi, työssä määritellään kolme näkyvyystyyppiä: transaktionäkyvyys, prosessinäkyvyys ja näkyvyys tuotteen käyttöön. Toiseksi, väitöskirjan tuloksissa korostuu näkyvyyden taktinen ja strateginen luonne. Taktisessa mielessä kyse on parantuneesta näkyvyydestä transaktioihin. Strategisessa merkityksessä näkyvyys tuo mahdollisuuksia arvioida ja muokata tarvittavan resurssiverkoston rakennetta vastaamaan paremmin asiakkaiden tarpeita alati muuttuvissa tilanteissa. Työn tulokset osoittavat, että lähestymällä tilannetta näistä kahdesta toisiaan täydentävästä näkökulmasta, transaktiotehokkuus ja resurssiverkoston rakenne, voimme ymmärtää parantuneen näkyvyyden mekanismit. Kolmanneksi, tulokset vahvistavat, että näkyvyyden hyödyt realisoituvat kolmella tasolla: suorina operatiivisina hyötyinä, suorina strategisina hyötyinä ja pidemmän aikavälin

strategisina hyötyinä. Pysyvien, pidemmän aikavälin strategisten hyötyjen saavuttaminen edellyttää, että näkyvyyden tuomat mahdollisuudet ja tarpeet muokata resurssiverkoston rakennetta ja toimintatapaa huomataan. Lisäksi on oleellista reagoida koordinaatioon ja yhteistyöhön liittyviin haasteisiin verkoston toiminnassa.

Väitöskirjassa ehdotetaan, että näkyvyyden hyödyntäminen edellyttää työssä esitettyjen näkyvyyden eri ulottuvuuksien tunnistamista. On tunnistettava erilaiset näkyvyystyypit, näkyvyyttä on katsottava sekä transaktio, että resurssiverkoston rakenteen näkökulmasta ja mahdollisia hyötyjä on analysoitava eri tasoilta. Työn tulokset luovat pohjaa normatiiviselle analyysille näkyvyyden vaikutuksista. Väitöskirjassa esitettyjen empiiristen yleistysten pohjalta on mahdollista kehittää käsitteitä ja propositioita, joiden kautta teoriaa näkyvyyden roolista toimitusketjujen ohjaamisessa ja hallinnassa voidaan kehittää eteenpäin.

Avainsanat: toimitusketjun hallinta, toimitusketjuintegraatio, näkyvyys, e-liiketoiminta, palveluintegraatio

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Espoo, September 2006

Jaana Auramo

Science is the process of replacing unordered masses of brute facts with tidy statements of orderly relations from which these facts can be inferred. The progress of science is not (only) to produce new information but to discover the orderliness of the information already stored. With each important advance in scientific theory, we can reduce the volume of explicitly stored knowledge without losing any information whatsoever.

(Herbert Simon, 1971)

LIST OF PUBLICATIONS

The separate publications included in this thesis are the following (in chronological order):

Auramo, J, Aminoff, A., Punakivi, M. (2002), "Research agenda for e-business logistics based on professional opinions", International Journal of Physical Distribution and Logistics Management, Vol. 32, No.7, pp.513-531.

Auramo, J., Tanskanen, K. Småros, J. (2004), "Increasing operational efficiency through improved customer service", International Journal of Logistics – Research and Applications, Vol.7, No. 3, pp.167-180.

Auramo J., Kauremaa, J., Tanskanen K. (2005), "Benefits of IT in supply chain management – an explorative study of progressive companies", International Journal of Physical Distribution and Logistics Management, Vol. 35, No. 2, pp.82-100.

Auramo, J., Ala-Risku, T., (2005), "The challenges of going downstream", International Journal of Logistics – Research and Applications, Vol. 8, No. 4, pp.333-345.

Auramo, J., Eloranta K., (2006), "Www-system use and business value in project networks", International Conference on Organizational Learning, Knowledge and Capabilities (OLKC) 2006 Conference proceedings, ISBN 0-902610-79-1, Warwick, UK.

1 INTRODUCTION

1.1   Background and motivation

Supply chain visibility is an important issue for academics and industry both in a theoretical sense and in practice. Visibility is a complex issue that involves people, processes, technology and information flow (Montgomery et al., 2002). From the supply chain management point of view, it sustains, accelerates or enables other practices driving the supply chain, such as sharing real-time data with key customers, suppliers, and partners or standardizing processes and practices, eliminating inefficiencies, and improving inventory and order management. Ideally, visibility enables all supply chain members timely access to all relevant information related to that particular member's role in the supply chain.

Visibility can be approached from both a tactical and strategic perspective (ibid.). The tactical perspective focuses on transactions as it offers visibility to the flow of materials, available capacity and resources within the supply chain. From a strategic perspective, attention falls on resource networks. Visibility enables evaluation and re-shaping of the resource network more in line with changing business environments.

Supply chain visibility is attained by technological and organisational means. *Technological means* in this thesis refers to the development of e-business solutions that have enabled tightly integrated supply chains. Even though the value creation potential of e-business has already been formulated in the literature (for example, Mukhopadhyay and Kekre, 2002; Subramani, 2004; Zhu and Kraemer, 2005), there has also been a lot of exaggerated claims surrounding the development and lack of confirmatory empirical evidence of the possibilities of benefiting from the improved visibility (Cagliano et al., 2003; Wu et al., 2003).

Organisational refers to various collaborative business processes where the supply chain parties agree on such cooperation and where the traditional firm boundaries do not hinder the setting of targets or, for example, collaboratively developed demand forecasts. In this thesis, we are interested in the increasing trend among manufacturing

companies to integrate into downstream operations by offering high-value services related to the products they supply (Lovelock, 1994; Gadesh and Gilbert 1998; Matthyssens and Vandenbemt, 1998; Wise and Baumgartner, 1999). This service integration, or move downstream, requires new ways to share responsibilities among supply chain partners. As a result, manufacturing companies are developing their capabilities to build better visibility into customers' processes and into actual products and their usage. Technological progress related to the Internet and remote diagnostics has hastened the pace of change in this area (Roth and Menor, 2003). However, the challenge is to create skills to take advantage of this visibility. This is an area where there has not been much research until now.

Overall, the motivation for the thesis arises from the need to improve our understanding of the opportunities to benefit from the visibility attained by the use of e-business tools and from the move to downstream services. Supply chain management is about transaction-related planning and execution issues on the one hand, and about design-oriented issues where decisions are made about the structure of the resource network on the other (Swaminathan and Tayur, 2003). Thus, it is important to recognize the opportunities from both the transaction and network structure perspectives.

1.2   Objectives of the thesis

The main objective of this thesis is to identify and understand different perspectives of supply chain visibility. Regardless of the recognized importance of visibility, the body of literature discusses visibility and its role in supply chain management mainly from the transaction excellence point of view, concentrating on such issues as demand or material flow visibility. Especially the more strategic perspectives related to the structure of the resource network have not been extensively covered.

As visibility is a complex and multifaceted construct, it is presumed that a more comprehensive understanding of its different perspectives could enhance the possibilities of exploiting attainable outcomes in different supply chain problem situations. This knowledge is essential for a more normative analysis of visibility that could increase the understanding of the relationships between the means and ends in

specific problem situations of supply chain management. In order to attain this understanding, we follow the theory-building process identified by Handfield and Melnyk (1998) where observations are transformed into empirical generalizations (Wallace, 1971, p. 18) through discovery and description. Discovery creates awareness of the phenomenon that must be explained, while description explores the territory further, both with the aim of providing a thorough and useful picture of the phenomenon. Consequently, this thesis aims to form empirical generalizations that may, through further concept and proposition formulation, lead to a theoretical model of the role of visibility in supply chain management.

In order to approach the above-stated objective, the research is broken into sublevel objectives. The first is to understand the needs and challenges companies are facing when considering initiatives to improve supply chain visibility. The second sublevel objective is to identify how companies are using the new tools to create visibility and explain why they use them as they do. The third objective of the thesis is to identify how companies benefit from improved visibility through e-business investments and collaborative business processes.

This thesis is a bundle thesis that consists of five individual research papers and a compendium part. The compendium part, and especially Chapter 5, addresses the main objective of this thesis. The specific sub objectives are discussed in individual research papers found as appendices to this thesis; however, the main results are also reviewed in Chapter 4.

1.3   Scope of the thesis

First, the research context of the thesis is supply chain integration in manufacturing industry. Manufacturing companies are increasingly building capabilities to share supply chain information within their supply chains. Apart from some leading companies, especially in the electronics industry, the majority of manufacturing companies are still behind the retail industry, in which many types of information-sharing solutions were first developed (Småros, 2005).

Second, we are interested in the technological and organisational means that provide visibility. The discussion of technological means is focused on e-business solutions. Organisational means in this thesis refers to service integration within manufacturing industry. Issues related to selecting the right tools or business processes, or the implementation of these tools and business processes, are excluded from the thesis.

Third, as this thesis is based on five separate studies and published research papers, the analysis presented in this thesis is limited to the topics and issues reported in these research papers.

1.4   Research process and research papers

The starting point of the research reported in this thesis is the need to understand the impact of e-business and service integration on supply chain management (SCM). In order to uncover areas for research and theory development and identify what the key issues related to these two phenomena are, several explorative case studies are conducted. Thus, the results of this thesis are based on the five research papers made from the case studies carried out during the period 2000 to 2005 (Table 2). During the process of conducting the research and analyzing the findings from explorative case studies, visibility and its multifaceted nature as seen from the SCM viewpoint emerged. Thus, the focus of the compendium part of the thesis is forged around visibility and its role in SCM.

Papers 1, 2, and 3 investigate the challenges and deployment potential companies are confronted with when building visibility into the supply chain with the help of e-business and related integrative business processes. Papers 4 and 5 move the focus from e-business to industrial services and analyze collaborative business models related to manufacturers moving to downstream services. These business models provide value offerings to customers that enable better visibility into the demand chains of customers and the actual usage of the products.

Chapter 1: Introduction

Table 2 Publication details of papers that are included in the thesis

Paper 1	Auramo J, Aminoff A., Punakivi M. (2002), "Research agenda for e-business logistics based on professional opinions", International Journal of Physical Distribution and Logistics Management, Vol. 32, No.7, pp. 513-531.
Paper 2	Auramo J., Kauremaa J., Tanskanen K. (2005), "Benefits of IT in supply chain management – an explorative study of progressive companies", forthcoming in International Journal of Physical Distribution and Logistics Management
Paper 3	Auramo, J., Eloranta, K., Tanskanen, K., (2006), www systems use and business value in project networks, International Conference on Organizational Learning, Knowledge and Capabilities (OLKC) 2006 Conference proceedings, ISBN 0-902610-79-, Warwick,, UK.
Paper 4	Auramo, J., Tanskanen, K. Småros, J. (2004),"Increasing operational efficiency through improved customer service", International Journal of Logistics – Research and Applications, Vol.7, No. 3, pp.167-180.
Paper 5	Auramo, J., Ala-Risku, T., (2005), "The challenges of going downstream", International Journal of Logistics – Research and Application, Vol. 8, No. 4, pp. 333-345.

Paper 1 reports the key findings of a study that was conducted during the so-called e-business hype-stage (late 1990's and early 2000's), when a lot of unsubstantiated claims were made regarding e-business in supply chain management. Many companies were struggling with the question of how e-business impacts the supply chain and there was a lot of uncertainty as to where the development was leading (CEST, 2000; Ferrari, 2000). This study identifies, categorizes, and prioritizes the research and development efforts to enable companies to benefit from e-business and visibility in supply chain management.

The author has been involved both in the planning and execution stages of the study. Furthermore, the author had a major role in designing and writing the journal paper based on the results of this study.

Paper 2 examines how leading-edge companies in Finland have been able to benefit from e-business implementations by creating visibility to transactions. The empirical work was carried out in 2004, during the so-called second wave of e-business (vanHoek, 2001), when companies with existing and well-established processes and performance were implementing e-business solutions to their supply chain management operations.

Based on the empirical study, five propositions are presented on the use and benefits of e-business in supply chain management. By developing these propositions, we have identified ways in which companies have been able to benefit from improved visibility. However, the study further points out that, in the SCM context, many manufacturing companies view visibility from a tactical perspective. Thus, companies are not fully exploiting the potential of the benefits that the investments into e-business tools and processes would enable. The findings of the study present an opportunity to further develop an understanding of the underlying mechanisms related to the possibilities of exploiting supply chain visibility.

The author worked with Mr Kauremaa in designing the study and participated in data collection and data analysis with the co-authors. Further, the author had the responsibility for the overall structure of the journal paper. All co-authors participated in developing the propositions presented in the paper.

Paper 3 examines the use of www systems in distributed engineering project (DEP) networks. It contributes to the debate of e-business value creation by analysing post-adoption usage of one innovative www-based collaboration tool and the benefits it brings to companies operating in DEP networks. The paper first describes how the www system creates visibility in the document management process in distributed engineering projects; following this, it reports the results, which show that a company's position in the DEP network influences the use, and possibilities of benefiting from, the improved visibility the www system provides.

The author contributed to the project design and to the data analysis, and also helped to determine the overall direction the project should take. Ms Eloranta, supported by Mr Kauremaa, had the overall responsibility of carrying out the actual research the paper is based on. Empirical work was carried out in 2005. The author contributed to the structure of the paper and wrote it together with Ms Eloranta.

Paper 4 illustrates how new improved visibility to customer demand chains and actual usage of products enable suppliers to organize their own supply chains more efficiently, while simultaneously providing better service to customers. However, the study argues

that the proposed benefits of increased planning possibilities, improved planning accuracy and reduced stock keeping units are not gained automatically. Moreover, the operations planning competencies of the customer and the supplier have to be very robust if such benefits are to accrue.

The author was responsible for designing the case study, conducting the interviews and performing the preliminary data analysis. This was carried out in early 2004. Prof. Tanskanen's and Dr Småros's comments and advice during the data analysis stages were very valuable. The author was responsible for writing the journal paper.

Paper 5 describes the challenges that the manufacturing companies face when they are moving from a transactional business imperative and offering more-integrated and value-adding services to their customers. Empirical work was conducted at the end of 2004. The study provides new understanding of the challenges related to benefiting from improved visibility to the usage of the products.

The author was responsible for the design and implementation of this multiple case study, and also for the data analysis. Mr Ala-Risku contributed to the writing process.

1.5   Structure of the thesis

This thesis consists of six chapters. The first chapter is an introduction to the study, presenting the background for the research problem, objectives of the thesis and introducing the individual research papers included in the bundle thesis. Chapter 2 covers the background literature and introduces the basic concepts and theories that are relevant to this study. Research design and methodology are discussed in Chapter 3. After that, the results of individual papers are presented in Chapter 4, followed by the discussion of the results in Chapter 5. Finally, the contribution of the thesis, its limitations and emergent ideas for further research are presented in Chapter 6.

2 LITERATURE REVIEW

This chapter first presents an overview of relevant previous research into supply chain integration and the role of visibility. Also, the different perspectives on visibility are discussed. After this, in Section 2.2 the focus is moved to the transaction and resource network viewpoints of supply chain management. Section 2.3 discusses key issues related to the development of e-business as a technological means of providing visibility. This viewpoint is taken despite the often-used definitions of e-business as an organizational "strategy" as opposed to specific hardware or software. Service integration is discussed in Section 2.4 as an organisational means to create visibility to supply chains. Section 2.5 summarizes the literature review and presents the research gaps of the thesis. For a more in-depth review of the respective relevant research of the individual papers, see the theoretical introductions to the attached research papers.

2.1 Supply chain integration and the role of visibility

The concept of integration has been used to study many different organizational phenomena (Galbraith, 1977). It involves various dimensions and varying intensities. In supply chain management literature, reference is made to structural integration (e.g. Bucklin, 1966), systems integration (e.g. Bask and Juga, 2001), process integration (e.g. Bowersox et al., 1999), relational integration (e.g. Gummesson, 1999; Lambert et al., 1998) and so-called soft forms of integration through socialization (Stern et al., 1996). The intensity of integration can range from full vertical integration to discrete market exchanges, with different co-ordination and integration mechanisms between these two options (Harland, 1996).

Actually, the entire concept of supply chain management is based on integration. Harrigan (1985), in her classic study, argues that a supply chain is characterized by different patterns that display varying stages and forms of integration (p.399). *Stages* refers to "the number of steps in the chain of processing which a firm engages in – from ultra-raw materials to the final consumer". *Forms* means ownership or other arrangements of control, such as shared ownership, long-term contracts, information exchanges, or resource and risk-sharing agreements.

Chapter 2: Literature review

The theory behind integration states that increased integration leads to higher performance (Pagell, 2004). From the SCM point of view, performance has two elements: superior customer value and effective operations (i.e. cost savings). Based on this, customer responsiveness has been acknowledged as one of the prime aims of supply chain integration (Narasimhan and Jayaram, 1998). Generally, responsiveness can be defined as the ability to react to unforeseen disturbances (Wong, 2005). Visibility increases responsiveness by enhancing the capability of the supply chain to respond to, for example, changes in customer needs. In addition to improvements in responsiveness, it is expected that an integrated and well-managed supply chain will lead to internal benefits. Lower operating costs and productivity improvements should be possible due to reduced inventory (Cooper et al., 1993) enabled by visibility. Visibility is also used as a countermeasure for local optimization (Reyes et al, 2002). Local optimization is one of the main causes of the so-called "bullwhip effect" (Lee et al., 1997), i.e. amplification of demand variability when moving from a downstream site to an upstream one (Småros, 2005).

Visibility is a complex issue that involves people, processes, technology and information flow (Montgomery et al., 2002). It sustains, accelerates or enables other supply chain drivers such as collaboration (e.g. sharing real-time data with key customers, supplier, and partners or standardizing processes and practices), optimization (e.g. elimination of inefficiencies), and execution (e.g. improvement of inventory and order management). Ideally, visibility enables all supply chain members a timely access to all relevant information related to that particular member's role in the supply chain.

It is possible to approach visibility from both a tactical and a strategic perspective (ibid.). The tactical perspective focuses on the visibility of the flow of materials, available capacity and resources. In this sense, visibility permits alerts regarding when, where and why a problem or changes occur and thus enables a quick response to the issue in question, whether a change in customer demand or a problem in manufacturing capacity. The tactical visibility perspective can be illustrated as in Figure 1; this categorizes visibility first into demand visibility (includes sharing of forecast

information) and supply visibility (includes sharing of inventory levels and capacity information). These are the areas where more sophisticated e-business solutions are implemented. Visibility of lifetime usage of products is becoming more and more important when manufacturing companies are integrating into downstream services. Overall, from the tactical perspective, efficiency and quality of operations are enhanced and, through improved visibility, supply chain members have a better control over various supply chain operations.
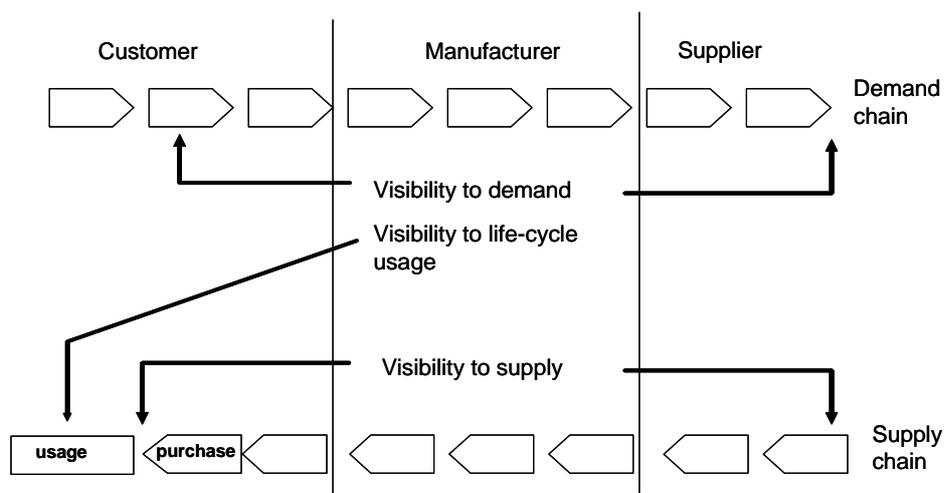
Figure 1 Tactical perspective on visibility in SC

The strategic visibility perspective on visibility allows us to see the possibility of evaluating and re-shaping supply chain processes to better meet the demands of customers or changing business environments (Montgomery et al., 2002). One example is the possibility of leveraging risk-pooling concepts so products can be stored at fewer locations than in traditional situations where the visibility of customer demand in limited (Swaminathan and Tayur, 2003). Another example is the possibility of moving make-to-order strategy a result of improved visibility in the supply chain (Gibson and Edwards, 2004). Overall, the strategic perspective focuses on establishing cooperative partnering relationships and collective decision-making practices amongst supply chain players (ibid.).

Actually, the division into tactical and strategic visibility perspectives is compatible with Swaminathan's and Tayur's (2003) classification of SCM objectives into two

broad categories: coordination (execution-oriented) issues that relate to the actual execution of the supply chain and can be considered representative of the tactical perspective, and configuration (design-oriented) issues that relate to the basic infrastructure on which the supply chain executes and can be considered more strategic in nature than tactical. Respectively, configuration-level issues include topics such as procurement and supplier decisions (supplier selection, outsourcing decisions, procurement policies etc.), production decisions (manufacturing sites, capacity allocations etc.), distribution decisions (channels, distribution and retail locations, transportation issues etc.), and information support decisions.

2.2   Transactions and resource network

Callon et al. (2002), who are economic sociologists, offer an interesting viewpoint on the duality of transactions and resource networks. Callon et al.'s (ibid.) analysis is based on the statement that the transformation of the economic system where the services play an important role is presumed to change the characteristics of the products traded in the service economy. This assumption led them to recognize and define the distinction between a good (i.e. transaction) and a product (i.e. the resource network).

Araujo and Spring (2005) build on Callon et al.'s work and stress that materiality and physicality or tangibility should not be confused when talking about a tradable good. Services can also be made tradable by defining, delimiting and standardizing their content (Callon et al., 2002). Services as well as material goods can have "objectified properties" and be fit for the attachment and transfer of property rights. Consequently, the division into manufactured goods and services provision is irrelevant. The important point is whether the buying and selling transaction can be explicitly defined or not. Or, as Hill (1977) defines a good, it must be capable of being the subject of a transaction between two or more different economic units. However, services do differ from goods in that they are not entities that can exist independently of their producers and consumers (Gadrey, 2000).

A product, on the other hand, is an economic good seen from the point of view of its production, circulation and consumption (Callon et al., 2002). It is a process that

consists of a series of operations that transform it, move it and cause it to change hands. The concept of product encapsulates the process that includes the transformations the product undergoes during its life cycle. There are different resource networks involved during the life cycle, i.e. during design, production, distribution and conception processes related to a product. The coordination of these resource networks is a key issue in the process that Callon et al. (ibid.) define as a product. Further, the definition of what a product is implies the concept of socio-technical capacity (Gadrey, 2000). This socio-technical capacity consists of human competences and material devices that have been designed and arranged in such a way that they can be mobilized in order to achieve desired results.

Actually, Callon's discussion about the distinction between a good and a product is in many ways similar to the classification of SCM objectives offered by Swaminathan and Tayur (2003). However, Callon et al. (2002) are more specific in recognising that the two perspectives, transaction and resource network, are present at the same time, and furthermore, their definition also incorporates service provision into the analysis.

2.3   e-Business in SCM

2.3.1   Recent developments in the field

E-business is particularly important for supply chain management as a consequence of the increasing need for integrated activities and information flows and to optimize the processes, not only at the single company level, but also at the level of inter-company processes (Stevens, 1989; Desouza et al., 2003). Researchers continue to exert great pressure to answer the question of whether and how e-business investments create business value for SCM (Zhu and Kraemer, 2005). Subramani (2004) adds to the discussion by arguing that companies are not confronted with the question of whether they should invest in e-business, but more importantly with that of how they can take advantage of e-business and the visibility it brings to SCM.

In general, the discussion about the benefits of e-business in supply chain management is fraught with problems because of the following points, which have been noted insightfully by Walton and Gupta (1999) in their discussion of the benefits of EDI.

First, some benefits are dyadic, some dependent on both (or a number of) supply chain parties, and some individualistic, i.e. within just one company. Second, the magnitude of change differs from slight to significant process change and to the creation of competitive advantage. Finally, the benefits depend on environmental and institutional issues.

Many conceptual papers (for example, vanHoek, 2001; Lee and Whang, 2001; Levary, 2000; Cross, 2000; Bowersox and Daugherty, 1995) discuss how the Internet and various e-business tools and methods impact supply chain management by providing visibility. However, existing theories of e-business benefits have several shortcomings. For example, the ambiguities in the existing theories make it unclear whether or how to distinguish between complex concepts such as operational efficiency, operational flexibility, and internal or external business process coordination (McLaren et al., 2004), which are the core concepts of supply chain integration. McLaren et al. (ibid.) recommend that the organizational impact of e-business to SCM should be evaluated independently for each of the four concepts. However, they note that there are significant interrelationships between each of them. Operational efficiency and operational flexibility are sometimes seen as contradictory goals, yet their study indicates that "efficient flexibility" is an important ability of e-business in SCM. That means that firms distinguish between processes that require support for efficiency (such as order processing) with those that require support for flexibility (such as sourcing) (Reddy, 2001). In conclusion, it can be stated that the viewpoint is generally that of transaction excellence when discussing the benefits of e-business to SCM.

The resource-based view (RBV) has been used as a theoretical basis for linking e-business use and value in SCM. Here the viewpoint is directed more towards the resource network that companies are engaged with in their supply chains. Rooted in the strategic management literature, the RBV of the firm posits that firms create value by combining heterogeneous resources that are economically valuable, difficult to imitate, or imperfectly mobile across firms. Also in the information systems (IS) literature, RBV has been used to explain how IT business value resides more in the organization's skills to leverage IT than in the technology itself (Clemons and Row, 1991; Ross et al.,

1996). This means that the value of e-business depends on the extent to which it is used in the key activities in the firm's value chain (Zhu and Kramer, 2005). Subramani (2004), who is interested in the value creation potential from the supplier's point of view, shows that the benefits are mediated by the deployment of relationship-specific investments. His findings are in line with the argument that sustained value can be derived from firm-specific, economically valuable, resources that are enabled or supported by technologies (Christiaansen and Venkatraman, 2002).

Previous research has produced various frameworks to theorize about IT benefits to SCM (see, for example, Mirani and Leader, 1998; Zhu and Kraemer, 2004). However, as a construct, the business value of e-business and improved visibility in SCM is a complex issue on the one hand, and subjective and relative in nature on the other; it would therefore be unrealistic to expect to find a single best theory or framework that explains the phenomenon (McLaren et al., 2004). Nevertheless, a framework is an asset in categorizing the realized or potential benefits of the phenomenon and in identifying new research opportunities. Mukhapadhyay and Kekre (2002) develop and test an integrative framework to couple both the strategic and operational gains of electronic integration for industrial procurement. They show that direct strategic benefits are gained as the implementation of EDI strengthens the business relationship between customers and suppliers. Their study also illustrates that the operational measures of relevant business processes improve at both the supplier and customer ends after implementation. Further, their analysis indicates that significant improvements in process performance lead to enhanced strategic gains, although there is a time lag involved. Similar results could be expected to be relevant to e-business investments also.

However, scepticism about the value of e-business and IT in general has been renewed recently, in part due to the gap between substantial spending by firms on IT, in particular on Internet-related technologies, and the widespread perception of lack of value from e-business (Zhu and Kraemer, 2005). Nicholas Carr's article (2003) "IT Doesn't Matter" triggered a wave of debate over the new "IT value paradox". Carr claims that IT has become a commodity, much as railroads and electricity became in

the past, and therefore it cannot possibly produce competitive advantage. The counter argument is based on the premises that only the "technology" has become commodity-like but the e-business solutions for integrating IT to companies' strategic contexts is by no means commoditized (Vandenbosch and Lyytinen, 2004). Thus, the value of e-business has emerged into an active research area (Straub et al., 2002). However, there is a lack of empirical results that examine the relationship between e-business and supply chain (Cagliano et al., 2003; Wu et al., 2003). Further, the more prominent ones tend to have a transaction focus, a natural choice as the main driver for e-business investments derives from transaction excellence.

2.3.2 Empirical research

Wu et al. (2003) study how e-business adoption affects business performance through a survey of telecommunications, semiconductor, and equipment manufacturing sectors. They analyze four business processes: internal and external communication, internal administration, order-taking and procurement. Thus, the focus of the study is in transaction excellence. Performance measures used are: efficiency, sales performance, customer satisfaction and relationship development. At the time of the study, online order taking and e-procurement were at low levels of adoption. According to the results, neither online order taking nor e-procurement significantly influenced any performance measures. Results are assumed to reflect the lack of adequate foresight into the potential performance outcomes during the planning stages. However, e-business adoption in communications has a positive impact on all four performance measures and adoption in internal administration impacts on customer satisfaction and relationship development. Overall results indicate that the benefits of e-business should be studied independently in relation to different business processes.

Subramani (2004) examines how the supplier benefits from information technology use in supply chain relationships through a survey of suppliers to a selected manufacturer. The manufacturer has a proprietary system through which suppliers receive a range of periodic reports about sales, product forecasts, and inventory alerts. Additionally, suppliers have access to field-service records for their products. Subramani's (ibid.) results indicate that suppliers can benefit by participating in supply chain management

initiatives of network leaders. However, suppliers need to deploy relationship-specific business processes. Further, suppliers that the focal firm is dependent on, for example, suppliers of innovations and inputs to critical decisions, are likely to benefit more. By collaborating with the focal firm and investing in relationship-specific solutions, suppliers can create differentiation and the relationship-specific asset can also be a strategic asset. However, Subramani (2004) does not provide detailed information as to what the operative and strategic benefits for suppliers might be.

Zhu and Kraemer (2005) study post-adoption variations in usage and value creation of e-business to organizations through an international survey. They analyze the characteristics of the Internet (open standard, public network, and global connectivity) from two functional perspectives: front-end functionalities and back-end integration that contribute to e-business value (Zhu, 2004). Front-end functionalities provide product information to customers on the Internet and facilitate transaction processing. Back-end integration links Web applications with back-office databases and facilitates information sharing along the value chain with suppliers and business partners. Their results indicate that back-end integration has a stronger impact on firm performance than front-end functionality. The reason is that back-end integration is firm specific, difficult to imitate, and less mobile across firms. It is often tailored to a firm's strategic context that is not transparent to competitors. Further, back-end integration and respective e-business solutions enhance linking fragmented resources together.

Puschmann and Alt (2005) provide one of the first studies of how companies use e-procurement systems and what benefits they bring along to SCM. They study the e-procurement practices in five multinational companies that are considered to be successful case examples. The study indicates that successful implementation relies on critical analysis of current procurement practices and realignment and reorganization of processes, cooperation with suppliers, careful content and catalogue management, and integration of e-procurement and back-end systems to achieve operational efficiency. The results further demonstrate that e-procurement is a non-technical issue. More effort is spent on organizational than on technical issues. This is in line with the findings of Power and Sohal (2002) who study the adoption of the European Article Numbering

(EAN) system for the application of business-to-business e-commerce in ten case companies. A common theme to emerge is that the planning process was "evolutionary" rather than "revolutionary" for many of the group. This is presumed to be due to the difficulties in planning for implementation in the face of rapid technological change.

2.4 Business value of service integration from the SCM viewpoint

2.4.1 Recent developments in the field

Manufacturing companies are confronted with the challenge of transferring themselves into a service business (Cohen et al., 2006). One area where this discussion is relevant is the manufacturing of high-cost capital goods that Davies (2003) calls complex products and systems (CoPS). Good examples are elevators, paper machines and mobile phone networks. Manufacturers of these products are moving away from the transactional business imperative and offering more integrated and value-adding services to their customers (Lovelock, 1994; Gadesh and Gilbert, 1998; Matthyssens and Vandenbemt, 1998; Wise and Baumgartner, 1999). This move or transition requires new ways to share responsibilities among supply chain partners (Simchi-Levi et al., 2004) throughout the entire life cycle of the products. It is presumed that the rules by which markets function may change as a result of changes in the characteristics of the products traded in the service economy (Callon et al., 2002).

Thus, to be able to operate competitively in a more service oriented business environment, manufacturing companies need to position themselves differently in value chains and develop systems integration capabilities (Wise and Baumbartner, 1999; Galbraith, 2002; Davies, 2003). As solution providers, firms need to rethink how value is created from the perspective of their customers (Galbraith, 2002). Further, manufacturing companies need to have better visibility into customer processes and into the products and their usage. Different solutions based on the Internet and, for example, remote diagnostics offer technological solutions (Roth and Menor, 2003). Also, various service offerings (for example, service contracts) that enable tighter integration into customer operations are being developed. Within the scope of this

thesis, we are interested in the manufacturing companies' skills that enable them to benefit from the improved visibility of customer demand in their supply operations. In many ways, this challenge is similar to the one described in Section 2.3, where we discussed the use and benefits of e-business to supply chain management. Here also the need to integrate activities and information flows creates a visibility that can be exploited in supply chain management.

Holmström et al.'s (1999) demand-supply network model is a tool that can be used to illustrate this change in service logic (Figure 2). The model integrates the customer's demand chain with the supply chain at order penetration point (OPP) and value offering point (VOP). The OPP is the point where the product or service is allocated to a specific customer (Sharman, 1984). The VOP is a concept complementary to that of the OPP. It is the point in the customer's demand chain at which the customer allocates the demand to a specific supplier. In a transactional business situation, the VOP is located in the customer's purchasing function, where the buyer selects witch supplier to use. When moving to downstream services, the VOP is located further down in customer's demand chain. The service provider thus benefits from better visibility in the customer's demand chain.
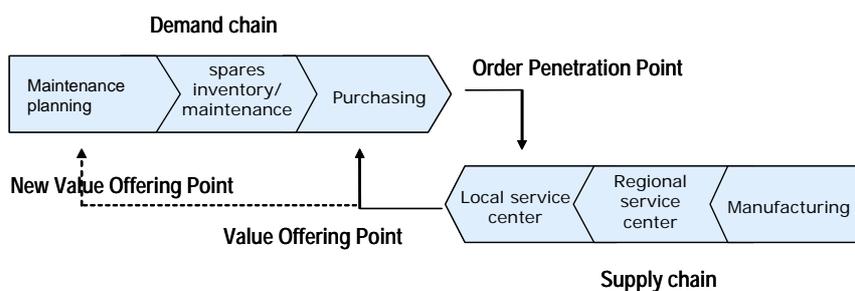
Figure 2 Value offering point and demand-supply chain model (modified from Holmström et al., 1999)

Holmström et al's (1999) conceptual demand-supply chain model can be used to highlight three important issues related to possibilities of benefiting from improved visibility. First, it shows that it is important to understand the demand chains, i.e. what the customers' processes that create demand for different services are (Vollman, 1996).

This involves gaining a detailed understanding of the activities a customer performs in using and operating a product through its life cycle, from sale to decommissioning. Second, Holmström's model enables specification of the value offering points (VOP) that the company wants to target. The location of VOPs determines what type of visibility into the customer demand chain is attainable. Third, the model helps to outline the structure of the resource network needed to meet the identified types of demand: Who are the main parties? What are their roles? Where is the value created? Here the question is whether we are able to utilize the improved visibility of customer demand in enhancing the resource network needed for fulfilling the targeted customer demand.

2.4.2 Empirical research

Oliva and Kallenberg (2003) present one of the few case studies available on capital equipment manufacturers that have gone through the transition from product manufacturer to service provider. The study includes eleven German companies that offer services related to the installed base of their products. It describes the challenges related to the change from manufacturing-oriented organization to service-oriented where the economics of the business is different from the product market. Oliva and Kallenberg (ibid.) show that successful companies have ended up creating separate organizations to handle the service offering in order to create the necessary metrics needed to run the business. Further, the study recognizes that later, in order to make better use of the installed service organization, companies have moved towards maintenance contracts. This transition changes the focus of the value proposition from making sure the product works on its own to the product's efficiency and effectiveness within the end user's process. However, Oliva and Kallenberg (ibid.) do not study the challenges or opportunities related to the improved access to the installed base of products.

Davies (2003) is another available case study of the challenges manufacturing companies face when moving into high-value services and solutions. The study includes five international suppliers of complex products and systems that offer comprehensive services to manage, maintain, and operate a product through its life cycle from sale to de-commissioning. The results indicate that it is possible for

manufacturing companies to leverage their position. Manufacturing companies are able to benefit from the improved visibility of the installed base by creating new feedback loops within different parts of the same company. Lessons learnt can be fed back into the design and build of the current and future generations of the products. Pure service companies do not have the same possibility. Davies (ibid.) gives Ahlstom, a train manufacturer, as an example. Instead of building the rolling stock and selling it to the train operator who then arranges maintenance, overhaul and train operations, Ahlstom now maintains, upgrades, converts, and re-deploys rolling stock as usage patterns change. In this closed loop, the rolling stock never leaves the oversight of the designer and builder and Ahlstom is able to have the managers responsible for maintenance and operational services involved in the front-end design of the rolling stock and propose modifications to create easy-to-maintain and easy-to-use trains.

Akkermans and Vos (2003) studied relevant root causes and associated countermeasures of the amplification phenomenon in service supply chains by conducting a case study in a service supply chain that was a part of a major U.S. telecom company. This chain was primarily responsible for providing new telecom services to customers and had experienced severe order backlog and workload fluctuations in the past. Improved visibility of end-customer demand and distributing that information upstream in the supply chain has proved to be a good countermeasure against the amplification of demand variability, i.e. the bullwhip effect in product businesses (Lee et al., 1997). According to Frohllich and Westbrook (2002), the same would not necessarily apply to services. Akkermans and Vos (ibid.) discovered that not all causes known in the manufacturing sector were valid in services. Given the nature of telecom services, "make to stock" was not possible; hence, batch-ordering effects did not occur. Shortage gaming also did not apply. Amplification effects arising from delays in demand signalling did apply to some extent and price variations were considered to be a key cause of demand amplification in their case study. Their research further indicated that there is a new root cause for amplification that is relevant for services: interactions of high workloads and reduced process quality start reinforcing each other once workloads pass a certain threshold. This finding highlights the

importance of process quality of service supply chains, and the necessity of viewing the processes of demand and supply simultaneously when developing services.

2.5   Conclusions of the literature review and gaps in theory

Visibility as a concept can be approached from many viewpoints related to excellence in supply chain management. First, visibility is achieved by both technological and organisational means. Second, it enables improvements to customer value that can be provided, as well as to the efficiency of internal operations. Last, visibility has a tactical and a strategic element, meaning that visibility impacts the transactions throughout the supply chain on the one hand, and the structure of the resource network on the other. The main research gap of this thesis is related to this multifaceted nature of visibility. Previous research into the subject of supply chain visibility has for the most part focused on transaction excellence and on such issues as how to create demand or material flow visibility; other such research has analysed the possibilities of different supply chain members benefiting from visibility. Thus, even though visibility has been discussed from many viewpoints, there are few studies that describe the different viewpoints from which visibility has been discussed as well as the potential linkages between them. Especially the more strategic issues related to the structure of the resource network have not been extensively covered. The compendium part of the thesis and especially the discussion in Chapter 5 addresses this gap by first identifying relevant perspectives of supply chain visibility and then providing a more comprehensive view of the role of visibility in supply chain management.

Within the scope of this thesis we are interested in the technological and organisational means of providing supply chain visibility, especially how these means are being used and what benefits from their use can be identified. When examining the existing literature about the technological means of improving visibility to supply chains, the identified research gap is based on the suggestion that one way to improve our understanding of the challenges and business value of e-business is to study post-adoption variations in usage (Zhu and Kraemer, 2005). Thus, more qualitative and empirically grounded research into the actual usage of e-business solutions in different supply chain contexts is needed, especially as the technology itself is becoming

commodity-like (Vandenbosch and Lyytinen, 2004). Research papers 2 and 3 address this gap by analysing the use of e-business and the attainable benefits.

Probing into the literature that deals with the issues related to the move from manufacturing-oriented business rationale to more service-oriented approaches through downstream integration demonstrates a lack of attention on the possibilities of improving the visibility of customer demand and installed base. Further, the literature review identifies a need for enhanced understanding of how to benefit from enhanced visibility in providing better value to customers or improving suppliers' own operations. Thus, improved understanding of the possibilities of benefiting from this improved visibility would be a valuable addition to the present body of knowledge. Research papers 4 and 5 address this gap by analysing the challenges and opportunities related to improved installed base visibility.

3 METHODOLOGY

3.1 Research questions

Based on the identified gaps in theory, the following research question was formulated:

RQ How can improved visibility in supply chain management be exploited?

This question is based on the observation that factors affecting the possibilities of benefiting from supply chain visibility in different problem situations are not adequately understood. Whereas previous studies on the subject of supply chain visibility have largely focused on transactions and concentrated on such issues as demand visibility or material flow visibility, this thesis aims to develop a more comprehensive conception of the role of visibility in supply chain management

In order to answer the main research question of this thesis, the problem is approached from three viewpoints. First, we need to understand the major challenges related to the technological and organizational means of improving supply chain visibility in different problem situations. The means studied are e-business solutions as technological means and service integration as organizational means, as specified earlier. Different problem situations refer to transaction and resource network perspectives. Second, it is important to know how companies are using the means to create visibility. Finally, insight is needed into the opportunities companies have to benefit from improved visibility in different problem situations. These issues are approached in research papers that form the empirical part of this thesis.

First, to uncover areas for research and theory development related to the impact of e-business on SCM, the research question in Paper 1 is formulated as:

Paper 1 RQ1 How can research and development efforts be focused to maximize the benefits of e-business in supply chain management?

To explore the territory further, descriptions of the use and attainable benefits of e-business to SCM are needed. Papers 2 and 3, which study post-adoption usage of e-business solutions, address following questions:

Paper 2 *RQ 2* *How are e-business tools used in supply chain management?*

RQ 3 *How do companies benefit from e-business in supply chain management?*

Paper 3 *RQ 4* *How are various project stakeholders using www systems in distributed engineering projects?*

RQ 5 *How do the benefits realize in different use modes?*

RQ 6 *What types of factors explain the way project stakeholders use the www system?*

The analysis of the use and benefits of e-business directed our attention to the role of visibility in SCM. Service integration offers another perspective on this phenomenon. As already discussed, manufacturing companies seek for opportunities to integrate better with the value-creation processes of their customers. Thus, an interesting question is raised: How do the changes in the customer-supplier interface impact manufacturing companies' opportunities to exploit improved visibility in SCM? To approach this question, Papers 4 and 5 seek answers to following:

Paper 4 *RQ 7* *Is it possible to improve operational efficiency and customer service simultaneously?*

Paper 5 *RQ 8* *How do manufacturing companies approach demand and supply management of industrial services?*

RQ 9 *What type of challenges related to demand and supply management of industrial services can manufacturing companies identify?*

3.2   Research design and methods

The research design is the overall program of research being undertaken, and involves the procedures the researcher carries out for the study (Emory and Cooper, 1991). This thesis builds on results from five individual research papers. The process is described in Figure 3.
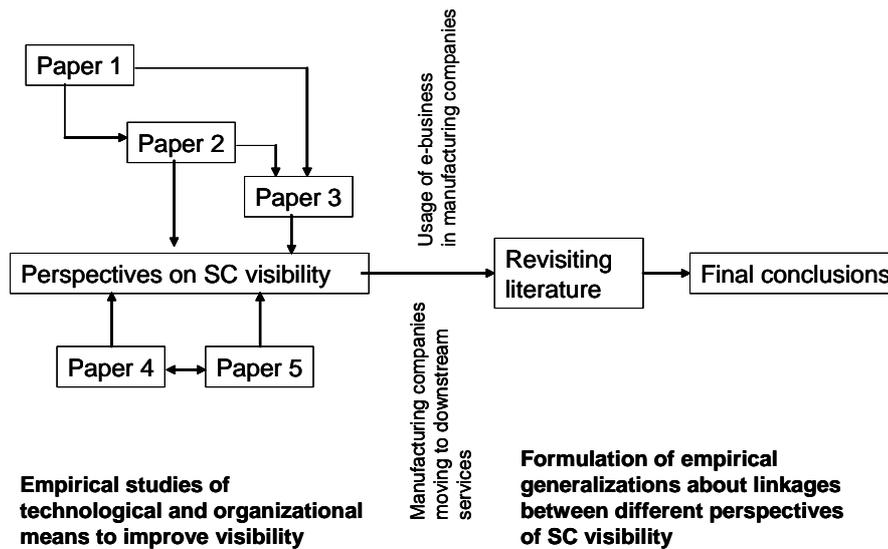
Figure 3 Research process

During the empirical part we identify and describe challenges related to the selected technological and organizational means that improve supply chain visibility, identify how companies are using the means and what type of benefits have been realized. After that, the literature is revisited to identify relevant theories and constructs that could further enhance the analysis of key findings from the empirical studies; the final conclusions about the research question of this thesis are then drawn.

In this thesis, the case study research approach is used in the research papers that form the empirical part of the thesis. Yin (1994, p. 59) defines it as an empirical inquiry that investigates a contemporary phenomenon within its real-life context, addresses a situation in which the boundaries between phenomenon and context are not clearly evident, and uses multiple sources of evidence. This is a useful approach when the phenomenon investigated is complex, the current theoretical base is thin, or the

phenomenon is difficult to study outside its natural environment (Bonoma, 1985; Eisenhardt, 1989). Further, the case method is frequently a recommended approach in situations where many of the variables related to the phenomenon are still unknown (Meredith and Roth, 1998). Handfield and Melnyk (1998) also recognize the usefulness of the case study approach when discovering and describing new territories in the early stages of theory-building process. Thus, this case method is well suited for inductively building an understanding of phenomena related to the role of visibility in supply chain management.

As the research is descriptive in nature and aimed at understanding and describing concepts (Ellram, 1996), qualitative methods are the main data-collecting methods used in the thesis. The data is collected by interviews and analysis is mainly performed by categorization, pattern search and key element identification. The methods used in the individual research papers include topical study, single and multiple case approaches. A single case study is applicable when the case is unique or where the researcher is able to access a previously remote phenomenon or an exploratory or pilot study of a situation to be representative of a large population (Yin, 1994). Multiple case studies provide a purposive sample and the potential for generalizability of findings (Miles and Huberman, 1994). Furthermore, multiple case studies provide a more rigorous and complete approach than single case study research, due to the triangulation of evidence (Eisenhardt, 1989, Yin, 1994). Additionally, multiple case studies are appropriate as they provide for rigorous methodology for replication logic (Parkeh, 1993, Tsoukas, 1998). The methods, sample, data collection and data analysis used in each paper are summarized in Table 1.

To formalize the empirical generalizations (Wallace, 971, p.18.) about the role of visibility in supply chain management, an approach described by Lewis (1998) as iterative triangulation was used. This inductive approach employs systematic iterations between literature review and case evidence. Naturally, intuition is present in the process. The process resembles that of abductive reasoning (Dubois and Gadde, 2002). Abductive reasoning is a process in which theoretical frameworks, empirical fieldwork, and case analysis evolve simultaneously and includes elements of both induction and

deduction. It implies that we start with the particular, identifying a particular phenomenon, and then account for that phenomenon by relating it to broader concepts (Coffey and Atkinson, 1996). Within the context of this thesis, this means that new theories and constructs are introduced in the search for the "best explanation" of the role of visibility in supply chain management described in individual research papers. In this thesis, the iterative triangulation is limited to the five research papers included in this thesis.

Table 1 Research methods used in individual papers

	Research method	Sample	Data collection	Data	Analysis
Paper 1	Delphi method based topical study	Sixty-five experts from companies, service providers and research institutes	Interviews Delphi workshop	Opinions on and experiences relevant to key challenges of e-business in SCM	Identification, categorization and prioritization of key challenges
Paper 2	Multiple case study	Forty-eight companies in Phase 1, of which eighteen used in Phase 2	Phone inquiry, in-depth interviews	IT application description, implementation experiences, observed benefits and challenges	Within-case analysis and cross-case pattern search for proposition formulation
Paper 3	Multiple case study	Ten companies from project networks (customers, engineering offices, manufacturers)	Structured interviews	Process information on document management practices, experiences and opinions	Within-case analysis and cross-case pattern search
Paper 4	Single case study	One industrial service provider – customer relationship, maintenance services	In-depth interviews, workshops	Process information, experiences and opinions	Identification of opportunities to increase efficiency and improve customer service
Paper 5	Multiple case study	Five industrial service providers	Semi-structured / thematic interviews	Experiences and opinions	Identification of challenges

3.3   Validity and reliability

Concerns regarding validity and reliability are particularly important for case-based research (Yin, 1994). A good research design requires external validity, reliability, construct validity, and internal validity (Ellram, 1996).

External validity reflects how accurately the result represents the phenomenon studied and to what extent the study's findings can be generalized beyond the immediate case study. It is an issue that must be addressed during the design of the research and especially when selecting the cases (Stuart et. al, 2002). Multiple cases have higher external validity than single cases (Voss et al., 2002), but overall, limited external validity is regarded as a weakness of the case study method (Stuart et. al, 2002). In Papers 1, 2, 3 and 5, analytical generalization, as recommended by Yin (1994), has been enhanced by using replication logic in multiple case studies. Paper 4 is based on the results of a single case study. Its external validity may thus be weaker. However, it is possible to generalize from one case (Stuart et. al, 2002, Schonberg, 1982)

Reliability is the extent to which a study's operations can be repeated with the same results. In the case study context, the issues that are key to reliability are the use of a case study protocol, and development of case study database. During the empirical work for this thesis, pilot interviews were used to refine the research content and procedure before each data-collection phase. Pilot interviews were also used to refine the case study protocols and the interview guides used in the studies. Reliability was further addressed by sending copies of the interview guides to the respondents before the actual interview sessions with information stating the objectives of the research. Also, case study databases were formed with detailed summary write-ups of each of the cases covered in different studies of this thesis (Stuart et al., 2002).

Construct validity addresses the establishment of the appropriate operational measures for the concepts studies. One way to deal with construct validity, according to Yin (1994), is to return the case study reports to the informants for verification. This was done in Papers 2 and 3. In Paper 1, the majority of informants participated in a Delphi workshop to discuss the results. Regarding Paper 4, the draft findings of the case analysis were presented to the management team of the company. In Paper 5, the draft case reports and preliminary analysis was discussed with one of the case companies, as well as with a team of supply chain experts. Second tactic is to describe how data were collected via sources used in the study. All of the research papers have a clear description of data collection procedures.

Chapter 3: Methodology

Internal validity is the extent to which causal relationships, as distinguished from spurious relationships, can be established between constructs (Stuart et al., 2002). According to Ellram (1996), internal validity in case study research relates to making proper inferences from the data, considering alternative explanations or use of convergent data. Internal validity is typical for explanatory research, but is not applicable for descriptive or exploratory case research (Yin, 1994, Ellram, 1996).

4 RESULTS OF INDIVIDUAL STUDIES

4.1 Research agenda for e-business logistics (Paper 1)

Paper 1 provides answers to the question: How can research and development efforts be focused to maximize the benefits of e-business in supply chain management? The focus of the analysis is on supply chain integration. It analyses the opportunities to improve supply chain visibility and identifies, categorizes, and prioritizes the key research and development topics that should be dealt with in order to help companies face the challenges the emerging e-business technologies and respective business processes bring to an SCM context.

This study was conducted during the so-called e-business hype stage (late 1990's and early 2000's), when a lot of unsubstantiated promises were made in supply chain management (Figure 4). Motivation for the study derives from the finding that many companies were struggling with the question of how e-business impacts the supply chain and when there was a lot of uncertainty as to where the development was leading (CEST, 2000; Ferrari, 2000). Also, organizations like the National Technology Agency of Finland that offer funding to promote the diffusion of new technologies to foster the competitiveness of industry needed guidelines as to where to steer research initiatives.
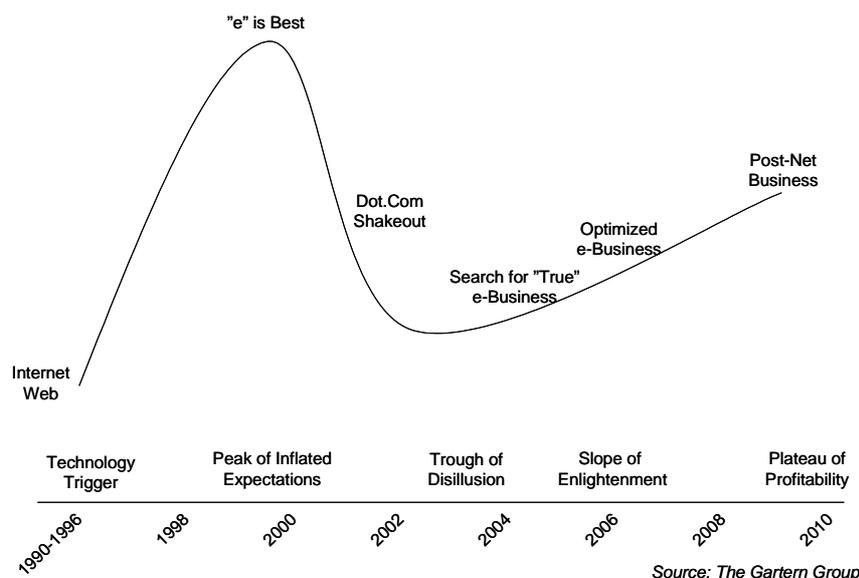
Figure 4 The e-Business Hype Cycle

Chapter 4: Results

The empirical setting of Paper 1 is based on a Delphi method (Linstone, 1975) where experts' views and opinions are first gathered through an iterative process and then discussed and agreed on in a workshop. During the process, sixty-five experts from leading Finnish companies and academics were interviewed and a panel workshop to finalize the results was organized. Based on the prioritization of R&D topics in the Delphi workshop, Paper 1 presents the research agenda to be used as a guideline to focus research and development initiative to capture the full potential of e-business in supply chain operations. Three themes are emphasized:

Theme 1	Improved supply chain visibility and supply network integration
Theme 2	New logistics service concepts and their role in integrated supply networks
Theme 3	New identification methods such as RFID and their role in integrated supply networks

Theme 1 is about improved supply chain visibility and supply network integration. Regarding this, Paper 1 calls attention to three important issues. First, enough resources must be allocated to increase companies' understanding of the new possibilities that e-business tools and methods bring to supply chain integration. Second, solutions that help companies to actually increase supply chain visibility and thus improve the possibility of using real-time data (demand forecasts, demand information, inventory levels etc.) with supply chain partners need to be developed. Third, it is further emphasized that technology development related to the information transfer and real-time visibility is not enough. New business processes that enable information flow across company interfaces need to be developed. Here it is imperative to allocate enough resources to build knowledge and expertise as to what information to share, how to share information, how to use the shared information in decision making, how the responsibilities and risks are shared etc. All these are preconditions to successful collaboration between supply chain partners, which forms a building block fundamental to beneficial supply chain integration.

Chapter 4: Results

Paper 1 confirms that visibility and real-time data transfer between supply chain partners also creates new challenges and opportunities for logistics service providers. These service providers will be more tightly integrated into the supply chains through various e-business applications and operational measures such as delivery accuracy, delivery frequency, and delivery time will become even more important. Thus, Theme 2 of the research agenda calls for research and development of new logistics service concepts and their role in the more integrated supply networks. Additionally, as integration with these new logistics services would enable companies to focus on their core competencies (Prahalad and Hamel, 1990), more knowledge as to how collaboration should be organized and what type of changes must be made to the various business processes, both by the logistics service provider and by the focal company, is needed.

The third identified research and development theme, Theme 3, focuses on research into identification methods such as RFID (e.g., product, parcel or batch identity with the radio frequency identification method) in the supply network. Paper 1 specifies that two perspectives are needed. First, it is important to understand what possibilities new technologies that enhance visibility bring to SCM. Especially, as March (1981) noted, innovations in organizations are driven by solutions rather than by problems, meaning that organizations engage in an opportunistic surveillance by scanning the environment for new ideas that might be beneficial to the organization (Rogers, 1995). Second, new collaborative business processes create new technology demands that need to be identified.

The paper makes two main contributions. First, the findings of this study support the diffusion of e-business to SCM. Uncertainty is always related to the diffusion of innovations in organizations, especially in the initiation stages when companies are scanning the environment for new ideas that might be beneficial to the organization (Rogers, 1995). This is particularly true regarding IT innovations. Information is a means of reducing uncertainty (ibid.) and a research agenda like the one conducted is an important element in the diffusion process of e-business. Second, from the more practical point of view, the presentation of the research agenda and the highlighting of

those areas that are the most crucial to the success of e-business initiatives helps companies to see the interrelation of e-business and supply chain management more clearly, and thus will help them to allocate research and development resources to the areas with most potential.

4.2 Benefits of e-business in SCM (Paper 2)

Paper 2 is the first of the two empirical studies that analyze the use and benefits of e-business solutions to SCM. It first identifies and describes the usage of different types of e-business solutions that early adapters have implemented. These means are used to foster transaction execution, improve collaboration and coordination or enhance decision making within the supply chain. Second, it identifies the benefits related to the use of e-business means and describes possible mechanisms behind the benefits of e-business.

The motivation for Paper 2 is twofold. First, the adoption, use and value of e-business solutions is an active research area (Straub et al., 2002) as there is strong pressure to answer the question of whether and how e-business investments create business value (Zhu et al., 2004). Especially, there is a recognized need for more empirically grounded research to increase awareness of e-business initiatives and of possible mechanisms behind the practical benefits of e-business in supply chain management. Second, the issue of productive capacity of new technologies in supply chains is of paramount interest to the institutions investing funds in development and promotion of these new technologies.

The empirical setting of Paper 2 is based on the multiple case study method; this was conducted in two phases. First, forty-eight leading-edge companies that operate in a B2B environment were selected to participate in a phone inquiry. The aim was to identify what e-business solutions companies have implemented and to get a more general understanding of the type of practical benefits companies have been able to recognize. The interview questionnaire used is presented in Appendix I. Eighteen e-business solutions from the interviewed companies were selected for the second phase. These were implementations that had brought recognizable benefits to supply chain

management, and thus were interesting cases for further analysis. The selected cases included solutions based on web portals, direct system-to-system links or information logistics services provided by a 3rd party transaction hub. Cases of the identified benefits are reported in Appendix II.

Paper 2 identifies three categories of e-business solutions – process, dyadic and network – based on the level of collaboration and cooperation needed between the supply chain partners when planning and implementing the solutions. When answering the question of how companies have been able to benefit from e-business in supply chain management, Paper 2 puts forward five propositions. These propositions were the result of a qualitative analysis of the identified benefits. First, the benefits were listed and grouped and regrouped according to various criteria. Then, the selected five propositions arose from the data. With these propositions, Paper 2 aims to concretize what the benefits might be and of what they might be composed. This chapter includes only a short description of the propositions. A further explanation and empirical findings supporting the propositions can be found in the attached journal paper of Paper 2. The five propositions are:

1. Improved efficiency in supply chain operations allows company personnel to focus more on critical business activities rather than spending time on tedious data-processing activities.

2. The use of e-business solutions improves information quality within the supply chain.

3. Successful companies have developed focused e-business solutions for improving customer service elements that are most important in their business.

4. e-Business solutions that are based on planning collaboration improve the agility of the supply network.

5. For receiving strategic benefits, the use of the e-business application has to be coupled with process re-design.

Chapter 4: Results

By developing these propositions, we have identified ways in which companies can benefit from e-business in supply chain management. However, the results of Paper 2 indicate that, in the supply chain management context, the main body of companies view e-business primarily from an operational perspective and are looking for improvements to transaction execution. The possible strategic focus is related to the ability to build tighter customer or supplier relations, i.e. to create "lock-in" for customers and suppliers. There is less focus on long-term strategic opportunities to benefit from improved visibility related to the e-business investments.

Why the lack of focus on long-term strategic possibilities? First, the majority of manufacturing companies still have a lot to do regarding the basic IT infrastructure of SCM before implementing more sophisticated e-business processes. Second, according to Powell (1992), there is controversy over whether strategic benefits are deliberately planned for. It is often argued that many development projects that are considered strategic started off as simple transaction-processing systems (Mirani and Lederer, 1998). Our case findings confirm this, as it is often the combination of several more operational initiatives that, with a certain time lag, lead to strategic benefits. A third reason could be related to the premise that potential benefits are related to the degree of change in organizational routines (Venkatraman, 1994) and that a majority of the companies are still on the learning curve when exploring the opportunities of integration of processes and of improved visibility.

The study makes several contributions. First, it provides much needed empirical descriptions of the use and benefits of e-business to supply chain management. The findings of this study thus support and extend the prior research by describing the ways in which the leading-edge companies have been able to benefit from improved visibility enabled through e-business initiatives. The second contribution of the study is related to the nature of the benefits. How e-business and improved visibility enhances transactional efficiency in supply chains has been clear from the earlier research. However, characteristics of strategic benefits related to the improved visibility are not so well understood. By developing propositions 1, 2, 4 and, to some extent, proposition

5, Paper 2 presents an opportunity to further develop our understanding of the underlying mechanisms whereby IT investments lead to strategic benefits in SCM.

4.3   www system use and benefits in project networks (Paper 3)

Paper 3 extends the analysis of use and benefits of e-business solutions to SCM further. The research setting differs in this study from the previous. To overcome the bias of differences in e-business systems in Paper 2, this study concentrates on the usage of one application. Selecting only one tool enables a more thorough cross-case analysis of findings and possible more in-depth and consistent results than in Paper 2.

Paper 3 examines the post-adoption usage of an innovative collaboration tool, a web-based information logistics platform, within project networks. The tool under study is a www-enabled document management system (later referred as a www system) that supports centralized document management and supplier collaboration in inter-firm project networks. The www system is accessible from anywhere in the world with a www browser from any workstation connected to the Internet. Paper 3 analyses how various project stakeholders are using www systems in distributed engineering projects, how the benefits realize in different use modes, and what types of factors explain the way project stakeholders use the www system.

The empirical setting for Paper 3 is a multiple case study of companies operating in distributed engineering projects that use the www system for document management and collaboration within the network. The research sample includes ten companies in the Finnish marine and pulp and paper industry. The case companies were selected in such a manner that they represented both selected industries and three different positions in the project network, i.e. end customers, engineering offices and system suppliers. Five of the companies operate mainly in the marine industry and five in the pulp and paper industry. The sample included two end customers, five engineering offices and three systems suppliers. The interview questionnaire used in this study is presented in Appendix III.

Chapter 4: Results

Paper 3 first recognizes three levels of www system usage within the sample companies: 1) www-enabled centralized document management, i.e. "document sharing", 2) active use of the www system in stakeholder collaboration, i.e. "collaboration", and 3) "project management support", where companies actively both utilize the features of the www system to recognize document bottlenecks and improve processes, and use feedback information in project follow-up management. The summary of identified benefits related to different use mode categories is presented in Appendix IV.

The analysis of the identified benefits of the system use in Paper 3 confirm that the identified benefits can be divided to direct operational, direct strategic and long-term strategic, as is typical of most e-business investments (Mukhopahdahya and Kekre, 2002). Previous research states that enhanced strategic benefits related to the IT investments arrive with a time lag (Mukhopahdahya and Kekre, 2002). Our case analysis confirms this. The first example is the concurrent engineering approach and paralleling of different design phases, as the companies have on-time visibility of each other's design processes. It is not possible to enter into concurrent engineering immediately after implementing the www system to the project network. Project stakeholders need to learn the necessary collaboration practices first. However, once the concurrent engineering approach is established, it should be easy to add, for example, new system suppliers to the process. Another example of long-term strategic benefits is related to the system feature that enables efficient deployment of external resources, which shortens total lead times and brings noticeable flexibility and responsiveness to the project network. The application thus supports distributed projects by acting as a facilitator of true networking and reducing lead times, one of the key project success measures.

The results of Paper 3 show that different companies use the same www system differently, i.e. that they have different needs for improved visibility. Orlikowski and Iacono (2001) affirm that it is important to realize that tools based on technologies such as the Internet and other distributed applications do not provide the same properties in different contexts of use. Within our case sample, we realized that the network

company's position in the value chain and respective co-ordination needs define the optimal use mode for a particular company. However, the cross-case analysis indicates that companies are not necessarily using the www system as their value chain position and respective co-ordination needs may require. Paper 3 identifies four factors that seem to have an impact on how an individual network member utilizes the www-system features. These are defined as: company's internal capability, external capability, collaboration capability, and system use experience.

Internal capability refers to the way a company embraces IT and is motivated to implement the system. External capability relates to the use of external process consultants supporting the system implementation and new document management process definitions. This also includes organizational skills involved in collaborating with service providers. Co-ordination capability refers to the company's ability to link the company's other project network partners to the system use. Conversely, co-ordination capability relates also to a situation in which some other company in the network requires a company to adopt the use of the system. Further, one important identified aspect of collaboration capability relates to the ability to facilitate process changes among project network partners. Finally, system-use experience relates to the actual system-use time and its quality accumulated for a company from distributed engineering projects: a company that has been utilizing the system in a number of projects is likely to be in a more advance use mode category. Paper 3 argues that investing in these factors is a prerequisite for maximizing the benefits from improved visibility the www system use may provide to project network members.

The study makes two main contributions. First, as there is not much published research about the use and benefits of www-based collaboration tools in distributed project networks, the study provides important information that forms a basis on which to develop the research. Further, the results confirm that the benefits brought by the system follow the division into direct operational, direct strategic and enhanced strategic benefits and confirm that the last mentioned arrive with a time lag. The second contribution of the study is related to the issue of tools based on technologies such as the Internet and other distributed applications not providing the same properties in

different context of use. The results of Paper 3 indicate that the company's position in the value chain and respective co-ordination needs define the optimal use mode and potential benefits of the tool for a particular company. Particularly the identification of the factors that either confine or enable the optimal use of the tool offers possibilities of furthering our understanding of the mechanisms that enable e-business to bring business value.

4.4 Improved visibility and operational efficiency (Paper 4)

Paper 4 moves our focus from e-business to industrial services. It is the first of the two studies dealing with the supply chain management challenges related to manufacturers moving downstream. In this paper, we take the view that improved visibility of the service demand creates an opportunity to increase the supplier's own operational efficiency, while at the same time providing better service to the customer. In adopting this view, the study argues against the idea that there is a trade-off between service level and cost of providing that service (Christopher, 1998). Thus, Paper 4 provides an answer to the question: Is it possible to improve operational efficiency and customer service simultaneously?

The empirical setting in Paper 4 is that of a single case study. A case company from manufacturing industry was selected as representing a mature industry with relatively slow market growth. The selected case company is a supplier of production equipment to the process industry. It offers both standard and tailor-made equipment, in addition to spare parts and maintenance services to the equipment supplied to its global customer base. As for many other suppliers in mature industries, the supplier is currently in a transition phase. It is moving away from the traditional way of doing business, i.e. selling equipment, spare parts and repair services and is building long-term partnerships with its customers and taking greater responsibility for their processes.

In Paper 4, one of the case company's pilot customer situations is analyzed. The study uses the demand-supply framework (Holmström et al., 1999) to illustrate the opportunities to benefit from improved visibility into the customer's demand chain as the case company moves from a transactional situation to a more collaborative business

model that involves entering into a co-operative service agreement with the pilot customer. The value offering point (VOP) is a critical concept used with the framework. As discussed in Chapter 2.4.1, VOP is the point in the customer's demand chain at which the customer allocates the demand to a specific supplier. Moving the VOP changes the economics of the customer relationship. For example, by moving the VOP to inventory management, the supplier can gain access to earlier demand information from the customer, enabling the supplier to shift from make-to-stock to make-to-order production without increasing the need for capacity buffers (Holmström et al., 1999). This is the logic behind our analysis of the case situation presented in Paper 4. Details of the analysis are best recorded in the paper. Here we go directly to the identified opportunities brought about by improved visibility into customer's demand chains.

The first is the opportunity to move OPP. By offering maintenance and inventory management services, the supplier gains access to earlier demand information from the customer when, for instance, dealing with maintenance plans rather than spare-part orders. If this information is used effectively, the supplier can gain more time to react to the customer's needs (e.g. already in the maintenance planning phase rather than when the spare parts are actually needed) and it can arrange its own operations more efficiently. There are two elements to this. First, the supplier can minimize the spare-part inventories at the local service centre as it has enough time to serve the customer from the centralized supply centre. Second, it is possible for the supplier to manufacture more spare parts in a 'make-to-order' fashion than in the transactional situation where the supplier did not have such visibility of demand.

The second opportunity arises from improved quality of demand information. When the supplier is close to the situation as the demand is realized, it is possible through its expertise to identify the demand correctly and so make the order more accurate.

The third opportunity is about the possibility of influencing the demand creation rather than solely fulfilling the demand. The preventive maintenance programme is a crucial part of the new co-operation and the supplier has the responsibility to plan the

preventive maintenance programmes on the customer's behalf, the supplier being able to specify what type of spare parts will be used at the plant

In Paper 4, we argue that the supplier's new role, together with the customer as a co-producer of value, creates a potential to increase the supplier's own operational efficiency, while simultaneously providing better service to the customer. We have argued that it is possible to move away from the conventional trade-off between service level and cost of services (the better the service, the more it costs to offer it to a customer) and move the VOP to create the potential to increase the supplier's own operational efficiency. By offering value-adding services to the customer, the supplier has a new role that allows it to have improved visibility of customer demand. As a partner, the supplier has access to information that could be used to plan its own operations more effectively.

It is nevertheless clear that the proposed benefits are not gained automatically when shifting the VOP deeper into the customer's process. Instead, high requirements are set for the operations planning competencies of the supplier company. The supplier must be able to utilize earlier, more precise, information and increased planning freedom in its planning processes. Paper 4 identifies management actions that need to be taken in order to benefit from moving the VOP and respective improvements in visibility. First, performance metrics need to be changed, as, in the new situation, the supplier has the responsibility and the freedom to decide the exact timing and quantity of its deliveries. Thus, the supplier needs to build competence into operations planning to be able to use this freedom to better optimize its processes. Second, skills need to be developed to be able to capture earlier access to demand information. The supplier must use the earlier demand information to be able to benefit from increased reaction time, which can be used for optimizing production and deliveries. Because the supplier has more time to react, it is easier to reach the performance targets that the customer has set while serving the customer from centralized inventories, for example. Third, the supplier must realize that, when the VOP is moved backwards, the supplier gets closer to the origin of the customer's needs. This decreases the errors and distortion of demand information that is created by the customer company's information processing. Better

quality of information enables more accurate planning, which in turn has a positive effect on both effectiveness and customer service. Last, skills need to be developed to use the supplier's position to influence demand. When the supplier is involved in its customer's planning process in an early phase, it must actively influence both the content and timing of the customer's purchases. The supplier should, for example, guide the customer to use more standard components, which decreases the number of SKU's that the supplier controls. This in turn decreases the complexity of operations planning, which leads to better effectiveness and enables improved customer service.

Overall, Paper 4 is about opportunities to take advantage of improved visibility in the use of products. The main contribution of the study is that it offers a clear description of the possibilities of exploiting the improved visibility of customer demand in enhancing the supplier's service operations. Thus the results of Paper 4 offer an interesting avenue to further develop our understanding of the challenges of creating visibility through organisational means on the one hand, and creating opportunities to benefit from this improved visibility in service operations management on the other.

4.5   Improved visibility and operational efficiency (Paper 5)

Paper 5 is an explorative case study with the aim of increasing our understanding of the challenges companies face when moving to downstream operations. It sets out to provide answers to the following two questions. First, how do manufacturing companies approach demand and supply management of industrial services? Second, what challenges do manufacturing companies face regarding demand and supply management of industrial services?

The sample of companies interviewed consisted of five companies that were in different phases of repositioning themselves in relation to downstream operations. Two of the cases, a process machinery supplier, Alpha, and an electronics manufacturer, Beta, are looking for service opportunities to achieve new growth and profitability. Two machine-manufacturing cases, Delta and Epsilon, are already well known for their service offerings. In addition, one independent service provider, Gamma, which has no own-product manufacturing, was included in the study to provide viewpoints on

industrial service provision not influenced by manufacturing background. Additional information about the cases is presented in Appendix V.

The study follows the advice of Wise and Baumgartner (1999), who emphasize the need to understand the customer's value chain when creating or offering downstream services. Furthermore, the study builds on the ideas presented by Holmström et al. (1999) that state that, when considering the changes in the value offering, it is important to look at the demand and supply simultaneously. This means that manufacturers need to understand and manage both the processes that create demand for industrial services and the supply network structure needed to provide those services.

Paper 5 highlights several important issues regarding the characteristics of demand for industrial services. First, it confirms that knowledge of the customer value chains is a necessity when learning about the demand creation processes for industrial services. Second, the study points out that different customers wanting the same physical product might have different needs for supporting services. Consequently, the lessons learnt about the demand behaviour of the products are not transferable to the service demand management. The process machinery supplier Alpha is used as an example. One of its customers, Customer A, regards maintenance of process machinery as one of its own core competence areas and orders only spare parts and transactional services from Alpha. Meanwhile, Customer B's business strategy is to concentrate on the manufacturing process, which it sees as its own core competence. Customer B has outsourced necessary support services such as maintenance and development work to Alpha. Here Alpha's service offering is more relationship based and is what Mathieu (2001) calls a service supporting the client's action. To be able to respond to customer B's more complex demand, Alpha needs new competences in managing the spares inventory and maintenance operations on behalf of customer B. Third, although this diversity of service needs is common knowledge to service companies, the results of Study 4 confirm that manufacturing companies are easily confined to product-line thinking, and do not see that the demand for different service propositions does not depend on the product type, but rather on the customer type. Knowledge of differences

in customer demand chains could be better utilized both in focusing service offering to different customers, as well as when planning service supply operations.

The results of Paper 5 show that management of the installed base is crucial to demand management of industrial services. Managing the installed base includes staying informed about the condition of the products, i.e. knowing the past services performed on, and the scheduled service needs for, each individual product. Visibility of the installed base becomes much more important with sophisticated maintenance service contracts, where the supplier's role in managing the installed base increases. Paper 5 draws attention to three different interpretations of the somewhat fuzzy concept of installed-base visibility. First, better visibility is called for in terms of access to such knowledge that enables better understanding of the market needs for industrial services. The companies need to get better information on the actual uses and operating environments of their products to be able to develop new service offerings. Second, improved visibility of the installed base was required to understand the behaviour of demand for various service offers. This knowledge is an important element when designing the supply networks to serve the selected customer base competitively. Finally, improved visibility was deemed necessary for better understanding the customer situation in a single service call, so that service operations in a single customer case are provided efficiently and according to the agreed service level.

The results of Paper 5 confirm that there is a need for more rigorous research on the demand and supply management of industrial services. One of the key areas identified as in need of the attention of the research community is the visibility of the installed base: how is it created and, most of all, exploited by manufacturing companies that are moving downstream and offering more integrated industrial services to their customers? The exploitation potential is in transaction execution on the one hand, and, more importantly, in the management and design of efficient resource networks needed to provide competitive services on the other.

4.6 Summary of key findings and their implications

Table 4 presents a summary of the five research papers included in this thesis. It lists the key findings and their implications.

Table 4 Key findings of the studies and their implications

	Key findings	Implications
Paper 1	Identifies challenges that need to be addressed on order to benefit from e-business in SCM: (1) What possibilities do e-business tools bring to SC integration? (2) How can real-time data / visibility best be used? (3) What info should be shared, how and with whom? (4) How should business processes be changed?	*Managerial implications*: Offers directions to allocate R&D investment. R&D investments to identified areas speed the diffusion of e-business to SCM.
Paper 2	Presents five propositions that describe ways in which to benefit from e-business in SCM. Confirms that companies have been able to benefit from e-business in transaction execution. Companies have not (yet) exploited full potential of e-business. Focus has been on operative benefits related to business transactions. Only a few companies have received real competitive advantage through innovative solutions.	*Managerial implications*: Emphasis on the need to improve understanding of the nature of long-term benefits related to e-business investments. *Theoretical implications:* A step towards identifying the mechanisms or factors that enable companies to gain strategic benefits from e-business investments.
Paper 3	Recognizes three levels of www system usage in project networks and identifies how benefits evolve through application usage, i.e. how improved visibility can be exploited. Confirms that enhanced strategic benefits arrive with time lag, and that they are not always planned for. Confirms that the value net position affects the ability to benefit from e-business. Identifies factors that determine how an individual network member uses the www system: company's internal capability, external capability, collaboration capability and system use experience.	*Managerial implications:* Identified factors offer an opportunity to further develop understanding of the mechanisms whereby e-business brings business value. *Theoretical implications:* Illustrates the mechanisms whereby benefits related to the www-system usage advance as experience of use accumulates.
Paper 4	Improved visibility of customer demand enables suppliers to improve their operational efficiency. Identifies potential benefits. However, states that benefits are not gained automatically. Study identifies issues that need to be addressed for benefits to be realized.	*Managerial implications:* Manufacturing companies should look for opportunities to utilize improved visibility in enhancing their operational efficiency. *Theoretical implications:* Illustrates the use of VOP/OPP framework. Tests claims of Holmstöm et al.'s DSCM theory.
Paper 5	Identifies challenges related to demand-supply network management of industrial services. Clarifies the concept of installed base visibility: (1) Access to knowledge that can be used for product and service development. (2) Knowledge of demand behaviour can be used for supply network design. (3) Single customer situation can be handled more efficiently.	*Managerial implications:* Emphasizes the need to improve understanding of the role of installed base visibility in successful demand and supply chain management of industrial services. *Theoretical implications:* Improves understanding of the concept of installed base visibility.

5 CONCLUSIONS

In this chapter, the results of the individual papers are discussed in order to develop a more comprehensive understanding of the different perspectives of supply chain visibility. The aim is to identify linkages between different perspectives of supply chain visibility and form empirical generalizations. The discussion framework consists of three elements. First, the nature of visibility that has been studied in individual papers is defined. Second, two perspectives on the supply chain situation is specified, and, third, a three-phase framework of direct operational, direct strategic and long-term strategic benefits related to a technology adoption (Mukhopadhyay and Kekre, 2002) is discussed.

5.1   Nature of visibility

When looking at the different types of visibility that have been studied in individual papers it is possible to classify visibility into three categories: visibility of transactions, visibility of collaboration processes in distributed networks, and visibility of use of products related to service integration. The relationship between the individual research papers and the nature of visibility is presented in Table 5.

Table 5 Nature of visibility

Study	Mean that provides visibility	Nature of visibility
Paper 2	e-business application	Visibility of transactions.
Paper 3	www tool	Visibility of the status of project documents and discussion related to the design stages, i.e. visibility of process.
Paper 4 Paper 5	moving VOP	Visibility of use of products to capture customer demand earlier, i.e. visibility in use.

5.2   Two perspectives on the supply chain situation

In the literature study of this thesis we noted that supply chain management problems can be divided into two wide situation categories. It is about execution-oriented and transaction-related issues on the one hand, and about design-oriented configuration

issues where decisions are made about the structure of the resource network on the other (Swaminathan and Tayur, 2003). We also noted on page 8 that visibility as a concept also has this dual role. From a tactical perspective, it is about visibility in transactions and, from a strategic perspective, it is about the possibility of evaluating and re-shaping the resource network to better meet the demands of the customers or changing business environments (Montgomery et al., 2002).

Further, we brought in the viewpoint presented by Callon et al. (2002) about the duality of transactions and resource network. Their analysis is based on the premise that the transformation of the economic system where the services play an important role is presumed to change the characteristics of the products traded in the service economy. This assumption led them to recognize and define the distinction between transaction and resource network and claim that the two perspectives a good (i.e. transaction) and a product (i.e. resource network) are present at the same time.

To summarize the discussion on page 11, a good must be capable of being the subject of a transaction between two or more different economic units. It can be either a physical good or a service. However, services do differ from goods in that they are not entities that can exist independently of their producers and consumers (Gadrey, 2000). A product, on the other hand, is an economic good seen from the point of view of its production, circulation and consumption (Callon et al., 2002). There are different resource networks involved during the life cycle and coordination of these resource networks is a key issue in the process that Callon et al. (ibid.) define as a product. Further, the definition of a product implies the concept of socio-technical capacity (Gadrey, 2000) that consists of human competences and material devices that are needed in the process.

So, to sum up the above discussion, two distinct, but complementary, perspectives on the supply chain situation can be formally specified as *transaction* and *resource network*. These are two generalized problem situations that will be used when discussing the relevance of the identified attainable outcomes of visibility.

5.3   Perspectives on attainable outcomes

The relationship between means that provide visibility in the supply chain and potential benefits is a complex issue. As Walton and Gupta (1999) stated, some benefits are dyadic, some individualistic, the magnitude differs from slight to significant process change to creation of competitive advantage, and the benefits depend on the environmental and institutional issues. However, a framework is an asset in categorizing the realized or potential benefits. We base the analysis of the identified outcomes of means that improve visibility (i.e. the findings from the individual studies) on the work of Mukhapadhyay and Kekre (2002). They present a three-phase framework (Figure 6) of technology deployment to analyse the strategic and operational benefits of electronic integration for industrial procurement, as has already been discussed on page 14.
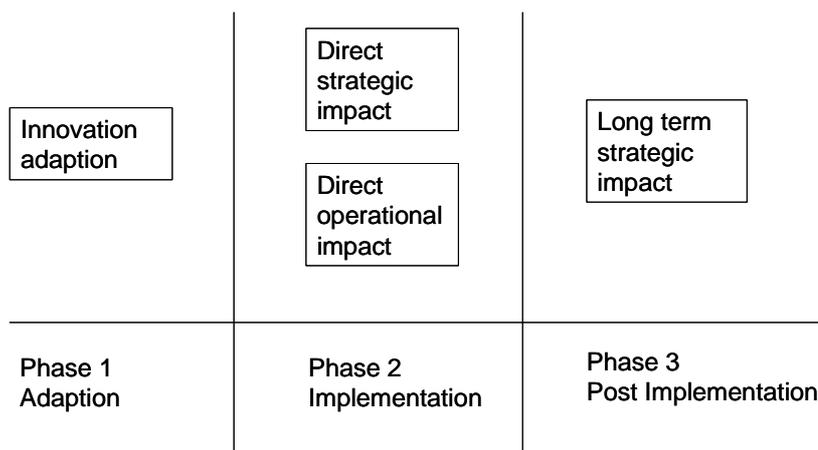
Figure 6 Framework of benefits (Mukhopadhyay and Kekre, 2002)

Mukhopahdayay and Kekre (ibid.) state that, once the adoption process is complete, the emphasis shifts to measuring the benefits of the technology implementation in Phase 2. The impacts are of two types: a) direct strategic impact through strengthening the business relationship between customers and suppliers, and b) transaction processing impact that can be measured through improvements in process-based operational measures. Finally, in Phase 3, the improvements in operational measures during Phase 2 have a potential to lead to enhanced (indirect) strategic benefits. These benefits accumulate over an extended period of time and they are presumed to capture the long-

term potential of the innovation deployment and use. Thus, significant improvements in process performance lead to enhanced strategic gains, but there is a time lag involved.

5.4   Situations, means and attainable outcomes

In this section, the results of the individual papers are discussed in order to identify the different perspectives of supply chain visibility and their interrelationships.

5.4.1 Visibility of transactions

The various e-business solutions studied in Paper 2 are solutions used in buy-side and sell- side transactions, and inbound and outbound material flows and inventory management. These means are used in situations where the transactions can be explicitly defined between the supply chain partners. These transactions are about manufactured goods as well as services (for example, transportation services). The analysis in Paper 2 enabled us to formulate propositions on the benefits that are achieved through the use of the e-business solutions and improved visibility. The identified outcomes from improved visibility in Paper 2 are presented in the Table 6.

Table 6 Identified outcomes with visibility of transactions

Visibility	Opportunity
Visibility of transactions	**Direct operational benefits** Plan e-business solutions carefully to improve information quality (relevancy, accuracy and reliability) (Proposition 3 in Paper 2). Understand the implications of the possibility of basing operative decisions (coordination decisions) on same the data throughout the supply chain (Proposition 3 in Paper 2).
	Direct strategic benefits Capture the possibility of transferring released resources (due to the efficiency improvements) to business-critical activities from time-consuming routines (Proposition 2 in Paper 2). Develop e-business solutions to such customer service areas that are most important to the business (Proposition 1 in Paper 2).
	Long-term strategic benefits Base e-business solutions on planning collaboration to improve agility of the supply network (Proposition 4 in Paper 2). Couple e-business tool with process re-design. Possibility of moving to make-to-order mode (Proposition 5 in Paper 2).

What then is the relevance of these realized benefits from the transaction execution point of view? Earlier research has indicated that the mechanisms enabling or hindering companies to benefit from access to, for example, downstream sales data are clearly not sufficiently well understood (Småros, 2005). Information quality is the essential mechanism in connecting IT to business performance (Lillrank, 2003). Thus, one important component related to the possibilities of benefiting from improved visibility in transaction execution is the understanding of the concept of information quality. It was very clear in Paper 2 that, in those cases where enough time and effort was invested in analysing what data was needed, in what context and to what purpose it was used in relation to the transactions throughout the supply chain, case companies have clearly realized improvements in information quality. Information quality benefits make the available information more useful, accurate and reliable (Mirani and Lederer, 1998). Also, the implementation of e-business solutions brought new quality requirements to product structures and content management. Everything needed to be explicitly defined in the systems in order for, for example, e-procurement solutions to function reliably.

Thus, the requirement stated by Callon et al. (2002) that, for a transaction to occur, both buyer and seller must have a common understanding of what they are trading becomes even more restrictive in e-business implementations. There must be no uncertainty whatsoever regarding of the nature of a good that is being traded through the system in order to acquire direct operative and strategic benefits. Only then do e-business solutions enable network parties to base their transactional decisions on the same data. This improves the quality of demand-fulfilment decisions and potentially counters the problem of demand-information distortion – the bullwhip effect – in a supply chain (Lee et al., 1997).

This leads us to the question: What is the relevance of visibility of transactions from the resource network point of view? It is important to realize that improved visibility of transactions create an opportunity to move resources from transaction management to the management of the resource network. In order to improve agility or responsiveness to changes in customer demand within the supply chain, transactional solutions need to

be balanced by planning collaboration. Galliers (2006) points to the common dilemma related to IT investments by stating that companies often gain efficiency at the expense of innovation. Cooperation with supply chain partners that includes regular meetings facilitates an environment that provides a supportive context for learning and interaction. As earlier research and practice shows, it is important to note that it has been difficult to implement collaboration in practice because there is too much focus on technology, failure to understand when and with whom to collaborate, and a lack of trust between trading partners (Barrat, 2004). Further, this finding is in line with Power and Sohal (2002), who stated that implementing and developing e-business systems is an "evolutionary" rather than "revolutionary" process. Thus, operative gains in transaction excellence have a potential to lead to enhanced or long-term strategic benefits if there is room for exploration of new possibilities.

However, in order to capture this potential, companies need to invest enough resources to conduct a post-adoption evaluation of the tool and respective business processes. Case Vaisala in Paper 2 is an example of where the company has successfully exploited the new opportunities brought by improved visibility into its supply chain. As described in Paper 2, Vaisala has been able to also realize the unanticipated benefits related to the adoption of e-business tools and respective changes in business processes. Consequently, the company was able to transform its global operations into a true make-to-order mode. That change has clearly created recognizable competitive advantage to the company. This finding confirms the argument presented by Simchi-Levi et al. (2003), who offer an interesting viewpoint related to the competitive advantage in their discussion about push and pull strategies. According to their analysis, e-business enables companies to improve performance by moving away from traditional push strategy where production and distribution strategies are based on long-term forecasts. In pull strategy, production and distribution strategies are demand driven and are coordinated with true customer demand rather than that forecast. Right push/pull combinations depend on the industry, but, according to Simchi-Levi et al. (ibid.), emerging e-business models enable companies to implement a suitable strategy, and thus improve their competitive advantage.

5.4.2 Visibility of the process

The e-business solution studied in Paper 3 is the www system that is used in distributed project networks. It is a tool that is used in business situations where the good (using Callon's terminology) to be delivered cannot be defined without a lengthy qualification procedure. In our case samples, the tool is used in the design phase of a large investment project where the project network partners use the tool for standardizing the process related to qualifying the good, i.e. specifying, designing and making a paper machine or ship. As the tool provides visibility to that process, and as the problem situation in Paper 3 is about the management of the resource network, the identified opportunities and implications of improved visibility need to be primarily approached from the resource network's point of view. The realised benefits from the use of the www system in distributed project networks are presented in Table 7.

Table 7 Identified outcomes with visibility provided to process

Visibility	Opportunity
Visibility provided to process	**Direct operational benefits** Enhance document management practices and streamline processes. Capture cost savings due to easy access to documents; information available on real-time basis and decreased time used in searching. Develop efficiency in reacting and controlling changes to documents.
	Direct strategic benefits Provide document visibility to customers throughout the project.
	Long-term strategic benefits Use the accumulated metadata to manage potential bottlenecks in project network operations. Utilize the collaborative features for concurrent engineering approach.

The use of the tool enhances collaboration between project network partners. It provides structure to the collaboration and therefore enhances the possibility of introducing collaborative practices to the resource network. The proper use of the tool requires that the network partners discuss the document management practices and

related processes in detail. There needs to be clear understanding of processes and related information flows, i.e. who needs the information and to what purpose.

However, as Orlikowski and Iacono (2001) state, it is important to realize that tools based on technologies such as the Internet and other distributed applications do not provide the same properties in different contexts of use. Thus, not all of the network members are necessarily interested in investing in collaborative practises. This is the big challenge with collaboration in general; the benefits do not distribute evenly (Småros, 2005). In our case sample, it was mostly in the engineering office's interest to enhance the process streamlining activities within the project network. Thus, they carry the greatest role in getting the other network members motivated to use the tool and participate in collaborative practices.

An important opportunity to enhance the operations of the resource network is related to the accumulation of so called metadata. Project execution can be analyzed and understood by evaluating the metadata generated by the www tool. It is also possible to identify potential bottlenecks from the process. To be able to benefit from this type of visibility in practice is challenging. It is not easy to interfere with a problem that is located in another network member's sphere of responsibility if working collaboration practices are not in place (Barrat, 2004). A great deal of trust and openness is needed for project network members to tackle identified problem areas openly. Another problem is finding the time and resources to analyze past performance, an issue related to the success of knowledge management practices that is often discussed (Harmaakorpi et al., 2003). However, the use of the tool provides "hard evidence" that can be used to pinpoint the problem areas. This potentially makes it easier to confront identified problems. Further, providing information about project status may lead to self-organisation and problem detection and co-ordination that bypass the hierarchical management structures (Hameri and Puittinen, 2003).

From a transaction point of view, workflow coordination means that network partners can streamline and automate the transfer of work and responsibilities and thus make work more transaction like (Lee and Whang, 2001). Performing tasks concurrently between multiple actors cuts the lead-times of large investment projects (Zack, 2002) as

the waiting times from different processes are minimized. Work can also be shared and outsourced more easily. However, the ability to collaborate with multiple-network members to re-design processes is a prerequisite for moving to the concurrent engineering and outsourcing approach. Project stakeholders need to learn the necessary collaboration practices first. Then, in the long run, the competitiveness of the entire project network is improved as the new approach made possible by improved visibility in document and real-time communication related to them enables faster project lead-times. This is consistent with Mukhopadhyay and Kekre (2002), who state that enhanced strategic benefits that improve competitiveness arrive with a time lag.

5.4.3 Visibility in use

In Papers 4 and 5, we analyze a situation where a manufacturing company is moving away from the traditional way of doing business, i.e. selling equipment, spare parts and repair services and offering long-term partnerships to its customers and taking greater responsibility for their process. As discussed in Paper 4, this transition means that the customer is no longer interested in the efficiency of single transactions. It is more concerned with the effectiveness of the resource network that the partnership brings along. According to Gardrey's (2002) in service logics there is a move from request for intervention (Z asks Y to do something that includes socio-technical capacity) to making available (Z uses socio-technical capacity that Y makes available).

In this area, our analysis of identified opportunities is preliminary compared to the two previous ones, visibility in transactions and visibility in process. As the whole research area is still not so well understood, we are taking some first steps in building our understanding on the opportunities to benefit from the improved visibility attained by moving VOP deeper into the customer's demand chain. Attainable opportunities are presented in Table 8.

Table 8 Identified outcomes with visibility in use

Visibility	Opportunity
Visibility in use	**Direct operational benefits** Capture earlier access to demand information and use the time benefit to serve customers from centralized inventories. (Paper 4) Capture better quality demand information to increase accuracy and effectiveness of planning. (Paper 4) Use supplier's position to influence customer demand. (Paper 4)
	Direct strategic benefits Change performance metrics from delivery time and preciseness to availability and performance level of customer's process. (Paper 4) Capture better quality demand information to enhance customer service. (Paper 4)
	Long-term strategic benefits Transfer the accumulated knowledge of product usage, operating environment and customer behaviour into new or improved service offerings. (Paper 5) Capture earlier access to demand information and use the time benefit to move make-to-order strategy. (Paper 4)

Visibility in use shifts the perspective on the problem situation from transaction to the resource network management. In the studies, when entering into a partnership, efficiency of single transactions related to spare parts or service operations become an internal issue of the supplier and the resource network it controls. The recognized operational benefits, earlier access to demand information, better quality of demand information and the possibility of influencing the customer demand can be leveraged to improve the operations of that resource network. First, it will be possible to optimize the location from where to serve the customer. This will be possible for both the physical products (equipment and spare parts) as well as various maintenance service operations. The decision as to what can be done from the centralized location and what needs to be near the customer is based on a more realistic understanding of the customer demand. Second, the time benefits from earlier and more reliable access to customer demand enables the possibility of moving to a make-to-order strategy for such equipment and spare parts that are specially made for a particular customer. Of course,

the criticality requirements of customer process must be taken into consideration when actually implementing new operating policies.

As with the use of metadata in Paper 3, the accumulated knowledge of the product usage, service needs, operating environment and customer behaviour offers a chance to create such knowledge that can be used for increasing understanding of potential problems related to the use of the products on one hand, and exploring new opportunities on the other. New opportunities can be new goods, both physical and services, or new innovative ways to manage the resource network.

5.5   Summary

The aim of this chapter was to identify and discuss the identified linkages between different perspectives of supply chain visibility. We first identified the three different types of visibility as being visibility of transactions, visibility of the process and visibility in use. Then, on the basis of the work of Swaminathan and Tayur (2004) and Callon et al. (2002), we have formalized the problem situation as being either about transaction or the resource network; following that, we showed the importance of understanding the nature of visibility as it is related to different means from these two viewpoints. Finally, we have specified the potential benefits with the help of the framework introduced by Mukhopadhaya and Kekre (2002).

The analysis of the identified attainable outcomes of improved visibility of the supply chain confirms that it is possible to exploit improved visibility at three different levels: direct operative benefits, direct strategic benefits, and enhanced long-term strategic benefits. Further, the analysis shows that approaching the problem situation from the two complimentary viewpoints of transaction and resource network management can provide insight into how the attainable benefits are interrelated. Callon et al. (2002) state that it is increasingly important to recognize these two perspectives in situations where new solutions based on the use of information technology are present. To be able to realize the long-term strategic benefits related to the improved visibility, the resource network perspective needs to be recognized and the problems related to coordination and collaboration addressed. Thus, this thesis proposes that the three perspectives 1)

Chapter 5: Conclusions

transaction vs. resource network, 2) nature of visibility, and 3) attainable outcome are all needed in order to understand the opportunities to exploit visibility in supply chain management.

6 DISCUSSION

In this chapter, we first present the most important findings related to the objectives of this thesis and discuss how they contribute to previous literature in Section 6.1. Then, in Section 6.2, there is a discussion of the limitations of the research, followed by ideas for further research in Section 6.3.

6.1 Contribution

The main theoretical contribution of the thesis is that it brings new insight by combining different perspectives of supply chain visibility. By introducing the different viewpoints and discussing the interrelations between each of them, this thesis presents empirical grounds for a more in-depth and normative analysis of the impact of visibility in supply chain management. In the philosophy of science, there are several conceptualizations of the relation between the means and the ends in a certain problem situations. Examples are Niiniluoto's (1993) technical norm, Simon's (1996, p. 102) production system and Popper's (1963, p. 461) technological rule concept. In this thesis, we have technological and organisational means to provide visibility, we have operative and strategic benefits, i.e. ends, that all need to be understood in two different problem situations: the transaction and resource network situations. The empirical generalizations of different perspectives of visibility contribute towards theory development. Thus, based on the results presented in this thesis, it is possible through further concept and proposition formulation to start building a theoretical model about the role of visibility in supply chain management.

While previous studies about supply chain visibility have largely focused on transactions and concentrated on such issues as demand visibility or material flow visibility, this thesis introduces a more comprehensive conception of the role of visibility in supply chain management. The discussion of the operative and strategic nature of the benefits and of how the opportunities of improved visibility should be analyzed from the two problem situations of supply chain management, i.e. transaction and resource network, enhances the understanding of the mechanisms that enable improved visibility to bring business value. Further, the argument that, in order to

realize the long-term strategic benefits related to the improved visibility, the viewpoint needs to be that of the resource network is an important contribution, both from the managerial and theoretical point of view.

The results of the thesis also point out the importance of learning or exploration (March, 1991) related to the unanticipated benefits of technological and organizational means in order to realize the full potential of improved visibility in supply chain management. After implementation, there is a certain period before the new technology or business process becomes institutionalized to organizational routines (Rogers, 1995), which Tyre and Orlikowski (1994) call a window of opportunity. During this time, the innovation is re-invented to accommodate the organization's (or, in this case, the supply chain's) needs and structure more closely than was possible to plan beforehand. At the same time, the organization's structure is modified to fit the innovation. This is the period when unanticipated consequences related to the means need to be identified and captured.

This thesis also contributes towards theory development related to service operations management, especially to service demand and supply chain management. New theory is needed as services play an increasingly important role in manufacturing firms (Araujo and Spring, 2005; Davies, 2003) and as performance-based contracting replaces traditional service procurement practices (Kim et al., 2006). It means that the contract explicitly identifies what is required, but the supplier determines how to fulfil the requirement (Macflaran and Mansir, 2004). Thus, there is a clear separation between the buyer's expectations of service and its performance goal, and the supplier's implementation of the required services. This makes the life-cycle management of the installed base even more important and fosters the need to create visibility in the use of products and build competences to exploit this visibility. Attained knowledge is crucial in effective management of resource networks needed for service-demand fulfilment.

The managerial and theoretical implications of the individual studies were summarized in Table 4 on page 42. The results based on empirical findings gives new insight into the needs and challenges companies are facing when considering initiatives to improve visibility. This is important as there is always a certain level of uncertainty related to

where new technology and respective business processes are leading. Information is a means to reduce this uncertainty (Rogers, 1995). Improved understanding of the challenges related to investments in new technology and business-process enhances the possibilities of capturing attainable benefits. Further, the thesis identifies how companies are using different means to create supply chain visibility. This is important, as it is the actual usage of the means that will make a difference as to the benefits that are attainable (Vandenbosch and Lyytinen, 2004). These types of descriptive case studies, which illustrate the phenomenon from the practical point of view, are needed when developing theory into the field.

6.2   Limitations

Several limitations exist in terms of the generalizability and interpretation of the results of the thesis. The results in this compendium part are based on iterative triangulation of the applicants own research papers. Even though the selected approach is a useful alternative to study supply chain visibility in diverse organisational contexts, the following limitations can be identified. The first concern is about the quantity of research papers used in the analysis. Second, the cases studied in individual research papers may provide incomplete information about the role of visibility. The empirical cases were taken from one country at a particular point of time and from a set of companies representing only a small proportion of the overall economy. Third, there is clearly some insufficiency in showing the explicit chain of evidence, as the analysis is based on the issues reported in scientific articles. On the other hand, as the results used for iterative triangulation have undergone a development from case reports to conference papers and finally to peer-reviewed journal papers, it is possible to assume some form of credibility of the "raw material" used in theory development.

Another limitation is related to the justification of the selected approach in iterative triangulation process. Have we selected suitable constructs for the analysis? The transaction – resource network perspective clearly evolves from the literature, as does the division of benefits to operational and strategic benefits. The nature of the visibility perspective, however, emerges from the case material used in individual research papers. It is tentative and its validity has not been tested.

A further identified limitation relates to the dynamic process of theory development (Handfield and Melnyk, 1998). According to Handfield and Melnyk (ibid.) any theory is always "work-in-process" that needs to be developed further. One important way to increase quality and validity in theory building process is to have a thorough discussion of unfolding literature: What is similar? What does it contradict, and why? This is obviously an important area where this thesis is not developed as far as one would wish. During the exploration and description stages of the theory building process, as in this thesis, it is not so easy to carry on this kind of discussion. However, it is believed that the empirical generalizations presented in this thesis offer an avenue to such research that would enable an increased understanding of the possibilities of exploiting visibility in supply chain management and develop the theory further.

Had there been the possibility of doing a longitudinal study by following specific means or artefacts over periods of time, as described by Orlikowski and Iacoo (2001), we could have better captured the changes that occur in the environments where the means are being used, as well as the changes in particular means. As the focus of the thesis was on the different perspectives on supply chain visibility, the selected approach was considered justified. However, future research might benefit from collecting more longitudinal data.

6.3   Future research

Researching and writing a dissertation is a learning process. New knowledge and understanding gained during the research process makes one feel that one's results are only the starting point for researching the phenomena in question. In this thesis, we have elaborated potential implications of improved supply chain visibility. The process has opened several interesting avenues for future research.

First, the empirical generalizations of the role of visibility in supply chain management need to be developed further. The next step in theory development according to Wallace (1971 p.18) is to form concepts and propositions by inductive and deductive logic as a method. One way to go forward is to follow the theory building through using the case study research method (Eisenhadt, 1989), thereby developing normative

hypotheses about the means and ends of improved visibility in different problem situations in supply chain management.

The second area acknowledged as needing to be pursued further is related to the service integration that manufacturing companies are engaged in. The discussion in Section 5.4.3 and the analysis in Paper 4 identified potential opportunities as to how the improved visibility of customer demand can be leveraged to enhance the efficiency of the resource network needed for service. This analysis needs to be developed further. Also, the demand-supply framework as a concept (Holmström et al., 1999) should be developed further and its applicability to the analysis of industrial services expanded.

The third area is related to the decision-making situations in the supply chain management area. In this thesis, we have analyzed the identified opportunities related to improved visibility from two supply chain viewpoints, transaction and resource network. As discussed in the literature part of the thesis, transaction or coordination issues relate to the actual execution of the supply chain, and resource network or configuration issues relate to the basic infrastructure on which the supply chain executes. A starting point for future research could be the observation that transaction-related decision-making situations occur periodically and that it is possible to set fixed targets. According to Cyert et al. (1956), these are repetitive problems that are highly programmed and usually rather detailed decisions that involve tangible considerations, to which the economic models that call for finding the best among a set of pre-established alternatives can be applied rather literally. Decision-making situations related to the resource network are more case-specific. Target setting to measure success is not so straightforward and the actual measuring of the results is often qualitative. These are non-repetitive problems according to Cyert et al. (1956). They are about long-range questions about the whole strategy of the supply chain or some part of it. These issues arise initially in a highly unstructured form and require various research processes. It would be interesting to study further how improved visibility, combined with exploration, impacts uncertainty related to supply chain decisions.

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8 APPENDICES

APPENDIX I: INTERVIEW GUIDE USED IN PAPER 2

Interview guide in Phase 1
A. Technologies used in logistics operations

What technologies you are using in logistics operations? Please use the codes bellow:
1=planning to use
2=in implementation
3=in use over 1 year
4=in use over 3 years
5=in use over 5 years

1. Technologies used in purchase transactions?

Operation	Technology	Status of use (use codes above)
Ordering	1.	1 2 3 4 5
	2.	1 2 3 4 5
	3.	1 2 3 4 5
Invoicing	1.	1 2 3 4 5
	2.	1 2 3 4 5
	3.	1 2 3 4 5

2. Technologies used in sell side transactions?

Operation	Technology	Status of use
Order confirmation	1.	1 2 3 4 5
	2.	1 2 3 4 5
	3.	1 2 3 4 5
Invoicing	1.	1 2 3 4 5
	2.	1 2 3 4 5
	3.	1 2 3 4 5

3. Technologies uses in inbound material flow?

Operation	Technology	Status of use
Advance information about transportation needs	1.	1 2 3 4 5
	2.	1 2 3 4 5
Delivery of consignment notes	1.	1 2 3 4 5
	2.	1 2 3 4 5
Acceptance of materials	1.	1 2 3 4 5
	2.	1 2 3 4 5
Delivery of other information	1.	1 2 3 4 5
	2.	1 2 3 4 5
Tracking	1.	1 2 3 4 5
	2.	1 2 3 4 5

4. Outbound material flow?

Operation	Technology	Status of use
Advance information about transportation needs	1.	1 2 3 4 5
	2.	1 2 3 4 5
Delivery of consignment notes	1.	1 2 3 4 5
	2.	1 2 3 4 5
Delivery of other information	1.	1 2 3 4 5
	2.	1 2 3 4 5
Tracking	1.	1 2 3 4 5
	2.	1 2 3 4 5

B. Technologies used in supply chain management

5. What information you share with your supply chain partners and with whom?

	With whom (mark the partner)				
Do you share information about….	1st tire customers	1st tire suppliers	Customers' customers	2nd tire suppliers	Logistics partners
… inventory levels					
… demand information					
… demand forecasts					
… production planning					
… production capacity					
… order status					
… products					
… transportation needs					

6. What information you receive form your supply chain partners?

	With whom (mark the partner)				
You get information from….	1st tire customers	1st tire suppliers	Customers' customers	2nd tire suppliers	Logistics partners
… inventory levels					
… demand information					
… demand forecasts					
… production planning					
… production capacity					
… order status					
… products					
… transportation needs					

7.   What technologies you use for sharing information identified in questions 16 and 17?

1=planning to use
2=in implementation
3=in use over 1 year
4=in use over 3 years
5=in use over 5 years

Shared/received information	Partner	Technology	Status of use				
Inventory levels	Customers	1.	1	2	3	4	5
		2.	1	2	3	4	5
	Suppliers	1.	1	2	3	4	5
		2.	1	2	3	4	5
Demand information	Customers	1.	1	2	3	4	5
		2.	1	2	3	4	5
	Suppliers	1.	1	2	3	4	5
		2.	1	2	3	4	5
Demand forecasts	Customers	1.	1	2	3	4	5
		2.	1	2	3	4	5
	Suppliers	1.	1	2	3	4	5
		2.	1	2	3	4	5
Production plans	Customers	1.	1	2	3	4	5
		2.	1	2	3	4	5
	Suppliers	1.	1	2	3	4	5
		2.	1	2	3	4	5
Production capacity	Customers	1.	1	2	3	4	5
		2.	1	2	3	4	5
	Suppliers	1.	1	2	3	4	5
		2.	1	2	3	4	5
Product information	Customers	1.	1	2	3	4	5
		2.	1	2	3	4	5
	Suppliers	1.	1	2	3	4	5
		2.	1	2	3	4	5
Order tracking	Customers	1.	1	2	3	4	5
		2.	1	2	3	4	5
	Suppliers	1.	1	2	3	4	5
		2.	1	2	3	4	5

8.   What technologies are used in following operations?

Operation	Technology	Status of use				
Supplier selection	1.	1	2	3	4	5
	2.	1	2	3	4	5
Collaboration	1.	1	2	3	4	5
	2.	1	2	3	4	5
Supply network planning	1.	1	2	3	4	5
	2.	1	2	3	4	5

D. Identified benefits

9. Describe what benefits have been identified for the 4 logistics technologies that you have implemented in less than 5 years ago.

Technology 1:_____

Identified benefits:

Technology 2:_____

Identified benefits:

Technology 3:_____

Identified benefits:

Technology 4:_____

Identified benefits:

<u>Interview guide in phase 2</u>

1. Detailed description of a selected e-business technology used in the company

2. Identification of attained benefits

3. Challenges related to implementation

4. Future development plans

APPENDIX II: BENEFITS ANALYSIS OF PAPER 2

Case	Description of e-business solution and technology used	Identified benefits
Datex Ohmeda Medical instruments	Supplier web, Third party transaction hub	More accurate visibility to demand forecasts. Decrease of manual work, 20 persons allocated to more value adding responsibilities.
Elcoteq Electronics manufacturing	Demand forecasts to suppliers, EDI, RosettaNet XML	Same demand forecast that drives Elcoteq's production planning drives operations at key suppliers, with EDI demand forecast and respective confirmation from upstream in few days, with XML possible to do in hours (still in pilot stage) -> increases the responsiveness of the entire supply chain
Finnish Post	Offers web service for centralized purchases. Extranet, EDI, XML	Possibility to manage supplier relations centrally, but ordering etc operative work done locally in different locations.
GNT Finland IT wholesaler	Sell-side web, Extranet, system integration over web	Cost savings in order management. Inventory turn over increased by 25%.
Innogas LSP	VMI, EDI	Easiness of inventory management and gas purchase operations.
Kiitolinja, LSP	Sell-side web, extranet	Better quality information about transaction -> less work needed at Kiitolinja's side. Earlier access to transaction related information -> more time in route planning operations.
Kone Elevator manufacturesr	Supplier web and collaboration with LSP	Possibility to confirm the execution capability to customers in three days. Delivery time improved from 8 weeks to 4 weeks. Less hassling cost in local operations due to increased accuracy.
Kväerner Power Power stations, pulp mill machinery	RFID tracking	Improved visibility to material flow during transportation. Improved visibility to materials at the construction site. Increased suppliers quality of operations due to the visibility to their operations.
Nokia Networks Telecom networks	Dynamic VMI, EDI, RosettaNet XML	Responsibility of inventory levels to suppliers. Inventory levels follow the changes in demand forecasts. From supplier's side benefits realized through more accurate production planning possibilities.

Optirock Construction materials	Real-time integration with logistics service provider. System integration and mobile data terminals.	Information about the shipment keyed in once. Visibility to shipments real time, also customers have this access -> important in construction business. Decrease of paper work. Integration extended also to more strategic level; quarterly meetings with LSP to discuss future trends in for example in customer situation -> LSP in better position to plan own capacity allocations
Orion Pharma Pharmaseuticals	Integration with package manufacturer to exchange product information electronically,	Package manufacturer is working based on the latest version of the package design. Through-out put time of packages increased.
Rocla Lifting machinery	Supplier web, extranet	Automation of ordering work Decrease of manual work, estimated to be 2,5 man-years. Possibility to increase volume without need to employ more personnel. Improved delivery accuracy, from 90-95% level to 100% level. As a result, possibility to cut delivery time to end customer from 10 days to 6-8 days, in average 20% enhancement.
SE Mäkinen LSP	Logistics control system, extranet, EDI, systems integration, mobile data terminals in vehicles	Improved customer satisfaction Possibility to use unmanned terminals Full visibility to unmanned terminals and vehicles Significant efficiency improvements Real time information enhances overall management of operations.
Tellabs Telecom	Direct delivery model EDI solution	Easiness of receiving orders. Elimination of local inventories at the customer site. Real-time order confirmation to the customer. Customer able to reduce personnel engaged with ordering due to the easiness of ordering and reliability of the process.
Tellabs	Integration with LSP	Enabler for the above mentioned direct delivery model
UPM Kymmene Paper products	Self-billing	Still in implementation stage, no confirmed benefits yet

Vaisala Instrumentation	Supplier web solution with back office integration with a third-party transaction hub. 50 suppliers included that represent 80-90% of total volume.	System used of demand forecasts, orders and recalls. Co-operation with service provider released own development resources to other areas. Key suppliers' delivery time shortened from a week to two days after implementation due to visibility to Vaisals's sales plan daily, however difficult to identify exact the reasons behind the shortening. Possibility to lower inventory levels. Overall suppliers more effective and more flexible to changes in demand situations.
	ERP integration with logistics service provider	Manual work related to consignment notes etc dimnished. Customers can do tracking -> Lessen the workload on Vaisala's customer service
	ERP integration of sales offices.	Harmonized product codes and order processes internationally Real time visibility to orders at production
	Total impact:	Possibility to move to make-to-order mode internationally. Shutdown of local inventories. Delivery time globally 5 days. Local sales offices can sell all Vaisala products, not limited to local inventories.
Wärtsilä Service Power generation equipment	Sell-side web, extranet	Increased efficiency in order management routines and less mistakes in orders. Order handling time arrival to order confirmation from 5,3 days to 1,8 days, in best cases in a few hours due to the accuracy of information in the system.

APPENDIX III: QUESTIONAIRE USED IN PAPER 3

Section 1: Background information

A) Interviewee background information

1. **Name of the interviewee** _____
2. **Position of the interviewee** _____
3. **Company unit of the interviewee** _____

B) Project business
Nature of the company's project business
4. **Amount of project personnel within the company** _____
5. **Average monetary value of a project** _____
6. **Average project labor input amount** _____ (labor months)
7. **Average amount of documents in a project** _____
8. **Average amount of design changes in a project** _____

C) Changes in selected key measures
9. **How have the following average project key measure values changed during the past five years?**
   We kindly ask you to answer with numerical values. You may give your answer in the form you follow the values in question.
   a. **Project lead time**
   b. **Project delay time**
   c. **Project delivery accuracy**
   d. **Project budgeting accuracy**
   e. **Project hit-rate**

Section 2: Project document management

10. **Please select, the tools your company uses in managing project documentation**
- [ ] E-mail
- [ ] Company disk space
- [ ] WWW-enabled document management application
- [ ] Some other:_____

A) The implementation of WWW-enabled project document management application
11. **What is the name of the application you use?** _____
12. **When was the application implemented?**_____
13. **Did you use a separate consultant during the implementation in addition to a systems supplier?**
- [ ] Yes
- [ ] No
14. **If you used a separate consultant, please select in which of the following processes the consultant was involved?**
- [ ] Education
- [ ] Installation
- [ ] Process definition and depiction to the application
- [ ] Some other:_____

B) The use of WWW-enabled project document management application
15. Please, select what kind of documentation you have in the application

- [ ] Project plans
- [ ] Project follow-up reports
- [ ] Drawings
- [ ] Memos
- [ ] Minutes
- [ ] Manuals
- [ ] Instructions
- [ ] Quality policies
- [ ] Tendering documents
- [ ] Marketing documents
- [ ] Supplier and customer mails
- [ ] Approval and audit documents
- [ ] Project e-mails
- [ ] Some other:_____
- [ ] Some other:_____
- [ ] Some other:_____

16. The amount of application users in your company _____

17. The amount of application users outside your company based on the amount of user IDs _____

18. The amount of external companies using the application _____

19. Average document amount stored in the application in one project _____

20. The share of projects in which the application is used _____%

Section 3: Business effects of the WWW-enabled project document management application

21. Please, select from the following list five most important benefits the application brings, when you compare the current state to the time before the application use.
Please, number your answers in the order of significance from one to five (1-5)

Centralized document and information management

☐ Project documents are available centrally and globally

☐ Documents can be found more easily and better organized

☐ The unity of information

☐ Project documents are more comprehensively under control

☐ Better document availability for maintenance needs after the project delivery

Communication and collaboration

☐ Fast communication on changes and change management

☐ Faster document control and approval procedures

☐ Collaboration with suppliers and customers is easier and more visible

☐ Structured management of e-mails and paper-based documentation

☐ Transfer of large document packages in the project network

Project follow-up and project processes

☐ Follow-up of the actual project state is easier

☐ It is easier to identify the process bottle-necks

☐ The new application enables more systematic project processes

☐ Follow-up of the sharing schedule of contractually defined documents

☐ The early follow-up of activity and contribution of the companies operating in the project network

22. Please, mark in the following list, whether the issue is a challenge brought by the application.

	Is a challenge	Is not a challenge
Parallel electronic and paper-based processes causing double work	☐	☐
Minor use of the application in the whole project network	☐	☐
The application is difficult to use	☐	☐
Inclarities related to the approval process legality and responsibilities	☐	☐
Insufficient functionalities of the application	☐	☐
Problems related to the technical operation of the application	☐	☐
Overmuch information flood for example in the form of unnecessary e-mails	☐	☐
Enticing the employees to use only this application	☐	☐
Replacing old ways of operating	☐	☐

Some other:_____

23. What kind of effects have you perceived in the following factors <u>due to the use of application?</u>

1 = Strong negative influence
4 = No influence
7 = Strong positive influence
ITE= impossible to evaluate

Factor	1	2	3	4	5	6	7	ITE
Financial and operational measures								
Project profit								
Project business costs								
Project administrative costs								
Project communication costs								
Project "hazzle costs"								
Project lead time								
Project delivery reliability								
Amount of errors during a project								
Keeping in schedule								
Budgeting accuracy								
Customer satisfaction								
New customers								
Project hit-rate								
Project processes								
Systematic project processes								
Fastness of information sharing								
Efficiency in reacting to changes								
The efficiency of time use								
Fastness of decision making								
Amount of labour input								
Discipline in design changes								
Recognition of bottle-necks								
Follow-up of project state through the ratio of completed project documents								
Information flow								
Systematicy of information sharing								
Real-time information								
Correctness of information								
Time used in searching information								
Time used in collecting and sharing information								
Time used in transferring information from one system to another								
Collaboration in the network								
The depth of co-operation with project partners								
The stability of co-operation with project partners								
Strifes among project partners								
Awareness of the project team operations in your company								
Awareness of the project team operations in other companies								
Comprehension of project stakeholders on joint project goals								

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Section 4: In-depth questions

Background information

Interviewee background information

24. **Experience from current position and duties**
25. **The role of the interviewee in the practical project execution and the possible previous experience**

Project business

26. **Average turnover of the project unit (thousands of euros)**
27. **Average amount of projects in a year**
28. **How do the projects differ in terms of**
    - Size
    - complexity
29. **Do you clearly have different project types and if yes, how do they differ from each other?**
30. **What are the reasons for design changes**
    - Internal?
    - External?
31. **Who are the external stakeholders of a project (companies and authorities)**
    - Amount
    - Type (for example a main supplier, supplier)
32. **How stabile is the project network of a company from one project to another project (including external stakeholders)**

Changes in selected key measure values during past five years

33. **What are the factors that have, in your opinion, affected the changes in measure values you mentioned in question 9?**

Project document management of the company

The background of project document management

34. **What kinds of project document management applications does your company use?**
35. **When have these systems been implemented?**
36. **Have you depicted the processes in terms of project document management?**
37. **For which purposes do you mainly use your WWW-enabled project document management application?**
    - Centralized document management
    - Supplier collaboration
    - Follow-up of project document sharing and change schedule
    - For other purposes?

38. **Which external stakeholders have a user ID? (companies, authorities etc.)**

WWW –application use history

Starting point
39. **What were the tools of project document management before the implementation of the application?**
40. **What kinds of problems existed before the implementation of the application in terms of project document management?**
41. **Why was it decided to acquire the application?**
42. **What were the reasons you chose a certain application and the system supplier who delivered the application?**

Implementation
43. **Please, describe the implementation of the application and the changes you have perceived immediately during the application implementation and later**

- Please, describe the history of application implementation

- How did the implementation change your processes?
    - Immediately during the implementation
    - Later

- What kind of effects have you perceived in using the application?
    - Immediately during the implementation
    - Later

- What kind of challenges have you perceived in using the application?
    - Immediately during the implementation
    - Later

- If you used external consultants in the application implementation, please evaluate the role and effect of the consultants on the success of the implementation

- How have the user ID quantities developed inside your company from the implementation until today?

44. **How do the different applications differ from each other?**

Future

45. **What kinds of upcoming changes do you forecast in the distributed project environment?**
46. **What do these changes require from the information systems and information management?**
47. **What kinds of development needs do you see in WWW-enabled project document management systems?**
48. **Please, estimate the upcoming development of user ID quantities**
    - Inside your company
    - In the whole network
49. **Are you planning of changing the WWW-enabled project document management system supplier in the future?**

APPENDIX IV: USE MODE ANALYSIS OF WWW SYSTEM

Document exchange	Collaboration	Project management support
Cases: *EC1,SS1,SS3*	*Cases:* *EC2,EO3,EO4,SS2*	*Cases:* *EO1, EO2, EO5*
Sharing documents in a centralized place over the web. This also leads to the increased "electronification" of documents (using fax and sending drawings via postal services diminishes).	Documents are not purely stored and downloaded from the system. Active communication on documents starts taking place through the application (not via e-mails)→documents are actively exchanged, shaped reviewed, on-line commented, revisited and approved by utilizing the system (active use of systems features).	In this mode, the information (metadata) produced by the system (about inter-firm and intra-firm document management processes) can be utilized in project process streamlining, optimization and progress measurement→the tool then supports actual project management processes.
Documents are stored in the joint application instead of separated company file systems→document visibility in the network.	System informs about statuses and document changes automatically→one can start trusting the system and does not individually have to be "active/initiative" anymore	Examples on project management support use: X% of documents ready→predictions and anticipations for future project execution; Project organization streamlining (communication structures and matrices within the project organization i.e. who communicates with whom)→change and revision loops improvement
The way documents are exchanged changes (not e-mails, faxes, paper drawings)→ a change in the way of operating	Document management processes are depicted and documents linked to the processes→communication patterns become systematic and also visible.	Examples continued: Controlling and measurement (realized document exchange timetable against the baseline) → useful progress data, possible bottleneck recognition (previously this inter-firm communication data was not in this kind of "formal" easily reported objective mode)
Communication on the documents and modifications takes still mainly place in the tradition form (e.g. e-mails).	The visibility of communication patterns and the fact that each inter-firm transaction is "recorded" in the system changes the way people act and "forces" one to be more formal and non-hazzling→following the guided procedures (the system forces to)	Gradual shaping of processes is ongoing right from the start. However, learning to utilize the inter-firm communication information in progress measurement and control enables more large-scale process changes: increased design outsourcing and paralleling of processes (visibility and control measures enable this)

The system is a "passive" document warehouse.	Within this mode the network acknowledges the need to define and communicate the document structures, folders and management processes at the beginning of a project so that these are followed (active inter-firm collaboration mode requires this in order to be effective)	
Everyone can view the documents and use this way latest information in one's own work (information can be trusted)→procedures for searching information change (Information is searched based on need from the system. Thus, requests for documents are not sent to other project partners.)	Effects on the partner selection procedures (one has to have the capability to use the system actively)	

APPENDIX V: CASES IN PAPER 5

Service products	Service demand management	Service resource management	Installed base management
CASE ALPHA			
After sales support, Maintenance agreements, Consulting services	Challenges related to after sales demand mgm understood. Process improvements always needed. Challenges related to demand mgm of more integrative services not fully understood. Remote control technology in some products, not used for service demand management.	Locally managed in each country / region. Global experts managed centrally. New challenges emerged as the amount of maintenance agreements increases. How to build necessary competences to various regions. Also the resource networks to be managed have expanded, especially the number of external partners.	Development programs underway. Importance realized. Company is offering auditing services to customers. As customers are process plants, all equipment are itemized in plants ERP system. Through maintenance agreements Alpha has access to installed base information at a particular customer. Use of this information outside one customer case not (yet) relevant
CASE BETA			
After sales support Managed services Consulting and integration services	Product and service account managers responsible for same customer collaborate. Service demand mgm process follows the same principles as in product business. Information of demand needs entered to same data bank as product demand..	Mgm processes for resources needed in after sales support and installation in satisfactory condition. New challenges emerged as company moving to more long term service contracts with customers.	Critical focus area thus under development. Reliability of information related to installed base is a problem. How to assure such reliability that execution of service delivery can be based on this information?
CASE DELTA			
Maintenance support Maintenance agreements Full service agreements	Information from preventive maintenance agreements are keyed into Delta's ERP system. It is possible to withdraw base demand from ERP. Service categories help to identify demand. Remote control installed to new products, not used for service demand management.	Locally managed with global use of "super experts". Preventive maintenance agreements provide base load for resource management. Salary structure supports overtime work during peak times. It has proven to be a good way to balance resource needs.	Relatively good as company has long history in service operations. Has been able to include competitors' products that Delta is servicing.

CASE EPSILON			
Maintenance performance mgm Equipment performance mgm Maintenance consulting	Demand information from each customer site entered into central data base. This is site manager's responsibility. Possible to evaluate overall demand of the entire customer base in Finland. However, accuracy need to be improved. Remote control used for condition monitoring, not for service demand management.	Locally managed based on customer sites. Technical skills of service personnel categorized, very detailed, over 3000 different categories.	n.a.
CASE GAMMA			
Maintenance agreements Operation agreements	Locally managed at each customer site. Interaction between customer sites base on site managers' activity / available network within the company.	Locally managed at each customer site. General service know-how and "super experts" centrally managed	No own production so not as relevant as for other case companies. Information about installed base at each customer site however important. This information from customer.