Developing And Implementing
IS/IT in Aftermarket Logistics

MAGNUS HOLMQVIST

IT University
of Göteborg

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MAGNUS HOLMQVIST

Doctoral Dissertation

IT UNIVERSITY OF GÖTEBORG
GÖTEBORG UNIVERSITY
SE-402 75 Göteborg, Sweden
www.ituniv.se www.gu.se www.chalmers.se

Volvo Information Technology
Tech Watch & Business Innovation
Lindholmen Science Park
SE-405 08 Göteborg, Sweden
Magnus.Holmqvist@volvo.com
www.volvo.com

ABSTRACT

Although developing and implementing information systems and information technology (IS/IT) in aftermarket logistics is not easy, it has become a necessity under current business conditions. Growing globalisation, product advancements, intensified IS/IT dependencies, and increasing transport demands due to heavy competition and regulation are all sharpening the requirements in aftermarket logistics, a dynamic area with direct importance for a considerable share of the world economy.

This thesis is motivated by a quest for a better knowledge of IT-Management, despite prevailing uncertainty and complexity. The objective is to improve the understanding of how to develop and implement IS/IT in aftermarket logistics. Collaborative practice research and interpretive case studies, coupled with in-depth access at Volvo, have resulted in several contributions.

First, this research shows that using scenario development facilitates strategic awareness. It also shows that gradual development and continuous implementation nurture learning and even innovation. Agile capabilities are needed to achieve sustainable progress in both systems development and business implementation. Further, the findings indicate that process integration takes time—often longer than the involved actors expect. Finally, organisations can align business and IS/IT through a joint formation that executes comprehendible projects according to a clear direction.

The research has implications for both strategic planning and alignment. Applying formal and comprehensive planning approaches with Strategic IS Planning (SISP) is difficult because of the range of actors involved in executing any plan. It is also difficult to thoroughly use the strategic alignment model without getting stuck in meta-activities. This contributes to existing questions on actual usage and delivered business value. Overall, the dominant characteristics of the aftermarket logistics context call for research into their implications and a search for alternative approaches.

The contributions of this thesis have resulted in considerable business value in terms of industrial effects. These include high return on investment and a user-driven development with direct adjustment capabilities that result from rapid implementations. Beyond these business values is the priceless potential for sustainable learning and innovation. Nevertheless, developing and implementing IS/IT in aftermarket logistics remains challenging. This research implies that using scenario development—along with gradual development and continuous implementation—contributes to aligning business and IS/IT. This alignment results from driving progress with comprehendible projects.

Keywords: IT-Management, development and implementation, aftermarket logistics

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PROLOGUE AND ACKNOWLEDGEMENTS

A thesis is like a journey: The more challenging the journey, the higher the logistical requirements. Informatics is an area concerned with managing and applying IS/IT. In this thesis journey, the objective is to enhance our understanding of developing and implementing IS/IT in aftermarket logistics.

This journey has required considerable effort, and unfortunately it is not possible to convey all the experiences gained. Furthermore, as explorers and travellers know, it is the whole journey, rather than only the final goal, that makes it all worthwhile. In a way, this thesis is merely a milestone in a greater journey of gradual developments, but it is a step of continuous implementation that can offer valuable insights.

No matter how long a journey, it starts by taking the first step. Driven by a desire to research and find new roads, I found a sense of orientation through existing knowledge. On one hand, direct practice outsmarts any guidebook; on the other hand, there is much to learn from maps made by those who have undertaken similar journeys before. Even with maps at hand, however, one must determine from what perspective those maps were drawn and for what purpose. Successful interpretations in turn bring out insider rationality and promote understanding of new ways.

My in-depth experiences from and interest in the business context of global aftermarket logistics provide a foundation for this thesis. The commercial automotive sector and Volvo play an important role with the ambition to always moving forward. Availability has been paramount. By the contextualisation of aftermarket logistics within the field of IT-Management this journey uncovered an intertwined relationship between development and implementation. *Why care about IT-Management in complex contexts?* This question both nurtured and annoyed the curiosity that drove this research. It might seem pessimistic in general and unprofessional in particular, especially to those engaged in the field. But it is essential to be self-critical and to reflect on very basic questions.

The research method provided the engine for the journey. Although not visible from outside, if an engine does not run smoothly, the consequences can be severe. Academic results may in practice be compared to a vehicle. Like vehicles, they can promise many things, exist in many models, require testing on how they work or ought to function, and, when they are good, will be widely admired. Also, as in vehicle designs, thesis ideas must work in relation to ideas in specific communities, as well as in relation to overall regulations. So, setting out for a journey like this requires both rigor and relevance.

Bridging academia and industry is not easy, but it is definitely worthwhile, and collaborative practice research offers acknowledged and valuable guidance. Regardless of the number of road bumps, both practitioners and people in academia with an interest in IT-Management can benefit from this work. The thesis is based on a collection of research contributions. These form a map consisting of five main stations and an overview that provides a route between them. Reading a thesis can in itself be a journey, and the traveller here can gain knowledge of different IT-Management aspects. Unfortunately, words in a text like this may mean little without prior knowledge, interest, or experiences in the field. Given such pre-requisites, however, the thesis can launch further journeys, whether into existing sources or the reader's own research and/or operational endeavours. Influential viewpoints and sources will be highlighted throughout this journey and can encourage further exploration.

Customs clearance authorities apply different perspectives according to their own traditions; likewise, the established sciences of informatics as well as logistics regard any research in relation to their own bodies of knowledge. The journey of this thesis, while based in informatics, will also bridge areas connected to the field of logistics. Building bridges contains the risk of not achieving connections, while crossing borders contains the risk of being misunderstood. Still, approaching both information systems and logistics systems can be valuable for industry as well as academia. This thesis is crossing some borders and aims at contributing to some bridging which can nurture discussions and provide opportunities for further work.

Many people were, at various times, passengers and fellow travellers on the journey that resulted in this thesis. Naturally, this includes all those involved in published papers and book chapters (from co-authors to review-peers), opponents and colleagues in seminars and conferences, as well as participants in interviews, projects, and other various activities that played a fundamental role in the interplay that generated the facts, experiences, and insights that this thesis relies on. Many are those that deserve my gratitude for this journey.

My mother, Marie-Louise, is the single most important person that I want to acknowledge for so many dimensions of the journey through my life, far beyond any words. It is not possible to name all the many other people who contributed to this journey, but I thank them in my heart—please, feel it! Many organisations have been encountered, yet, one is named here. Volvo is fascinating and I acknowledge support from Parts: Bror, Bosse, Bjarne, Gun-Britt, and Mikael; to other units involving: Öknegård, Ambrusson, Hellberg, Wickman, Wingqvist, and Boll; and coming to IT: Magnus, Mats, Agneta, Harry, Inger, and JOJ. Wolodymyr "Max" ignited my interest in the academic world, wherein: Urban introduced me to Professor Dahlbom; Mathiassen and Henfridsson provided insights to rigor; Bergquist gave narratives; an industrial PhD peer was Dick; Håkan, Thanos, Maria and DELTA's sustain discussions on complexity and paradoxes; Kenth, Gunnar, and Ola served me the academic arena of logistics; and, toward the end of this particular journey especially Professor Ljungberg made valuable contributions, together with Kalevi Pessi, who has throughout the journey come to be my appreciated friend, rather than just a supervisor. Friends, as family and really loved ones (I'm fortunate to have soo many), have given me the necessary energy to make this journey and many others—for which I want to give continuous harmony in return. Thank You for taking your time and contributing: B+ ☺

Finally, to conclude this page without running into a dead end, is the quest for a better understanding of IT-Management in complex contexts and, more specifically, those relating to aftermarket logistics. Hopefully, the endeavours will contribute to driving progress…

Göteborg 2007

Magnus Holmqvist

[Semper Comperimus Unitis Vigor]

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1. INTRODUCTION

This chapter gives a brief background to the thesis. It outlines the research objective and the structure of the thesis.

1.1. Background

"Who made this?" the frustrated mechanic shouts as he stares at a PC screen near the truck he needs to repair. *"It's impossible to use! We can't do our job with this—we can't even see a drawing of the engine and facts on part numbers at the same time. And we can't get special tools because they're not available. From what I hear, there's no connection between the electronic spare-parts catalogue and the ordering of spare parts for delivery to the repair job. We have been promised a fully developed system, but this so-called 'system' has so many shortcomings that there's no way we can implement it into our business. We'll keep our paper catalogues—at least they work."* Unfortunately, the mechanic was not the only one who was frustrated: implementing the electronic spare-parts catalogue was possible only after several delays. Furthermore, the comprehensive planning on the implementation proved impractical because those plans had neglected the continuous flow of changes occurring in the aftermarket arena.

The above example is based on actual experiences in developing and implementing an electronic spare-parts catalogue for dealers repairing Volvo trucks and buses. During the 1990s, Volvo already had relationships with dealers, but providing them with electronic catalogue functionality nonetheless entailed a tremendous effort. Large change efforts at Volvo often resulted in large-scale projects. This single, large-system development project hit major difficulties early on while trying to specify all requirements. The project also failed to get input on context changes during development, and rarely sought user collaboration and feedback. Cooperation between people working on systems and people working in business was lacking. Furthermore, rolling out this "one complete and deployed" system became a huge project in itself. To gain business value, the system had to be implemented and used in businesses worldwide. Still, it took Volvo more than 10 years to reach an acceptable usage level, incurring significant cost and lead-time overruns. Might there be other, better ways to manage similar situations? Does the situation's uncertainty and complexity make it so difficult to set a clear scope that there is no hope of managing change? Can the systems development and business implementation actually be aligned and agile, as well as nurture innovation?

Those of us with practical industrial experience realise that failures in both systems development and business implementation are far too common. The research contributing to this thesis is driven by a desire to change this fact. Specifically, the thesis presents two cases aimed at improving the understanding of development and implementation in aftermarket logistics. The research is based on my many years of in-depth work as an Industrial PhD candidate at Volvo. Activities involved included individual, local interactions as well as global-level change in collaboration with academic institutions through collaborative practice research (Mathiassen 2002).

Aftermarket logistics is concerned with product service and the availability of spare parts and related information following the sale of a complete product. For example, it might involve use-related service of a truck and access and availability of spare parts for it, but it would not include the sale of the truck itself. Information systems and information technology (IS/IT) has become an integral part of aftermarket logistics and cannot be distinguished as an isolated part of the business. Growing globalisation, product advancements, increasing service and maintainability demands, intensified IS/IT dependencies, and transports that face heavy competition and regulation are all continuously sharpening aftermarket logistics requirements. Today, trucks and commercial vehicles drive and need service just about everywhere, thereby affecting a considerable share of the world economy. The number of involved actors, markets, products, services, and concerned individuals—as well as the transaction volumes in terms of goods, financials, resources, and information—are all accelerating, contributing to complexity and uncertainty. To proactively drive progress in this area, we must address the large and growing need for a better understanding of developing and implementing IS/IT in aftermarket logistics.

This thesis is grounded in research on IT-Management, but it also has strong links to industrial practice and research on supply-chain management (SCM). The importance of the aftermarket context is beginning to be acknowledged beyond those working in the field (Cohen et al. 2006). Researchers have different perspectives on how organisations can use IS/IT in development and implementation to continuously derive and leverage business value (Peppard and Ward 2004). Peppard and Ward (2004) address the need for further research and join numerous calls for more research of empirical cases that address development and implementation issues put into a business context (see Lai and Mahapatra 1997, Davenport and Markus 1999, Monteiro 2000, Farris et al. 2005, Baskerville et al. 2005). Although existing research provides an array of models, frameworks, theories, and suggested solutions, there is little evidence that practical problems have declined. There is also a great need for further research into the specifics of different contextual settings.

1.2. Research Objective

The objective of this research is to contribute to a better understanding of how to develop and implement IS/IT in aftermarket logistics. The research questions that have guided the attainment of this objective are:

- What are the characteristics of aftermarket logistics?
- How can IS/IT in aftermarket logistics be managed?
- What are the implications of this for developing and implementing IS/IT in aftermarket logistics?

The first pair of questions form a basis for discussions aimed at deriving implications and exploring case findings.

This thesis builds upon the idea that, by gaining a comprehensive understanding of a specific context in which IS/IT is designed, managed, and used, we can leverage results for both academia and business. The specific basis for the case findings in this research is aftermarket logistics in the automotive industry, which is a key sector in need of further research. By researching both development and implementation, this work nurtures an understanding of their intertwined relationship, which exists from systems design to actual business usage and back. The thesis contributes to discussions on IT-Management and refines the understanding of existing theory. Specific considerations on planning and alignment are made together with findings on development and implementation (Earl 1993, Henderson and Venkatraman 1993, Lai and Mahaparta 1997, Ciborra 2000, Christopher and Towill 2000, Dove 2001, Newkirk et al. 2003, Avison et al. 2004). Finally, the thesis will illuminate ways to utilise scenario development and provide case specifics on how to encourage a gradual development with continuous implementation. Taken as a whole, the research can contribute to an understanding of IT-Management with a focus on developing and implementing IS/IT in aftermarket logistics. The first chapter will now conclude with a thesis outline.

1.3. Structure of Thesis

Figure 1 offers an overview of the structure for this thesis. Part A is a "kappa," followed by part B ("papers"), which contains a reprint of selected research papers from distinguished conferences and journals. The thesis kappa is a natural result of these papers and existing research contributions. To ground and enhance the understanding of this work, it is best to read the papers before the research contributions of this thesis (to be presented in chapter 6). After the introduction in chapter 1, chapter 2 presents the research approach. Chapter 3 and 4 provide a frame of reference, discussing aspects of relevant theories in order to support the research objective. Chapter 5 presents the context at Volvo and details on the two case studies that are at the focus of this thesis. Following the research contributions in chapter 6, chapter 7 offers the conclusions.

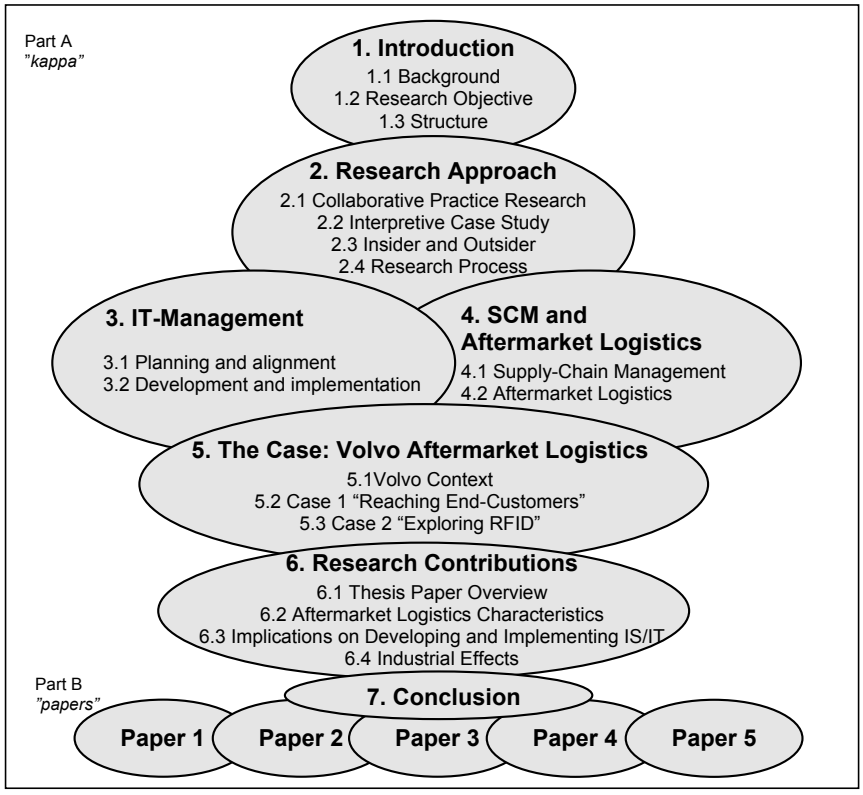

Figure 1 – Thesis structure.

The papers, which have been published in peer-reviewed journals and proceedings, resulted from the thesis research process. Table 1, which concludes this introduction, offers an overview of these publications and the papers they were directly built upon. Publishing during different stages in the research process contributes to the research objective of this thesis. However, all research has limitations; by explaining these limitations, it is easier to agree on results. The following chapter addresses this issue further by describing the research approach.

Table 1 – Published contributions in the research process.

Paper 1
Enterprise Wide Development A Survey of Critical Factors for Co-ordinated Development in Complex Organisations: What Development Managers Consider
Holmqvist M and Enquist H
IEEE proceedings of 36th HICSS (Hawaii, USA) Jan. 2003
Building on another peer-reviewed contribution: Enquist H and Holmqvist M. "Enterprise-Wide Development, A Survey of Critical Factors". *Proceedings of 23rd IRIS* (Uddevalla, Sweden) Aug. 2000.
Paper 2
Process Integration and Web Services A Case of Evolutional Development in a Supply Chain
Holmqvist M and Pessi K
Scandinavian Journal of Information Systems 16, Dec. 2004
Building on other peer-reviewed contributions: Holmqvist M and Enquist H. "IT IS Not New vs. Old, Yet Real e-Logistics". *Proceedings of 24th IRIS* (Bergen, Norway), Aug 2001. Also refined from a contribution with the same title in the *Proceedings of 1st Nordic Workshop on Electronic Commerce* (Halmstad, Sweden), May 2001.
Paper 3
The Logistical Consequences of e-commerce Theoretical Scenarios for Spare-Part Distribution
Holmqvist M, Hultcrantz O, Stefansson G, and Wingqvist A
Elsevier proceedings of 9th WCTR (Seoul, Korea), July 2001
Building on another peer-reviewed contribution: Holmqvist M, Hultcrantz O, Stefansson G and Wingqvist A. "The Logistical Consequences of e-Business—A Theoretical Scenario for Spare Part Distribution", in the proceedings as a "Work in Progress" of 14th *NOFOMA* (Århus, Denmark) June 2000.
Paper 4
Agility through Scenario Development and Continuous Implementation A Global Aftermarket Logistics Case
Holmqvist M and Pessi K
European Journal of Information Systems 15:2, Apr. 2006
Building on another peer-reviewed contribution: Holmqvist M and Pessi K. "Agility through Implementation. A Case from a Global Supply Chain". *Business Agility and Information Technology Diffusion* (Baskerville R, Mathiassen L, Pries-Heje J and De Gross J, Eds), Springer, New York, USA. 2005.
Paper 5
"Smart Goods" and Mobile RFID A Case with Innovation from Volvo
Holmqvist M and Stefansson G
Journal of Business Logistics 27:2, Nov. 2006

Building on other peer-reviewed contributions: Holmqvist M and Stefansson G. "'Smart Goods' and Mobile RFID—A Case with Innovation from Volvo". *Proceedings of 1th CSCMP European Research Summit* (Bruxells, Belgium), May 2006. Also refined from Holmqvist M and Stefansson G. "Mobile RFID. A Case from Volvo on Innovation in SCM". *IEEE proceedings of 39th HICSS* (Hawaii, USA) Jan 2006.
Additional publications:
Holmqvist M "Strategy AND Action—Global IS/IT Development And Implementation at Volvo". *IIIS proceedings of 10th WMCSI Annual Conference* (Orlando, USA), July 2006.
Ly N, Vindblom A, and Holmqvist M "Product Lifecycle Management—Let's Make Sure, a Reference Case in Industrial IT". Distributed through the 14th ECIS conference (Göteborg, Sweden), June 2006.
Holmqvist M and Pessi K "Strategy Turned into Action". *Managing Business in a Multi-channel World* (Tseng A and Tinnila M, Eds.) IDEA Group (Hershey, Penn., USA), 2005.
Holmqvist M and Pessi K "Innovation through Implementation—A Case from Global Implementation of e-Business", *Proceedings of 27th IRIS* (Varberg, Sweden), Aug. 2004.
Holmqvist M and Hultcratz O "Internet and e-Commerce Impact on Logistics". *Proceedings of 9th Logistics Research Network Annual Conference* (Dublin, Ireland), Sept. 2004.
Stefansson G and Holmqvist M "Collaboration with Logistics Service Providers". *Proceedings of 5th RIRL* (Fortaleza, Brazil), Aug. 2004.
Holmqvist M, Hultcrantz O, Stefansson G and Wingqvist A "The Logistical Consequences of e-Commerce for Spare Part Distribution". *Proceedings of 8th Logistics Research Network Annual Conference* (London, UK), Sept. 2003.
Enquist H, Magoulas T, Bergenstjerna M and Holmqvist M "DELTA Meta Architecture for Coordinated Development". *Proceedings of 25th IRIS* (Roskilde, Denmark), Aug. 2002.
Enquist H, Magoulas T, Bergenstjerna M and Holmqvist M *DELTA Meta Architecture for Proactive Management of Coordinated Development.* Final report book of DELTA project, NUTEK / Handelshögskolan vid GU 2001, Report:123., June 2001.
Holmqvist M and Sahlin P *Economic Evaluation Methods—Consequences and Valuation. A Case Study at Volvo, the Situation for an Enterprise-Wide IS/IT Investment in PDM.* Master's Thesis, Halmstad University (Halmstad, Sweden) and Bachelor (Hons) at University of Humberside (Hull, UK), May 1996.

2. RESEARCH APPROACH

This chapter outlines considerations on methodology, discusses the selected research method, and provides perspectives on how this thesis evolved.

This study is based on qualitative research (Myers 1997). Qualitative research uses qualitative data—such as interviews, documents, and participatory observations—to understand and interpret social phenomena in various fields. The field of IS/IT unfortunately contains a loose and unclear language that occasionally lacks focus and presents contradicting meanings (Orlikowski and Iacono 2001). Obviously, even our fundamental acronyms—IS (information systems) and IT (information technology)—can relate to different topics of study (Willcocks 1994). So, while it can be valuable to keep IS/IT together (as in this thesis), on other occasions it is better to study them separately. Without neglecting these challenges, there is little use here in extensively arguing definitions given the objectives of the thesis. In terms of basic terminology, then, this thesis regards developing and implementing IS/IT as the process of *bringing additional value into business through IS/IT usage*. According to conventional semantics, *developing* concerns *creation*, while *implementing* concerns *reaping the effects* of the development. Achieving additional value requires actual usage in business and enforces the fact that the act of managing is an ongoing process.

This research contains valuable results based on collaborative efforts. However, to facilitate understanding, this chapter will also address limitations of the research approach. The thesis research generally takes a managerial perspective, mainly from a business point of view (Earl 1989, Willcocks 1994, Ciborra 2002, Ward and Peppard 2002). It focuses on strategic and operational aspects related to internal and external processes of development and implementation. It does not cover fiscal details, nor does it go deep into behavioural theories. Aftermarket logistics in the automotive industry provides the context for the empirical knowledge gained at Volvo. Two cases lay the foundation for presenting the research contributions and conclusions in this thesis. The details of the research approach are described in the following four sections: Collaborative Practice Research, Interpretive Case Study, Insider and Outsider Perspectives, and the Research Process.

2.1. Collaborative Practice Research

Collaborative practice research is a way to organise and conduct research based on close collaboration between researchers and practitioners in the IS/IT field (Mathiassen 2000). Accordingly, this thesis is based on close collaboration among individuals and organisations based in both industry and academia. Such collaboration facilitates the two-fold aim of collaborative practice research: to improve practice (and thus be relevant to business) and to preserve the values of scientific rigor. Mathiassen (2002) argues that collaborative practice research is a practical way to strike a useful balance between relevance and rigor.

Researchers rely on research methods to maintain rigor during the research process and to facilitate peer evaluations of the results. A rigorous process can contribute to both organisational development and scientific knowledge (Schön 1983, Walsham 1995, Applegate 1999, Braa and Vidgen 1999, Yin 2003, Bhattacharjee and Paul 2004). It can be challenging to critically assess differences between industrial and academic objectives, but such efforts are worthwhile as the interactions can enable learning for both parties. Personally, this researcher has learned much thanks to many years of collaborative efforts between Volvo, Göteborg University, and the Viktoria Institute (www.volvo.com, www.gu.se, www.viktoria.se). Furthermore, the organisational commitments contributing to this specific thesis have remained strong since 1999, when the formal research process began.

Collaborations that bridge theory and practice can benefit the study of IT-Management. As Magoulas and Pessi (1998, p. 438) describe it:

> *"IT-Management is in essence a 'theory of practice' which implies that it neither follows a systematic procedure or applies a stereotypical theory of design. Our approach to IT-Management implies a continuous and situational striving to improve the information environment through the application of the study of practice, the study of values and the study of form (theories of action, theories of value and the theories of form)".*

There are clear gains from collaboration and interactions in activities between research and practice. As Mathiassen (2000 p. 132) states: *"…involved activities presuppose each other: we reach a deeper understanding of practice as we attempt to change it; we need to understand practice to design useful propositions; and the propositions and our interpretations of practice are ultimately tested through attempts to improve practice."*

Collaborative practice research offers a pluralist research methodology (Mingers 2001) that can combine elements such as case studies, action research, and experiments. As discussed in the next section, this thesis is founded on case studies with a basis in the interpretative case study method (Walsham 1993). While action research is deeply involved in linking theory to practice and solving practical problems (Galliers 1992), the research approach of this thesis entailed practical considerations that restricted the use of this method, as will be further described. Susman and Evered (1978) describe action research as a cyclical process that consists of diagnosing, action planning, action taking, evaluating, and specifying learning. Davison et al. (2004) extend this cyclical process with principles that ensure both rigor and relevance through canonical action research. Among the principles for collaborative research that these authors advocate are: making an agreement between researcher and client, using theory as a foundation for all post-diagnosis action, and facilitating learning through reflection.

As a researcher, it is easy to be inspired by action research. However, some of these principles—especially that of defining an applicable theory before engaging in action—are impractical for this research into developing and implementing

IS/IT in aftermarket logistics. Action research is goal-oriented in the academic perspective, and thus cannot easily deliver a descriptive story of the target phenomenon (Baskerville and Pries-Heje 1999). Baskerville and Pries-Heje (1999) address this conflict and further support the idea that action research and grounded theory cannot be completely integrated. The objective of this thesis is to contribute to findings that enhance our understanding of how to develop and implement IS/IT in aftermarket logistics. To fulfil the objective it is important to involve several independent supply-chain partners as well as to achieve situational interactions with various stakeholders in multiple organisations. In such a setting, the ability to set an action plan that can last several years is limited by the practice. Further, it would potentially inhibit the possibilities of exploring the empirical context in order to discover new implications. Consequently, the selected research method has been chosen in order to facilitate the research objective by combining rigor and relevance with collaborative interactions and interpretations.

2.2. Interpretive Case Study

In addition to describing characteristics from an empirical context, this thesis seeks to interpret how to better develop and implement IS/IT in aftermarket logistics. Interpretive case studies generally attempt to understand phenomena through the meanings that people assign to them. Such case studies are *"aimed at producing an understanding on the context of the information system, and the process whereby the information system influences and is influenced by the context"* (Walsham 1993, p. 4-5). Interpretive research does not predefine dependent and independent variables; rather, it focuses on the capability of human sense-making as the situation emerges through actions (Bhattacharjee and Paul 2004). Klein and Myers (1999) have described seven principles for conducting and evaluating interpretive case studies:

1. The Fundamental Principle of the Hermeneutic Circle
2. The Principle of Contextualisation
3. The Principle of Interaction Between the Researchers and the Subjects
4. The Principle of the Abstraction and Generalisation
5. The Principle of Dialogical Reasoning
6. The Principle of Multiple Interpretations
7. The Principle of Suspicion

Fundamentally, the hermeneutic circle assumes that human understanding is achieved by iterating the interdependent meaning of parts and the holistic whole that they form. Contextualisation requires critical reflection on the research setting's social and historical background. The interaction between researchers and subjects also requires critical reflection, as data is socially constructed through this interaction. Abstraction and generalisation require that the meaning of the contingent, possibly accidental, and often subjective phenomena is related to theoretical and general concepts. Dialogical reasoning requires sensitivity and repeated revisions to identify possible contradictions between theoretical preconceptions guiding the research design and actual findings ("the story that the data tell"). Multiple interpretations require sensitivity to possible differences in

interpretations among participants due to the likelihood of multiple narratives. Finally, the principle of suspicion requires sensitivity to systematic distortions and biases in narratives and stories.

This thesis research has benefited from using all of the Klein and Myers (1999) principles, albeit with some adaptations. Having many years of practical experiences can help a researcher see the *holistic process of change*, but this advantage must be balanced with critical reflections in order to follow the *principle of contextualisation*. The following section on insider/outsider perspectives describes the *interaction between researchers and subjects*, primarily as it relates to the dual role of an industrial PhD candidate. The principle of *abstraction and generalisation* has been affected by the same research situation, to which the references and discussions on IT-Management provide further considerations, especially in chapter 3. Specifics outlined in section 3.1 and 3.2 support analysis and implications as later derived in chapter 6, partly as it relates to using multiple approaches to enhance understanding (Mingers 2001, Alter 2004). Another way to exemplify how the possibilities for abstractions and generalisations have occurred is to look at the creation of scenarios in case 1 which can be independently compared with existing literature, as well as abstracted and applied in other situations (as further discussed in relation to data gathering in the Research Process section).

Dialogical reasoning has been adhered to in multiple ways, including: gathering several of the interviewed people into workshops; revisiting papers and publishing work that builds on previous publications; and sharing and discussing research with peers from both academy and practice during network gatherings (also further described in the Research Process section). This research has gained from easy access to data sources and has given special attention to *multiple interpretations*. For example, the assessment of different supply-chain actors and comparisons over several years led to discovering differences between various stakeholders (see especially papers 2, 3, and 5). The collaborative efforts in this research have also contributed to diversity and, by offering more perspectives on critical reflections, have promoted *the ability to be suspicious* of systematic distortions.

Overall, interpretive case studies can contribute to progress in IT-Management research and practice by benefiting from: "*…the drawing of specific implications, and the contribution of rich insight*" (Walsham 1995, p. 79). This thesis draws on specific implications for developing and implementing IS/IT in aftermarket logistics. Identifying implications provides useful input to related work as well as to other organisations and, potentially, to other settings. To further scrutinise the research approach, it is valuable to discuss insider and outsider perspectives before going into details of the research process.

2.3. Insider and Outsider Perspectives

The saying, "You only see what you believe, so you better believe what you see" reminds us of the importance of critical thinking. Peer-reviews, along with collaborative research efforts, have mitigated many of the risks in the presented research. The terms "insider" and "outsider" deserve special attention when an organisation's "inside" practitioners are working jointly with "outside" researchers (Bartunek and Louis 1996). Naturally, depending on the situation, these roles can be reversed—researchers, for example, are more "insiders" when it comes to theoretical work. As an industrial PhD candidate, it has been essential to take on both roles and learn to understand the perspectives accordingly. Bartunek and Louis (1996) emphasise the importance of respecting different roles in specific iteration situations, as well as the necessity of making intellectual shifts between theory and practice. Having good relations between research and practice is essential, but nothing that can be taken for granted (Mathiassen 2002). Practitioners must accept being the objects of study, be keen on critical reflections, and publicly discuss failures and problems. Researchers must strive to directly contribute to practice, realise that organisational priorities change, and be able to alter their research approach accordingly. Both parties must be able to reflect-in-action and reflect-on-action.

This thesis focuses on the process of developing and implementing IS/IT in aftermarket logistics based at Volvo. Being an "insider" in this context involved certain challenges, including an ability to handle an evolving understanding of the subject area and the necessity to relate to different organisational roles, cultures, behaviours, and politics (Coghlan and Brannick 2001). By validating data sources, testing assumptions, challenging interpretations, and discussing conclusions with other insiders and outsiders, the objective of building a better understanding has been continuously maintained. This also entailed confronting different views along the way that confirmed or contradicted existing interpretations and thus influenced research implications.

Developing and implementing IS/IT in aftermarket logistics is an evolutionary process. Conclusions are thereby derived in practice—on one hand, by being grounded in applied theories; on the other hand, by achieving operational results and industrial effects. On the journey toward this thesis, most paper publications have been co-authored with senior researchers, and all research projects have involved participants from both academia and industry.

Finally, an industrial PhD candidate needs to be a reflective practitioner and be prepared to confront paradoxes (Schön 1983). Close involvement can be counterproductive if the researcher fails to acknowledge aspects of the practice that are familiar and taken for granted—that is, if the researcher suffers from "tunnel-seeing" (see Stenmark 2002 p. 26-27). Furthermore, being an "insider" means having personal relations with both colleagues and research fellows. Such friendships and power relations can bias person-to-person inquiries such as interviews and workshop sessions. On the "outside", while the research questions support focus on the research objective, they must not become a hindrance for

uncovering interpretations and implications. Interpreting and interacting in a field of practice is a balancing act with in-context implications (Braa and Vidgen 1999). Interpretation is about understanding practice, while interaction seeks to derive implications that improve practice.

2.4. Research Process

Much of the author's evolving knowledge of the field comes through some 10 years' worth of practical experiences in working with Volvo on developing and implementing IS/IT in global aftermarket logistics. Such a background offers a foundation of individual experiences and knowledge acquired in practice. However, from a traditional academic point of view, there are clear limitations in terms of scrutinising and sharing such knowledge.

Re-entering the 'academic world'

Not unusual, when entering the business world fresh after earning a master's degree, the university gradually becomes a distant memory rather than a vivid collaboration partner. That might have been the case for the "once upon a time" master's student behind this thesis. However, after some years into a traditional business career, an opportunity for university collaboration was created. Therefore, to facilitate a rigorous research process, the author initiated several activities upon becoming a PhD candidate at the turn of the millennium; some of them will be presented here. These activities facilitated the researcher's ability to achieve distance from the target subject matter, a competence that every researcher needs to possess. In this case, the activities involved university course work, participating in seminars, enforcing learning of research methods, studying existing literature, etc.

In addition to completing academic courses and formulating an initial research plan, beginning the PhD study entailed significant participation in the DELTA research project. Paper 1 is a direct result of the DELTA work, which identified critical factors for IT-Management and provided an outside/in view to the Volvo setting**.** The DELTA network, which originated at the Göteborg University, has remained a continuous source of IT-Management inspiration, reflection, and validation. It has also enabled a complementary understanding of non-Volvo and non-automotive enterprises. Furthermore, the author gained increased understanding of methodological considerations and theoretical model creation (for example, details on a meta-architecture with a situational model in IT-Management is found in Enquist et al. 2001 and 2002). Although not included as direct results in this thesis, such knowledge contributes to the author's understanding of IT-Management research. The research process presented in this section is centred on the author's specific understanding of the critical factors, characteristics, and processes involved in doing research on developing and implementing IS/IT in aftermarket logistics.

This research process has produced a thesis with a collection of papers. For doctoral work involving several paper publications, it is important to consider the duality of the research outline and which part of the story one particular paper

will tell (Myers 1997). This is especially true given that the research process is an ongoing—and, to a certain extent, collaborative—effort. One has to accept the fact that it is impossible to grasp and tell the "whole story" in any one paper. One advantage is that it is sometimes possible to tell the same story from different angles and thereby enrich the thesis through a more in-depth understanding. This is particularly true for papers 2–4 in part B, together with the paper publications and book chapters that they build on (see overview of publications in table 1).

Empirical cases

Interpretive case study requires access to a case setting. A primary basis for the empirical case studies in this research is great accessibility, as well as responsibility for using such access to provide rigor and relevance in research. Generally, the sometimes cumbersome writing process has helped this author refine his thinking and figure out the whole story. The process of rewriting, rereading, responding to reviewers, and reformulating involved in early publications has proven as valuable as discovering, analysing, confirming, and validating actual research findings. The continuous peer reviews, reflections, and discussions also re-energised the writing process; quality was further enhanced by both refining the paper submissions and presenting the publications. Figure 2 provides an overview of the timeline to the research process. The boxes with dotted lines offer a time frame for the case study activities, which constitute a central part of this thesis.

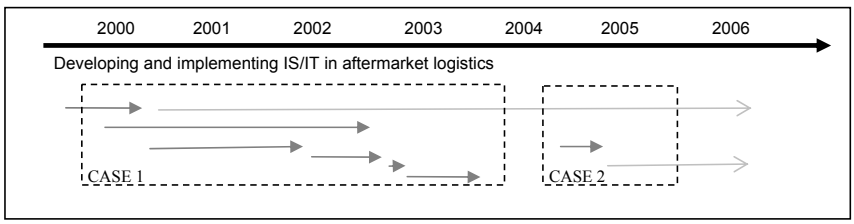

Figure 2 – Time line of research process and main empirical cases.

The practical goal of these activities was, in case 1, "to reach end-customers through Web services". The arrows exemplify various activities, ranging from establishing relations with new stakeholders and introducing simple Web usage to a continuous implementation of advanced Web services. The practical goal of case 2 was to uncover the implications of exploring more open usage of RFID (Radio Frequency IDentification) as a new technology; similar to case 1, it also sought to study the management of relationships among stakeholders. Paper 2 specifically introduces the empirical contextualisation of developing and implementing IS/IT in aftermarket logistics. It includes a social and historical context, which provides a basis for an inside/out view on the evolution of process integration.

Paper 5 illuminates specifics on innovation, collaboration, and learnings from "exploring RFID through collaboration" (the dotted line of case 2 in figure 3). Paper 5's main results also build on several peer-reviewed publications (as noted in table 1). Similarly, both cases 1 and 2 support each other in terms of validating

and enforcing the thesis findings. The work presented in papers 3 and 5 involved close collaboration with researchers at Chalmers University of Technology, while papers 1, 2, and 4 were based on collaboration with researchers at Göteborg University and the Viktoria Institute. Collaborative practice research means involving essential disciplines, and papers 3 and 5 are strongly related to logistics research. Furthermore, the work highlighted in paper 3 contributed to contextual understanding and scenario development, while its temporal aspects of prediction can be reviewed through a larger perspective in combination with papers 4 and 2, as well as in the light of this thesis. It should be stated that the author of this thesis was the first author on papers 2–5 (though, of course, co-authoring is a collaborative process), while paper 1 is based on the DELTA project principle of equal authorship. Together, the papers provide a holistic view, with detailed characteristics, interpretations, implications, and discussions that contribute to understanding of the issues involved in developing and implementing IS/IT in aftermarket logistics.

Data collection and analysis

Naturally, each of the publications from this research contains details on the research method, including data collection, analysis, and specifics. As an overview, table 2 describes and explains the various sources that are relevant for this thesis. All sources in the table will not be explained further here, but rather limited to highlights, ranging from more formal research (such as interviews) to more indirect research (such as direct involvement) to secondary data access (such as survey data).

Personal and semi-structured interviews were the primary data-collection method, together with focused workshops, analysis of documentation, and participatory observations (Walsham 1995, Yin 2003). The *semi-structured interviews* addressed open-ended questions on IS/IT development and implementation; strategic concerns; critical issues and priorities; and changes in relationships, processes, content, and context. In each of the case projects, the Steering Group chairman, Project sponsor, and the person in charge of the user site were always interviewed, along with other supply-chain representatives and various stakeholders. Alltogether 64 interviews have been fully documented. Compared to other data-collection methods, interviews are more likely to provide relevant answers on a specific subject. It is therefore crucial that the right people are interviewed. Knowing who the "right" interview subjects are of course involves a degree of uncertainty (Yin 2003). Preparation, analysis, and—perhaps most important—well-established contacts with people on strategic and operative levels facilitated the selection of relevant interviewees, thereby helping to secure valid data collection through the interviews. Direct quotations in the individual research contributions enrich the contextualisation (see especially papers 2 and 4 and Holmqvist 2006).

Direct involvement has led to prevalent usage of actual situations and collaboration among different actors. Maintaining direct responsibilities provides first-hand experiences, but also must be balanced with reflection and critical thinking.

Specific measurements (such as making more than 3.000 measurements on the RFID set-up explored in case 2) have provided complementary data and, on occasion, have been used for validation checks with interview subjects. Utilisation of workshops to facilitate group discussions and participation in network gatherings has enriched the researcher's insight. *Participatory observations* can be described in many ways and relate to direct involvement. Being "inside" a company offers researchers various opportunities at various occasions, such as listening to conversations among stakeholders at lunch and other informal gatherings where communication barriers are usually lowered. In the case of this research, the possibilities of accessing richer data was clearly beneficial as it provided a means to explore and convey findings from a complex context. *Secondary data* access has been facilitated by easy and direct access within Volvo. Fast access to documents, KPI data, and data such as systematic user-satisfaction surveys enabled the usage of comparisons between multiple data sources.

Table 2 – Overview of sources to this thesis.

Data source	Explanation
Open-ended, semi-structured interviews	Sixty-four fully recorded and documented interviews of practitioners, conducted together with other co-authors
Direct involvement	Participating in real-life context with different responsibilities for developing and implementing IS/IT in aftermarket logistics
-Workshops	Dedicated sessions on specific topics
-Measurements	Specific activities to gather complementary data, such as targeting usability, reliability, productivity, etc
-Network gatherings	Meetings between practitioners and academics who share common interests in IT-Management, for example DELTA network
Participatory observations	Taking part in situations where problems and solutions are derived, executed, and experienced
-Informal talks	Dialogue and informal conversations held throughout the research process, often leading to specific comments in the research diary
-Meeting notes	Informal notes from discussions and observations during meetings
-Research diary	Continuous diary of activities, reflections, and notes taken throughout the PhD research process
Secondary data	Easy and direct access especially to Volvo data
-KPI data	Access to databases with Key Performance Indicators
-Minutes of meeting	Formal minutes and documents on issues, considerations, decisions, and results
-Project documentation	Project work materials such as presentations, manuals, emails, discussion groups, etc
-Online surveys	Follow-up on user satisfaction, preferences, and quality

Data analysis within collaborative research involves certain ethical considerations because researchers have access to data in both formal and informal ways (Bartunek et al. 1993). Examples of this have been described above, including online surveys to follow-up development and implementation results, as well as using DELTA network gatherings to review findings among peers. Further discussions are provided in all of the papers, such as on workshop usage (see paper 1), creating a historical contextualisation (see paper 2), and outcomes of dealer clinics (see paper 3). Using many data sources also made it possible to accomplish triangulation (Patton 1987, Yin 2003) to enforce analysis and minimise bias, thus contributing to more rigorous findings. As Myers (1997) notes, it is not always possible for qualitative researchers to clearly distinguish between data gathering and data analysis. Furthermore, because a researcher influences data gathering, questions posed to informants largely determines what will be found. The analysis affects the data and the data affect the analysis.

Continuously reflecting on intentions and perceived results—and participating in discussions among research peers before, during, and after research activities—has reduced the biases in this research. The various paper submissions have also contributed to a continuous verification and quality assurance.

Concluding chapter two

Finally, a research process requires considerable resources. In this case, resources have been secured for collaboration between academia and Volvo. These have enabled the author's critical reflection, including time allocated for purely academic activities while maintaining a practitioner's position. A formal support group consisting of a senior researcher and a PhD student supervisor from the Viktoria Institute/Göteborg University, together with senior managers and an HR representative from Volvo, met two to four times per year to formally review the research status and facilitate dialogue and support. However, it was the continuous, daily collaboration activities that most contributed to the research efforts. Somewhat paradoxically, the journey toward a PhD is also a very personal and individual journey: Learning to see various perspectives more easily and discover how doing so can influence understanding and possibilities for communicating among peers, colleagues, and various people in different situations was both fascinating and gratifying.

3. IT-Management

This chapter discusses aspects of IT-Management that are essential to the contributions of this thesis.

IT-Management research is one important area in informatics and in focus of this thesis. Informatics is essentially a design-oriented study of IS/IT use, an artificial science that takes as its subject matter the intertwined complex of people, systems, and technology (Dahlbom 1997). In many ways, to again quote Magoulas and Pessi (1998, p. 438): *"IT-Management is in essence a 'theory of practice'…"*. They define IT-Management as: *"the judicious organisation of technological means to accomplish individual and social ends"* (p. i). That said, there is no currently agreed-upon definition of IT-Management. There is, however, comprehensive work to structure this field of knowledge, including wide ranging references to previous research (Magoulas and Pessi 1998). As the following examples show, the study of managing IS/IT means and ends involves issues such as business value, alignment, learning and innovation, planning, uncertainty, complexity, real-world pragmatics, and agility:

- Managing IS/IT in organisations requires a consideration of how organisations can continuously derive and leverage business value (Peppard and Ward 2004).
- Alignment between business and IS/IT to gain competitive advantages is a problem for IT-Management (Henderson and Venkatraman 1993, Reich and Benbasat 2000).
- IT-Management practice influence IT usage in complex organisations and affect learning and innovation (Boynton et al. 1994).
- Management practice affects information systems planning, even under dynamic conditions (Salmela et al. 2000).
- IT-Management must adhere to real-world pragmatics, which are imperfect, complex, uncertain, and co-created, but very much alive (Ciborra 2002).
- Managing our ecosystem—the mix of human and non-human actors that are shaping and are shaped by the ecosystem—is a complex task (Vidgen and Wang 2006).
- Managing IS/IT infrastructures, development, implementation, diffusion, and business require agility (Baskerville et al. 2005).

These examples illuminate key aspects of IT-Management that, along with further theoretical contributions, provide a critical foundation for understanding the thesis research. Research that focuses on developing and implementing IS/IT in aftermarket logistics requires the uncovering of complex and uncertain interpretations. Jaccuini, Hanseth, and Lyytinen (2006) argue that complexity should be seriously considered in IS/IT research. Recent research even proposes a paradigm shift and *"for IS scholars ready to take the paradigm-shift plunge, we offer complexity science as an apt means for moving toward a more dynamical theoretical and methodological platform better suited for studying IS dynamics at the dawn of the 21st century."* (Merali and McKelvey 2006). The research presented here does not go that far. In terms of this thesis, *complexity* means that there are multiple elements with multiple dependencies. A simple fact of complexity is: One aspect will always be followed by another. As paper 1 of this thesis discusses, complexity

is created from an increase in dimensions such as diversity/heterogeneity of elements with dependencies; dynamic behaviour; and speed/phase of development and change. In situations where cause is hard to distinguish from effect, and high uncertainty also exists, it is important to understand the specific setting's characteristics and process of change. Dahlbom and Mathiassen (1993 p. 103) describe the difference between complexity and uncertainty as follows: *"The degree of complexity in a given situation is a measure of the amount and diversity of relevant information needed to solve the problem. The more diverse the information is, the higher complexity. In contrast, the degree of uncertainty represents the accessibility and reliability of information that is relevant in a given situation. The more accessible and the more reliable the information is, the lower the uncertainty."*

This chapter will now divide specific IT-Management considerations into two sections: a section on planning and alignment, followed by a section on development and implementation.

3.1. Considerations on planning and alignment

Developing and implementing IS/IT in aftermarket logistics depends on multiple processes, products, and actors, which makes planning and alignment essential. By studying different multi-business perspectives, Nilsson and Olve (2001) found that determining a suitable management approach depends on the organisational level at which planning and follow-up occurs. This section first discusses IT-Management as it relates to Strategic Information Systems Planning (SISP), then examines business–IS/IT alignment in both static and dynamic conditions, which finally leads to a discussion of scenario development.

Strategic Information Systems Planning

SISP has been described as the process whereby an organisation determines an IS/IT portfolio in order to achieve business objectives (Lederer and Sethi 1988). In SISP, organisations analyse their information usage and processes using business information models; they also evaluate risk, current needs, and requirements. A survey of IS/IT managers identified SISP-related resource, planning process, and output problems (Lederer and Sethi 1988). The most severe problem that managers cited was the failure to secure top-management commitment for implementing the final plan. The second most severe problem was the need for substantial additional analysis following the IS/IT plan's implementation. Both of these problems relate to the output of the planning process. Paper 1 in part B of this thesis identified similar critical factors that must be addressed by organisations confronted with complexity. Some researchers have suggested a formal and comprehensive SISP approach, along with case study comparisons that target national differences and implementation predictors (Galliers 1987, Lederer and Salmela 1996, Gottschalk and Kandelwal 2002). Sabherwal (1999) has studied how successful planning efforts relate to IS/IT implementation and found that contextual conditions play a crucial role. IT-Management research has also debated the effectiveness of too little or too much SISP (Premkumar and King 1992, Sambamurthy et al. 1994, Newkirk et al. 2003). The basic contentions here are that too little planning results in insufficient understanding of the

planning context, while too much planning requires too much time. Furthermore, the dynamics of the environment have significant influence as well. Salmela et al. (2000) assert that even in turbulent environments, comprehensive planning can be beneficial because planning activities can facilitate reflection on the situation. Turbulence is relative to the specific conditions, and thus changes over time, which require an ability to take different perspectives. Formal and comprehensive planning efforts can be contrasted with alternative approaches, which shift from inflexible, structural, and thorough planning to incremental and informal planning to personal contacts, face-to-face communication, and subjective judgements (McBridge 1998, Newkirk et al. 2003). In any case, aligning plans and plan execution remains a challenge for IT-Management.

The alignment challenge

Aligning business and IS/IT requires some form of planning and execution—a challenge that has been investigated in IT-Management research. In their strategic alignment model, Henderson and Venkatraman (1993) emphasise the need to align business and IS/IT in four domains: business strategy, IT strategy, organisational infrastructure and processes, and IS infrastructure and processes (see figure 3, which has been adopted from their work). The model seeks to overcome the difficulties of realising the benefits from IS/IT investments, arguing that such difficulties are partially due to a lack of alignment between organisational business and IS/IT strategies. Fundamentally, the model considers two strategic characteristics: "strategic fit", which is the interrelationships between internal and external domains; and "functional integration", which is the integration between business and IS/IT domains. By breaking down the model into various components and discussing their relations, the strategic alignment model presents various perspectives. One example is *technology transformation*, in which a business strategy drives the selection of the appropriate technology. In contrast, the *competitive potential* perspective seeks to exploit an IS/IT strategy to derive a business strategy. Given the many perspectives, Henderson and Venkatraman wisely conclude that there is not one universally superior mode or strategy, but rather that strategic alignment is more of a process.

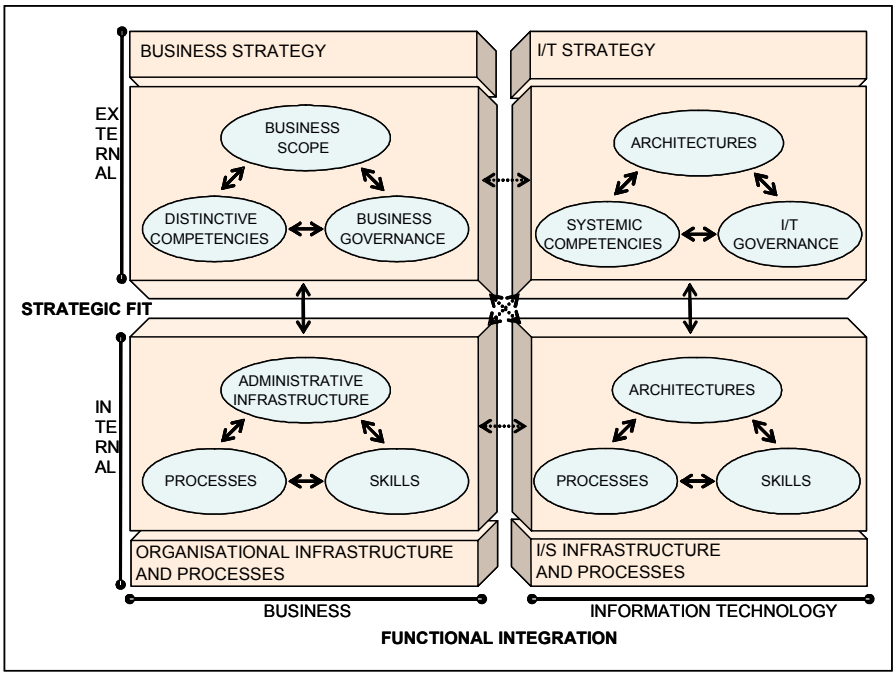

Figure 3 – The strategic alignment model.

Discussions on strategic alignment entail considerations of centralisation and decentralisation (Brown and Magill 1994); the balance between business and IS/IT, to which Reich and Benbasat (1996) add additional technical and social dimensions; and the increased difficulties of achieving strategic alignment in dynamic conditions (Sabherwal et al. 2001). Because the conditions for developing and implementing IS/IT in aftermarket logistics are often globalised and dynamic, these research contributions are sources for inspiration. However, there remains a lack of understanding about how to achieve alignment through academic work, as well as an absence of actual usage in practice (Kearns and Lederer 2000). There are also few reported cases of actual implementation (Grant 2003). Avison et al. (2004) are among the few researchers reporting actual usage and validation of the model; as are Sun and Chen (2006), who attempt a dynamic capabilities perspective. Indeed, the value of the strategic alignment model might be more conceptual than practical. This would justify the critique of those who distance themselves from the practical reality that IT-Management strives to improve.

Critique of the rationalistic approach to planning and alignment

Claudio Ciborra was highly critical of the IT-Management research that favours rationalistic, formal, and comprehensive approaches to systems planning and strategic alignment. Among his harsh critiques was the following assessment of some strategic alignment researchers: *"They idealised tinkering and called it strategy; idealised technology as a controllable set of means … transformed them into boxes and traced a line between them. Then they started the difficult journey back to*

the real world, and found difficulties in measuring 'the strength of a line' or formulating prescriptions that would be followed by practitioners" (Ciborra 2000 p. 29). This critique senses a navel-gazing that academic work risks succumbing to with its suggestions of model after model (unrelated to actual usage) and its discussion of frameworks for the sake of discussing frameworks. Ciborra (2002) strongly argues against procedures, since their neatness and structure focus mainly on the spatial dimension of IS/IT, often ignoring the temporal dimension, which places a higher value on improvisation than the conventional control paradigms. The critique also calls for a sensible urge for in-depth collaboration with real-world practice. This urge is at the heart of collaborative practice research, with benefits for both industry and academia (Mathiassen 2000). This thesis involves collaboration in the field of informatics and logistics with a focus on managing IS/IT development and implementation in a dynamic and uncertain context.

The crituque that Ciborra (2002) provides include several artefacts and descriptions that are important for IT-Management discussions:

- **Bricolage and Tinkering**. Bricolage is the constant re-ordering of people and resources, and constant "trying out" and experimentation as a true hallmark of organisational change. But Bricolage is not random experimentation; it is experimentation based on leveraging the world "as defined by the situation". That is, it is an evolutionary approach. An example here is an innovative project that suddenly becomes strategically important, ex post. Tinkering explains how companies actually make strategies in order to overcome the cognitive barriers that stand in the way of innovation. Tinkering relates to activities that repair and adjust, often in an unskilled or experimental manner.
- **Drift.** Through numerous examples, Ciborra has shown that systems development drifts between requirements specification, developments, and implementation, all of which affecting actual usage. Contextualisation plays a crucial role for understanding the practical conditions, as reality is often a runaway learning organisation that is both dynamic and unpredictable. Situatedness, drifting, complexity, and chaos—rather than order—need to be acknowledged and explored. Drift highlights temporal aspects of IT-Management in both time and space, particularly on the global level, where large deviations occur.
- **Improvisation.** "Improvisation as situated action" justifies a focus on the dynamic characteristics of improvisation. It means to catch the latest circumstances in emergent problem-solving and attune moods, feelings, and affections to the situation. In improvisation, one takes time, rather than being taken by time. Improvising managers are in the situation, and they take care. These personal, human aspects shape our encounters with the real world and show how humans define the situation at hand and so shape action.

Theoretical frameworks can represent sterile abstractions and simplified models that are purified of the rich messiness of our daily common-sense world. Their ideal representations—typically, geometrical diagrams with arrows and boxes depicting key business variables—encourage a commando-like attitude that

attempts to force impossible or misunderstood ideals upon a recalcitrant reality (Ciborra 2000). In the real world of global, large-scale business, with its turbulent and unpredictable circumstances, managers are busy muddling through, betting, and tinkering. The use of IS/IT itself is characterised by circumstances that compel managers and employees to improvise frequent adaptations and reinventions of the initial system. Some suggest that opportunistic adjustments must be carried out on the spur of the moment, with enterprise-wide implications (Ciborra 2000, Nandhakumar et al. 2003). However, we must approach large-scale and inter-dependent operations with both holistic understanding and persistence in our change efforts to achieve learning and innovation. That is, even as drift occurs, it must not replace the desire to drive overall progress in complex system structures. Ciborra actually focuses on rigor, relevance, and reflection and wants us to continue in *"a style that puts questioning and thinking at the centre of our efforts in coping with the management of complex organisations, a style that makes questioning the core activity of management research and practice, more pious and perhaps more effective"* (Ciborra 1997, p. 79).

Scenario development as one way towards progress

Scenario development can help managers contend with business environments characterised by interdependencies, complexity, and uncertainty (Schoemaker 1993). Scenarios are narratives of alternative future environments; they are like hypotheses of different futures, specifically designed to highlight the risks and opportunities in strategic issues. *"Scenarios help managers structure uncertainty when (1) they are based on a sound analysis of reality, and (2) they change the decision makers' assumptions about how the world works and compel them to reorganise their mental models of reality"* (Wack 1985, p. 74). Scenario development helps to change mental models and expose possibilities and opportunities that otherwise easily go unnoticed or entail underestimated risks. Bood and Postma (1997) have drawn a model that elaborates on Kolb's "learning cycle" by emphasising actions as well as multiple scenarios (see figure 4). They discuss how a balance between organisational levels and units encourages feedback and learning, which helps facilitate good agreements and resolve disagreements.

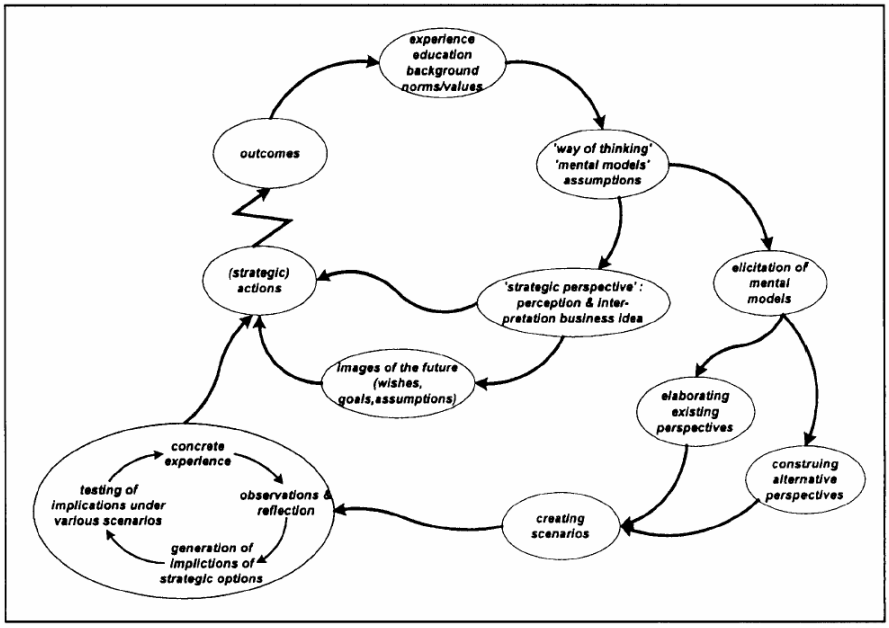

Figure 4 – Scenario development, the learning cycle, and actions.

Strategic awareness can be facilitated by scenario development (Bood and Postma 1997). Furthermore, it nurtures collaboration, learning, creativity, and understanding among participants (Van der Heijden et al. 2002). However, it has been suggested that measures should be taken to avoid making it a static process and participants should strive to obtain diversity and preferably involve some "outsiders" (Bood and Postma 1997, p. 645). Through the same authors, it is possible to outline a disadvantage: the experience gained through working with different scenarios means that multiple options and alternatives might increase the perceived uncertainty. In contrast, a formal SISP activity often recommends that efforts be focused on communicating one decided solution. However, when scenario development rapidly encourages people to gain practical experiences and put business implementations into operation, its usage can facilitate progress. Paper 3 in part B provides more details on how using scenario development contributed to the thesis research.

Having drawn attention to important IT-Management considerations on planning and alignment, it is now time to consider development and implementation. It is worth remembering, however, that while issues such as information value, project management, and governance aspects are valuable to IT-Management (see Shapiro and Varian 1998, Mähring 2002, Weill and Woodham 2002), they are not the focus of this thesis and, due to practical limitations, will not be extensively discussed here.

3.2. Considerations on development and implementation

Although this section will address IT-Management aspects first in terms of systems development, and then in terms of business implementation, it is important to grasp the two together for a more agile and sustainable perspective.

Systems development

Systems development has been in focus for researchers since the possibilities of automatic computation emerged several decades ago (see Wirth 1971, Checkland 1981, Freedman and Weinberg 1982, Greenbaum and Kyng 1991, Dahlbom and Mathiassen 1993, Jackobson et al. 1999, Jackson 2003, Fitzgerald and Hartnett 2005). Some studies have investigated failures within systems development (Lucas 1975, Oz 1994, Flowers 1997, Kiel and Mann 2000), while others scrutinised specific project views (Ewusi-Mensah and Przasnyski 1991 and 1994, Sauer 1993, Huang et al. 2003). Conventionally, detailed specifications—with formal and comprehensive systems development—have dominated, based on a sequential process ranging from waterfalls to prototyping (Pressman 1987, Kemerer and Sosa 1991, Greenbaum and Kyng 1991). There are also more iterative system development structures, and even alternative approaches, such as Rational Unified Process (RUP) and extreme programming (Jacobson et al. 1999, Fitzgerald and Hartnett 2005). IS/IT solutions have grown in usage and scope, and researchers have offered specific suggestions on how to manage complex systems development (Taxen 2003). Organisations often initiate large, global changes through large system development projects to be steered and controlled through robust project structures. However, fixed project gates and milestone deliveries often result in a mismatch with changing conditions, which increases the risk of project escalation (Keil and Mann 2000). This fact has given rise to research on de-escalation tactics (Montealegre and Keil 2000), which aim to re-establish the possibility of managing situations that have grown out of control. Of course, our search is guided by the desire to avoid such situations in the first place.

Decades of systems development have resulted in a practical problem: robust "islands of automation" have arisen in the system landscape of organisations, contributing to collaboration difficulties (Magoulas and Pessi 1998). IT-Management research addresses these difficulties, and structural needs have encouraged the use of artefacts from the fields of city planning and architecture. Information architects and theoretical frameworks address issues of integration, migration, and disintegration; they also use system maps to provide perspective and illuminate the systems development landscape (see Zachman 1978, Earl 1989, Sowa and Zachman 1992, Magoulas and Pessi 1998, Enquist et al. 2001, Finnegan et al. 2003). Researchers often use meta-architectural models and conceptual frameworks to define, present, explain, and evaluate IS/IT. However, systems maps and architectural plans can become rapidly outdated with the dynamic growth of inter-organisational integration; this common outcome has nurtured an emerging interest in service-oriented architecture (SOA) (Christensen et al. 2001, Ferguson et al. 2003). Ferguson and his co-authors (2003) identify Web services use as a way to accomplish flexible developments,

including enterprise-wide collaboration. Although the body of knowledge on IT-Management is still fragmentary, we can nurture valuable discussion through further in-depth contextualisation that holistically approaches enterprise-wide IS/IT issues (Enquist et al. 2001). Overall, using IS/IT influences business and brings a continuous need to balance the paradox of seeking both standardisation (implementations that drive economies of scale and scope, smooth collaboration, simplify integration, etc.) and differentiation (developments that deliver innovations in products and services, enhance customer satisfaction, facilitate customisation, etc.).

Business implementation

Organisations develop and implement IS/IT in part to secure competitive advantages by integrating its use into business (Bloem et al. 2005, Ward et al. 2005). Existing research mainly concerns development approaches (or planning phases and post-implementation results from executed activities) rather than the implementation process as such (Klein and Sorra 1996, Wainwright and Waring 2004). One reason might be, somewhat unfortunately, that details on the actual implementation and execution of actions are highly contextual by nature. However, that seems to be a poor explanation for the imbalance in research contributions in favour of planning phases, development approaches, and end-results. Furthermore, when the actual act of implementing is discussed, its highly contextual specifics are often only briefly and simplistically described. That said, there is research on implementation issues, such as defining a basic distinction between freeze/unfreeze/refreeze stages, for example (see Lai and Mahapatra 1997 for further references).

Implementation that will deliver business value into operations such as aftermarket logistics must address information infrastructures and the installed base of large-scale operations, as well as organisational learning and diffusion of innovation (Ciborra and Hanseth 1998, Weill and Broadbent 1998, Finnegan et al. 2003, Rogers 2003, Mustonen-Ollila and Lyytinen 2004). As paper 5 shows, innovation can emerge from exploiting the installed base of both IS/IT and stakeholder relations. It is done by finding new ways to implement integration through collaboration. Integration affects infrastructure, and there are different types of integration. Research on IS/IT integration in the automotive industry addresses value-chain integration and business integration (Tuunainen 1998) among participants in a network of inter-organisational IS/IT use. While value-chain transformations are increasingly virtual, relationships and hierarchies still change gradually, supported by electronic integration (Malone et al. 1987, Rayport and Sviokla 1995, Pant et al. 2003).

Implementations involve a process of business change over time—rather than a single system deployment at one location—and this contributes to incremental perspectives (Orlikowski 1993). As paper 2 describes in some depth, it is also possible to see IT-Management as part of an evolutionary process (Earl 1989). Earl (1993) suggests, based on a broad case study, that even if practice is not so concerned with formal methods, the development and implementation of IS/IT

needs to consider the organisational conditions. He concludes that organisational issues are more influential than method-driven initiatives or even business- and technology-driven factors. Monteiro (2000, p. 74) calls for *"A more satisfactory account of the interwoven relationship between IT and organisational transformation is lacking. More specifically, we need to learn, not just that this interplay exists, but how it works."* Still, whether they contain detailed or broad argumentation, most theoretical frameworks typically deal with issues of implementation without providing thorough examples and insights on how they work in the specific context in which the issues are confronted (Cooper and Zmud 1990, Lai and Mahapatra 1997, Wainwright and Waring 2004). Davenport and Markus (1999) are among those arguing that rich contextualisation and case material can also contribute to making IS/IT research accessible to practitioners. However, to do this, it is essential to go beyond the hype and buzz words that propagate across the field.

Agility and sustainability

Current research on managing IS/IT draws increasing attention to agile and sustainable capabilities. Agility relates to an organisation's ability to sense and respond rapidly to unpredictable events and thus satisfy changing customer demands. *"In a world in which change and uncertainty drive the needs for business agility, and digital information drives business, agility in IT is critical for business success. We believe it is important to understand how [agility] is multifaceted"* (Baskerville et al. 2005, p. 9). Paper 4 shows how developing and implementing IS/IT in aftermarket logistics requires that we confront uncertainty and ensure that agile capabilities extend adaptability and flexibility to include speed and scalability. Furthermore, external factors, such as threats and opportunities, must be matched with internal capabilities of innovation, proactivity, quality, and profitability (Sharifi and Zhang 2000, Highsmith 2002, Sambamurthy et al. 2003). Agility even influences new software development approaches, which emphasise productivity rather than process rigor and seek to deliver business value quickly in spite of changing user requirements (Cockburn 2001, Fitzgerald and Harnett 2005). This contributes to thoughts of considering development and implementation together. (In section 4.2, agility will be further addressed, as it has a strong heritage in SCM research, where it has provided an emphasis on sustaining valuable performance.)

Peppard and Ward (2004, p. 168) discuss on-going changes that occur as part of the evolution in how we manage IS/IT. They outline three previous eras: data processing (DP), management IS (MIS), and strategic IS (SIS). Furthermore, based on a resource view, they suggest that we are on the brink of a fourth era. *"We introduce the concept of an 'IS capability' and argue for organisations to understand, develop and nurture this capacity if they are to deliver value from investments made in IT on an ongoing basis."* (p. 169-170). They emphasise a sustainable, continuous process and illuminate an intertwined relationship between strategy and change with drivers derived from interactions of demand and supply in business and IS/IT (see figure 5, which is adapted from Peppard and Ward 2004).

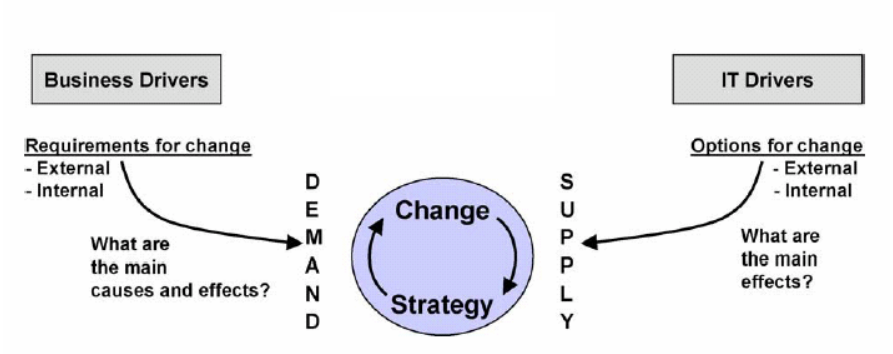

Figure 5 – View of demand and supply interactions with business and IS/IT drivers.

Peppard and Ward (2004) recommended an implementation-driven approach for development in environments of uncertainty because: *"Managing IS/IT and delivering business value is essentially a set of knowledge-based activities: a complex and multidimensional set of tasks and processes, incorporating many different but interdependent types of knowledge. It involves integrating … from different disciplines and backgrounds, with varied experiences and expectations, located in different parts…"* (Peppard and Ward 2004, p. 183). This thesis is based on such a mix; its goal is to turn strategy into results by achieving meaningful planning, development, and implementation.

4. Supply-Chain Management and Aftermarket Logistics

This chapter contains research on SCM and aftermarket logistics which introduces language and concepts that are central to articulating the context of this thesis. Thereby it can enrich the frame of reference and facilitate fulfillment of the research objective.

Before introducing specifics into the field of aftermarket logistics, it is valuable to offer a glimpse of logistics. Logistics is a research field of its own and, like informatics, it contains multi-disciplinary dimensions. This chapter seeks to enforce the frame of reference for this thesis by illuminating the importance of SCM in general, as well as in its particular relationship to informatics and aftermarket logistics. To facilitate a basic understanding, different characteristics will be highlighted here. Selecting such characteristics is a challenge, because the area is so broad. For example, the *Encyclopaedia Britannica* describes logistics at large as covering the planning and organisation that is needed to carry out any large and complex operation. Wikipedia (http://en.wikipedia.org/wiki/Logistics, accessed 1st February 2006) defines logistics as: *"Logistics is the art and science of managing and controlling the flow of goods, energy and information. The term logistics have evolved from the military's need of spare-part supply. It is now widely accepted to include activities like purchasing, transport, warehousing, organising and planning of these activities. In business, logistics may have either internal focus, or external focus covering the flow from originating supplier to end-user (supply-chain management)."*

Distinguished researchers have discussed SCM in relation to logistics, highlighting aspects such as intensified collaboration, implementation challenges, and integration (Cooper et al. 1997). These aspects are important for the research in this thesis, and they influence performance in IS/IT-dependent business processes. Lambert et al. (1998 p. 1) emphasise integration aspects and illuminate the involvement of multiple actors in defining SCM as *"the integration of key business processes from end user through original suppliers that provide products, services and information that shall add value for customers and other stakeholders."*

4.1. Supply-Chain Management

Independent of how broad or narrow a definition one makes of SCM, there are important research contributions in the field that relate to IT-Management (Bowersox and Daugherty 1995, Tilanus 1997, Lumsden 1998, Motwani et al. 2000, Stefansson 2004). Bowersox and Daugherty (1995) illuminate the need for IS/IT among actors in the supply chain in order to achieve transparency, accomplish long-term collaboration, measure performance, and enable time-based responsiveness. Tilanus (1997), among others, suggests that IS/IT plays a crucial role in enabling SCM for desired transformations in space (e.g., EDI messages between actors); time (e.g., RFID enabled comparisons between notification of goods and real deliveries); and form (e.g., the ability to simulate and visualise process changes between supply-chain actors). This thesis shares the view that the

most critical driver is availability, influencing strategy, actions, and collaboration along the supply chain in the automotive sector (Womack 1991). Availability is determined by SCM activities that create transactions of goods, finance, and information (Lumsden 1998). To manage the flow of transactions that takes place in the linkages between actors (thus forming the supply chain), it is essential to distinguish nodes of interaction, modes of transportation, and dimensions of analysis (see figure 6, adapted from Lumsden 1998).

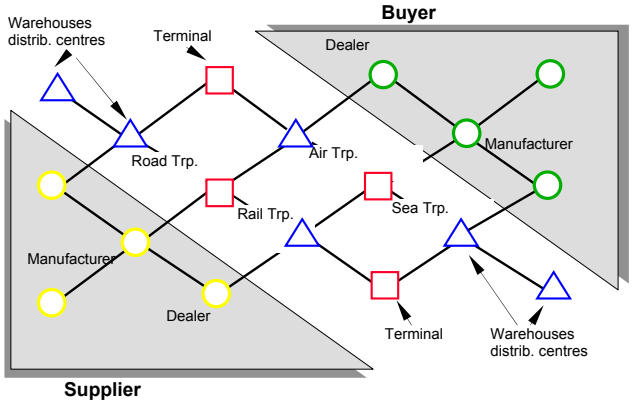

Figure 6 – Actors, nodes, and linkages in SCM.

Even if the full SCM picture is complex and thus difficult to fully understand, there is little debate about its overall importance. Due to the multiplicity of influencing issues, the challenge of gathering size estimates and facts can make comparisons within the field difficult**.** Still, as a general example, take the following statement from the UN Trade and Development conference (held 8 December 2004 in Geneva): *"International transportation of goods is increasingly carried out on a door-to-door basis, involving more than one mode of transportation. While there is little information on the overall proportion of cargo transported by multiple modes, data on the development of containerized traffic provide some highly significant indications, as containers are designed for transportation by different modes. These goods flows have grown from zero in 1965 to 225 million moves in 2000 and only this container traffic is forecast to more than double until 2010 to almost 500 million moves."* The same conference addressed the growing importance of IS/IT in order to manage such growth.

Economic liberalisation has contributed to the fact that international trade has almost doubled since 1970s. The World Trade Organization compiles an annual CD-rom with international trade statistics. The 2003 issue noted that the global GDP reached $33 trillion in the year 2000, with almost a third of its growth occurring in the last 10 years. SCM operations constitute more than a 10% share of this GDP. Taking a more detailed example: in the US, the operational costs for SCM activities were close to $1 trillion in 2004 (Wilson 2004). Of these costs, almost half relate to truck transports and about one-third were carrying costs. Within the automotive industry, costs of SCM operations typically amount to

about 10% of the company sales value. The high volume flows of physical goods, combined with multiple information stakeholders, have turned SCM into one of the most complex business functions (Cooper and Gardner 1993, Lumsden 1998, Ericsson 2003). The rise of SCM, including its software products and niche consulting, confirms this development. Figure 7 illustrates how SAP, the large software vendor, depicts IS/IT functionality for logistics service providers, from the suppliers (carriers) on the left to the receiving buyers (clients) on the right. Main components in their system are: sourcing in planning, procurement, and execution; operations in procurement, freight, warehousing, and order management; and customer (client) management as well as visibility and compliance, which is depicted as a cross-functional component that enables collaborative efforts.

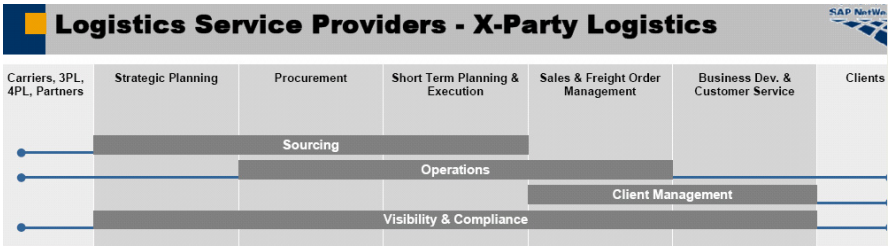

Figure 7 – Illustrative view of software functionality needs in logistics.

Because SCM spans all activities related to moving and storing raw materials, work-in-process inventory, and finished goods from point-of-origin to point-of-consumption, creating distinct interfaces for various supply-chain actors is crucial. Figure 8 offers an overview of SCM interfaces and flows to manage in collaboration (adopted from Stefansson 2004). The figure shows the interfaces between various flows of resources, materials, money, and information. The resource flows include internal resources (such as forklifts, cases, or other load units) and external resources (such as vehicles, containers, etc.). The material flow exists between the parties, and is usually downstream and moves in one direction. The information flow is bi-directional between parties, while the monetary flow is mainly directed upstream in the supply chain.

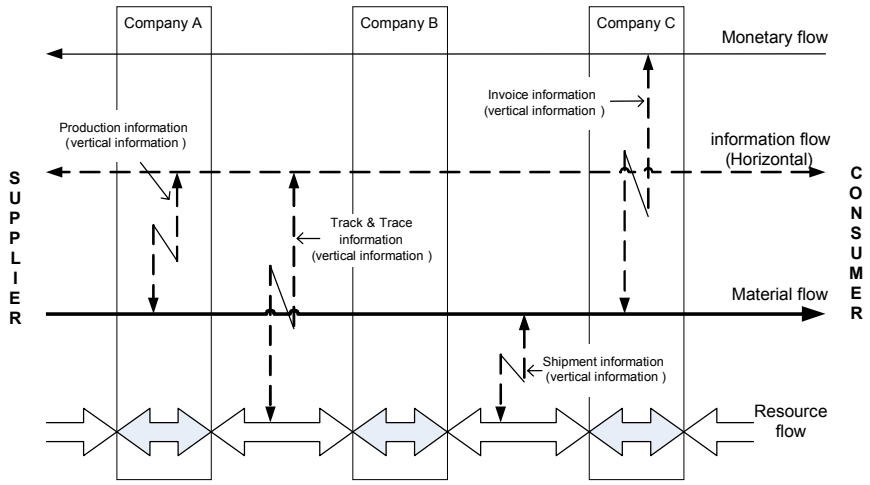

Figure 8 – Interfaces and flows to manage in SCM.

As the figure shows, the information flow is divided into two distinct flows: one horizontal, and the other vertical. The horizontal flow consists of information that primarily flows between organisations and between units within an organisation. In contrast, the vertical flow of information is primarily within an organisation and is more often monitored or controlled in some way. At the same time organisations typically want to distribute such information and make it accessible to other actors on many occasions (Ciborra and Hanseth 1998, Christopher and Towill 2000). The vertical information flow connects the material flow to other flows—such as the material flow to the resource flow for tracking and tracing purposes, and the material flow to the financial flow for payment purposes. Given this, identifying material and resources is very important, and capturing information—such as through RFID as outlined by Finkenzeller (2003) and elaborated on in paper 5 of this thesis—becomes central to support fast and reliable decision-making. Research in SCM includes both supply and demand concerns (Ericsson 2003).

In SCM, concepts such as just-in-time (Monden 1986 and 1993), Kanban (Levy et al. 1991), traceability (Florence 1993), collaboration (Cooper and Gardner 1993), lean production (Womack and Jones 1996), virtual managed inventory (Wild 1998), and resilience (Starr et al. 2003) have become common goods and have impact beyond the SMC field. Agility is another recent example. Within SCM, agility is challenging the previously dominant "lean" concepts (Benson et al. 1992, Kidd 1995, Christopher and Towill 2000). As described in section 3.2, agility is currently influential and generating research in the IS/IT field (Highsmith 2002, Sambamurthy et al. 2003, Baskerville et al. 2005). Agile capabilities are desired in aftermarket logistics, not least due to the prevailing uncertainty and volatility. Consequently, it gets particular attention in this thesis.

Christopher and Towill (2000) note several distinguishing characteristics of an agile supply chain. First, it should be market sensitive—that is, it should be able to sense and respond to real demand. Second, the organisation should use IS/IT to share information between customers and suppliers. Third, the process integration should be characterised by information exchange and sharing between supply-chain actors. Finally, the organisation should create and maintain competitive advantages through better structuring, coordination, and management of relationships with partners, and should focus especially on better and closer relationships with customers. Organisations should adopt agility responsibly, expressing it not just in words, but in structure and culture (Dove 2001). In this thesis, paper 4 in particular discusses both the importance and implications of sustaining agile capabilities in aftermarket logistics.

4.2. Aftermarket Logistics

The broad field of logistics and SCM is difficult to understand without practical experience; this is true even in the relatively narrow area of aftermarket logistics. Such tacit knowledge can be as challenging to convey as teaching someone "how to sail a boat by writing a book about it". Still, many books describe sailing, and readers can gain valuable insights, especially when the reading is combined with practical experiences. Unfortunately, the aftermarket logistics area is the subject of little research (Bijl et al. 2000, Farris et al. 2005, Cohen et al. 2006). Further, the research and scarce literature reviews that exist mainly relate to spare-parts inventory management, discussions of obsolescence costs, procurement planning, etc. (for further references see: Kennedy et al. 2002, Wong et al. 2005). Even within logistics literature, the specifics of the aftermarket are rarely considered (Tilanus 1997, Lumsden 1998, Stock and Lambert 2000). Of course, it is possible to argue that aftermarket logistics in many ways follows general SMC developments. In other ways, however, it deserves special attention; paper 2 and 3, for example, differentiates dealer and end-customer preferences for spare parts from new vehicle logistics. A growing number of businesses offer solutions rather than products, as they have acknowledged that selling spare parts and aftermarket services can be lucrative (Cohen et al. 2006). Still, as Cohen and colleagues, wondered: Why do so many companies still treat aftermarket services as an afterthought? The answer they found was that the aftermarket is so hard to manage that only businesses that provide efficient services can truly benefit. They also found—along with Farris et al. (2005)—that there is a need for more research of this field.

Aftermarket logistics is, as previously mentioned, concerned with services, availability of spare parts, and any other information and activities required after the sale of a complete product (for example: not the original truck sale, but truck repair services, along with access and availability of spare parts). With its global and time-critical operations, aftermarket logistics relies on economies of scale as well as competitive pressures for differentiation and innovation. Complexity increases with the number of concerned supply-chain actors, their actions and intentions, and the information involved (Lumsden 1998); it is therefore possible to conclude that aftermarket logistics is more complex than ordinary SCM.

Adopted from Cohen et al. 2006, table 3 outlines parameters and shows how aftermarket logistics' larger volumes and other unique characteristics contribute to higher complexity and uncertainty. Furthermore, it addresses the fact that aftermarket logistics relies on IS/IT, and that the number of supply-chain actors involved is much larger than in a traditional SCM setting.

Table 3 – Some characteristic differences in logistics.

Parameter	Logistics towards manufacturing	Aftermarket logistics
Nature of demand	Predictable, can be predetermined	Always unpredictable, sporadic
Required response	Standard, can be scheduled	ASAP (same day or next day)
Number of items in inventory	Limited	15 to 20 times more
Product portfolio	Largely homogenious	Always heterogeneous
Delivery network	Depends on nature of product; multiple networks necessary	Single network, capable of delivering different service products
Inventory management aim	Maximise velocity of resources	Pre-position resources
Reverse logistics	Does not handle	Handles return, repair, and disposal of failed components
Performance metric	Fill rate	Product availability (uptime)
Inventory turns (the more the better)	6–50 per year	1–4 per year

The size of the market for aftermarket parts is not easy to measure, but a recent McKinsey report states that it is a $400 billion business that covers everything from replacement toner cartridges to cruise ship engines (Gallagher et al. 2005). Automotive, industrial engines, and marine spare parts represent about a fifth of this market. Even though aftermarket sales account for around only 10% of the total sales for automotive manufacturers, the aftermarket profit can represent more than half of the total profits. In addition to the considerable size of the aftermarket, other challenging factors include availability, segmentation, regulation, and IS/IT-usage (Cohen et al. 2006).

Availability is at the core of aftermarket logistics activities, and is much more decisive than price in gaining customer loyalty and satisfaction. Cohen et al. (2006) note that it is more difficult to balance service levels and cost in the aftermarket than in the production systems because of higher volatility. This volatility is caused by the variety of products existing in the market population, the long life cycle of products needing service, and the multiple locations in which service takes place. Spare parts are part of interchangeable product life cycles; this contributes to complex supersession chains and thus requires advanced backorder handling. In the automotive sector, the volatility is increased by the fact that the serviceable products are mobile and can break down just about anywhere. Furthermore, a truck is a capital-intensive product and "down-time" is costly, especially if it entails unintended cargo delays. The frequency of interactions also differs between new sales and the aftermarket. Most automotive product customers make a new purchase only once every few years, but they need spare parts continuously and have demands on both product reliablilty and liability. The aftermarket thereby maintains a constant connection with customers

and every interaction shapes customer perception of the brand. Better quality in aftermarket logistics builds a better brand image. High quality requires sophisticated tools and advanced skills to maintain product up-time.

Segmentation is a common method for determining different customer needs and developing distinct product offers, thereby targeting brand features for a competitive niche. Logistics services can also be geared to respond to different needs (Christoffer and Towill 2000). In the aftermarket, there is large potential for segmentation given the number of stakeholders and the sometimes dramatic differences between various spare parts' value and frequency of use (Bijl et al. 2000). Paper 2 of this thesis offers examples wherein dealers use segmentation between key customers and other end-customers. Pricing segmentation is another area that can benefit from a set-up based on aftermarket needs rather than generalised product strategies. Executive management naturally devotes time and attention to product development, as it gives birth to new revenue streams for the company. However, management can also gain considerably from more analysis and attention to their aftermarket activities (Hammant et al. 1999). The identity and financial priorities of many companies, as well as the attitude of most employees, are focused on shiny new products rolling off the assembly line. Product development, manufacturing, and sales and marketing functions are often represented in the top-management teams, while the aftermarket function typically remains a part within one of the top functions (and thereby misses direct top-management representation). This contributes to lack of attention and communication between the people who produce the original products and their colleagues in the aftermarket.

The next chapter is dedicated to Volvo aftermarket logistics, including specific characteristics and two case studies showing how developing and implementing IS/IT can be accomplished. Thereby, chapter 5 will contribute to the empirical contextualisation of the thesis before the detailed examination of the research contributions.

5. THE CASE: VOLVO AFTERMARKET LOGISTICS

This chapter presents the specific context, in which this research has been conducted, for developing and implementing IS/IT in aftermarket logistics.

We can readily distinguish practical knowledge from theoretical knowledge; knowing how to do something is different from knowing that something is thus and so (Dahlbom and Mathiassen 1993, p. 34). To expand the understanding of developing and implementing IS/IT in aftermarket logistics, both types of knowledge play an important role. This chapter enlarges the discussions in previous chapters by outlining the specific context of Volvo aftermarket logistics. It thereby further grounds the research contributions of chapter 6. In addition to examining the context characteristics, this chapter outlines two cases on how IS/IT in aftermarket logistics can be managed and provides perspectives on the individual papers reprinted in part B.

5.1. Volvo Context

The Volvo Group is the world's largest producer of heavy-duty powertrains and a leading provider of commercial transport solutions, services, and products. With global presence and sales for 2006 almost reaching 250 billion SEK, its more than 80.000 employees focus business-to-business operations in the areas of trucks, buses, construction equipment, marine and industrial engines, and aero (www.volvo.com). Organisations such as Volvo contain an array of issues and dimensions to study, and the Volvo Group embraces an organisational legacy that is more than 100 years old. In many ways, any case description of such a context will be found wanting. Nevertheless, to avoid taking reality at face value means larger losses. Therefore, as discussed earlier in the Research Approach section, it is essential and valuable to share and examine specific cases in order to derive both research contributions and industrial effects through collaborative activities. Such activities and case findings are at the core of IT-Management, and in this thesis the complex scene of aftermarket logistics is illuminated. Figure 9 provides a high-level view of the Volvo Group's current organisational structure, while the following text narrows down the context toward aftermarket logistics and the target IS/IT components.

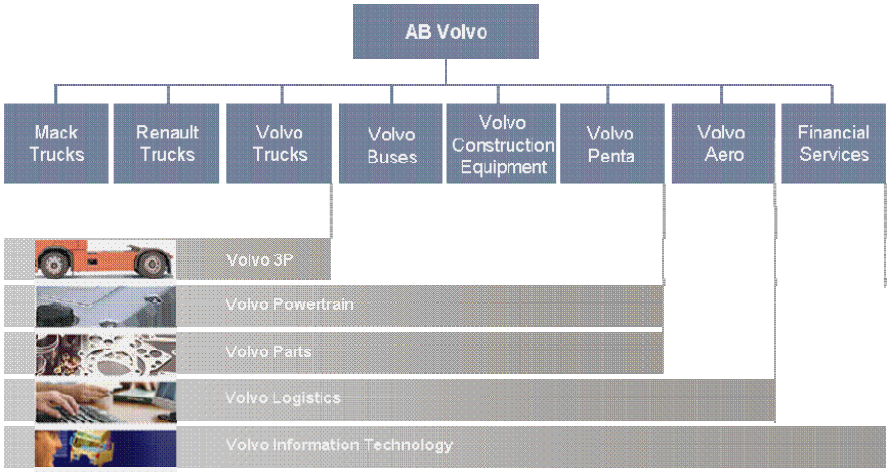

Figure 9 – The Volvo Group businesses 2006.

Aftermarket logistics is characterised by frequent activities that require intensive information exchange among several stakeholders in the Volvo supply chain. Global flows, just-in-time supplier deliveries, and customer customisation demands create interdependent collaborations among suppliers, dealers, and end-customers in the extended Volvo enterprise. Figure 10 (adopted from *Volvo Parts Operational Guide*, 1998) offers a simplified overview of these collaborations. In Volvo's spare-parts distribution, aftermarket logistics involves thousands of suppliers for tens of thousands of distribution points to hundreds of thousands of end-customers. Shipments are made to more than 180 markets, involving the original suppliers and initiating buyers, as well as intermediate parties and nodes. This involves transporters on sea, road, and in the air; cross-docking terminals; different types of warehouses; customs clearance; and numerous service providers (see figure 6 in the previous chapter). Volvo aftermarket logistics handles daily volumes of more than 70.000 orderlines all year around. Orders include different order types, such as stock orders, day orders, emergency orders, and automatic replenishments (Virtual Managed Inventory). Market dynamics, product characteristics, and numerous actors contribute to uncertainty, which must also be considered. In addition, fierce competition requires that business-to-business relations focus on bottom-line results in the context of diminishing margins. As the supply chain is dominated by heterogeneity among independent actors, Volvo—like any other actor—must collaborate to achieve change.

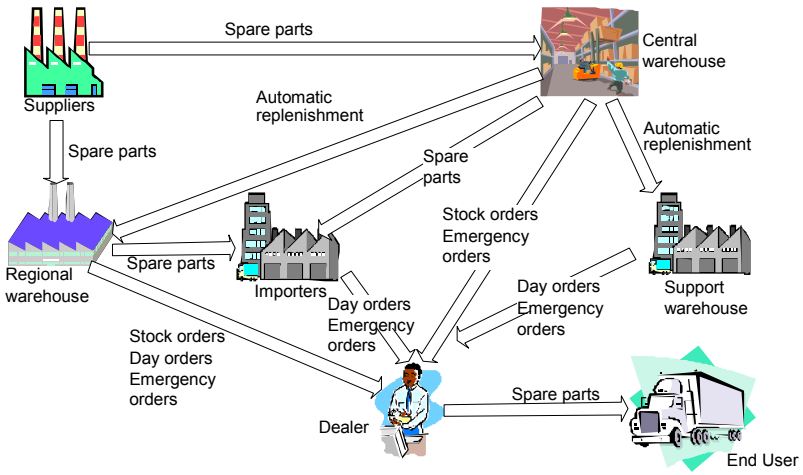

Figure 10 – Flows of information and parts in Volvo aftermarket logistics.

Volvo's industrial product families contain more than 100.000 parts, which demand both a long-term service responsibility and management of advanced supersession chains. Depending on how one calculates it, there are 45.000 to more than 60.000 mechanics throughout the world that service and repair Volvo products. Usage of electronic spare-parts catalogues have become paramount; getting the right spare parts to the right place at the right time with all the right conditions is crucial. Spare parts have become increasingly complex, both physically and because they are included in service arrangements and wider business solutions. Furthermore, Volvo has introduced and increasingly uses "digital parts"—software that replaces mechanical functions and can alter product performance. These digital parts are downloaded into vehicles to enable functions that handle such things as automatic breaking systems, safety features, satellite navigation aids to enhance delivery quality, and electronic fuel ignition to improve environmental performance. Recent survey results at Volvo shows that the percieved customer value can increasingly be traced to dependence of digital content. The parts master file contains hundreds of thousands of active items, and some of them are more than 20 years old. Also, perpetual engineering enhancements lead to a continuous transition of parts, thereby resulting in 10 or more master file items being added, replaced, or deleted each day (which leads to advanced supersession chains that need to be tracked).

Overall, the aftermarket logistics process places large demands on IS/IT, which is an integral part of everything from handling different order types, backorder handling and supersession chains to disseminating service instructions and spare-parts information. If the systems stopped, so would operations. So, some may say: "Don't fix what is working since the flux is the crux and the crux is the flux". At the same time, competitive conditions urge Volvo to exploit core competencies, improve usage of IS/IT solutions, and innovatively find new business propositions. Figure 11 shows the IS/IT systems involved in aftermarket logistics at Volvo.

Although the figure contains many names and areas, it is still just a high-level view. To provide a comprehensive description of the individual components is beyond the scope of this thesis; the figure's purpose is merely to illuminate the fact that developing and implementing IS/IT in aftermarket logistics is not about finding "one solution for everything" (see further discussion in paper 2). As described above, IS/IT is an integral part of the tightly integrated aftermarket logistics process. Similarly, comparing Figure 11's systems components map with the two thesis cases can enhance the reader's awareness of the fact that the changes in each case affected the entire systems landscape (albeit, the origin point for "reaching end-customers through Web services' is the portal structure to the right in Figure 11 and "exploring RFID through collaboration" stems from the inbound/outbound flow in the figure's centre).

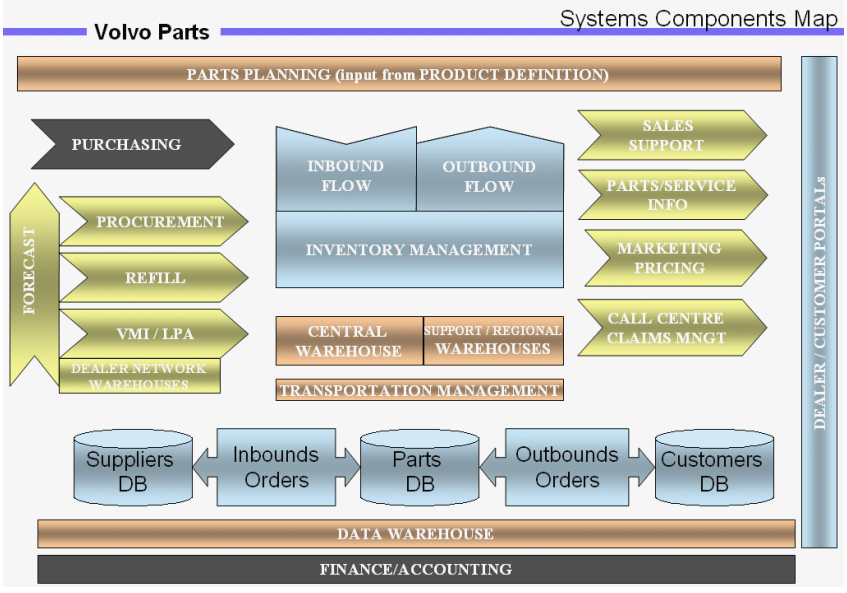

Figure 11 – A map of aftermarket logistics systems components from Volvo 2003.

Although all systems components will not be described, providing some examples is nonetheless worthwhile. In the examples, capital letters indicate a systems component and usage examples are offered in parentheses.

- PARTS PLANNING (on top of figure) has a clear interface to product development; it manages all spare-parts information related to product definitions (e.g., define weight and dimensions) and it concerns life-range planning and the creation of the supersessions chains that steer spare-parts replacement (e.g., spare-part material upgrades).
- INVENTORY MANAGEMENT (centre of the figure) involves perpetual stocktaking, a vital functionality for managing continuous and volatile inbound and outbound flows (e.g., insufficient spare-parts deliveries, discrepancies between the quantity the system suggests and that found in reality, and relating to warehouse locations).

- PARTS/SERVICE INFO (upper right in the figure) is a very large system component enabling: service instruction authoring; the creation of drawings, illustrations, and exploded views; descriptions of disassembly methods, including estimated times and special tool usage; and electronic spare-parts catalogue and service information (e.g., search the spare-part number of a new oil filter, define cross-reference to superseding supplier parts, and find illustrations of an engine overhaul).
- CALL CENTRE/CLAIMS MANAGEMENT (middle right in the figure) deals with contacts—mainly by dealers or customers—regarding unforeseen problems that normal system interactions cannot solve. Although system interactions handle the vast majority of the aftermarket logistics workload, Volvo still receives hundreds of thousands of calls per year (e.g., claim management relating to an engine warranty or taking care of a truck purchased in Spain that has broken down at midnight in Romania involving emergency orders between dealers in order to avoid back-orders).

Near the bottom, figure 11 shows a generalised depiction of the architectural need for database interchange, whether the databases reside with suppliers, at Volvo, or with customers (this can be compared with figure 7, in which SAP makes more clear borders between supply-chain actors). INBOUND and OUTBOUND ORDERS are at the heart of aftermarket logistics. Managing these orders determines availability (e.g., securing supplier delivery, providing order status information, arranging customer back-order logs, allocating every spare part according to order class). Order management functionality is derived as workflows interacting with all other systems components. To fully understand back-order handling of IS/IT in aftermarket logistics requires many years of practical experience; achieving operational change almost always necessitates changing all components that affect orders. We can view process integration as an evolution in developing and implementing IS/IT in aftermarket logistics, which has recently increased the involvement of dealers and end-customers in collaboration. DEALER/CUSTOMER PORTALS are cross-functional systems components that interface with most other figure areas involving interactions with dealers and customers. Much of the empirical research presented in this thesis, specifically that in papers 2–5, has been engaged with creating new areas achieving operational change and integration into the installed base.

Knowledge of existing components is a prerequisite to creating new components, along with an ability to adhere to the heterogeneity of conditions and the existing interactions among supply-chain actors (e.g., by combining parts/service info and marketing pricing through an electronic spare-parts catalogue it is possible to offer direct deliveries to end-customers while allowing dealers to maintain business relation and invoicing. Such an example involves several systems components, as well as collaboration between independent actors—not least to enable back-order handling and follow-up). As figure 11 shows, IS/IT in aftermarket logistics is a rich and diverse area and researchers need to face the fact that its components are tightly integrated.

As paper 2 describes, the historical and social context shows that Volvo was an early adopter of IS/IT in aftermarket logistics. In the 1970s, Volvo partially automated stocktaking and order handling at the headquarters level. During the 1980s, IS/IT were part of the international expansion and intensified collaboration with importers. Since the 1990s, integration has continued and has expanded to include dealers. Most recently, the incremental process integration at Volvo has grown to include end-customers as well. However, as it extends further out in the supply chain, the conditions become more heterogeneous and the number of involved actors increases.

Traditionally, Volvo has managed large changes through large systems development projects, with roll-outs organised into separated business implementation projects. These efforts have previously taken for granted that there will be a development of "one complete and deployed" system. The situation for managing development and implementation of IS/IT in aftermarket logistics is two folded. On one hand, IS/IT usage has existed since machine computation emerged, and IS/IT usage in aftermarket logistics currently constitutes one of the largest areas of installed systems bases and interacts with the largest number of stakeholders in the whole automotive business. On the other hand, given the vast operational areas that could benefit from further system support, automation, and/or integration within aftermarket logistics, IS/IT utilisation is still in its infancy. This is an obvious paradox. However, the aftermarket logistics area also offers the opportunity to put some of the most relevant IT-Management issues to the test. The challenge is to develop and implement IS/IT effectively and efficiently. A specific characteristic for developing and implementing IS/IT in aftermarket logistics considers the vastly different volume dimensions. These volumes drive complexity, which—combined with uncertainty—constitutes the area's fundamental characteristic. Despite substantial volume and dynamics, each situation requires individual attention, which impacts how IS/IT in aftermarket logistics can be managed. Another paradox: On one hand, competition drives resource optimisation and standardisation for economies of scale and scope; on the other hand, business innovation contributes to differentiation. When managing the prevalent situation for global aftermarket logistics, it is not possible to assume that we can find "one solution for everything". Although table 4 provides only some examples of logistical differences from Volvo, it can nurture needed reflection (especially when viewed together with table 3 from chapter 4).

Table 4 – Some characteristic differences in logistics at Volvo.

	Logistics towards manufacturing	Aftermarket logistics
Number of suppliers	~200	>2000
Active Part Numbers (P/Ns)	~10.000 (Pre-assembly P/Ns into assembly line)	>100.000 (Active P/N in parts master)
Sourcing	~15 main factories	>30 main warehouses
Output	~200.000 vehicles / year	>70.000 order lines / day
Drop points	~5000 dealers during normal office hours	>15.000 service locations and additionally 365/24/7 road side assistance
Life cycle	~5 years platform life in manufacturing	>20 years P/N life in the aftermarket
People in comparable functions	~20.000 persons on assembly lines, ~10 countries	>60.000 mechanics at service locations, >180 countries

Scenario development has recently started to play an increasingly important role in developing and implementing IS/IT in aftermarket logistics. Dynamic conditions and an increasing number of supply-chain actors have illuminated the difficulties of creating formal and comprehensive planning efforts. Furthermore, in Volvo's aftermarket logistics alone, there are many levels, processes, functions, and areas, which result in many different co-existing strategies. This research shows how usage of scenario development facilitates strategic awareness (as described in paper 3, with additional details in papers 2, 4, and 5). The approach to creating scenarios was similar in both cases 1 and 2, and both started with a clear direction ("reaching end-customers through Web services" and "exploring RFID through collaboration", respectively). The cases had different drivers—case 1 was more business-driven, while case 2 was more technology-driven. However, in both cases, scenario development involved several supply-chain partners (to obtain diversity) and, crucially, the scenarios were not simply made, then frozen. Instead, the scenarios were revisited and refined for two reasons: to refine strategic awareness as new partners joined in the scenario development, and to introduce new people to gradual development and continuous implementation. Consequently, a joint formation of business and IS/IT was also facilitated.

The following sections offer summaries of cases 1 and 2 to help further illuminate the thesis context. As introduced in chapter 2, the first case relates to reaching end-customers through Web services, while the second explores RFID through collaboration.

5.2. Case 1: Reaching End-Customers through Web Services

"To reach end-customers, establish relations, and create a new channel" (see paper 4, p. 150) was a clear direction established at the start of this case, which is further presented in papers 2–4. The case scrutinised a part of the process integration evolution in which Volvo reached out to end-customers. Figure 12 shows a time line and the case's main activities. At the turn of the millennium, a

strategy revision at Volvo highlighted drivers of change, emphasising the establishment of relations with end-customers and the use of a Web channel (Paper 2 offers technical descriptions of the Web services that facilitate interoperability and interface exchange under heterogene conditions.). Establishing end-customer relations and a Web channel could: Mitigate the risks of competitors and/or third-party entrants gaining superiority through new channels; Deliver cost reductions by increasing process productivity and customer support improvements; and Create new services through distinguishing innovation, expansion of the total offering, and so on. The company knew that large changes would be required. It also realised two things: comprehensive planning could not involve all concerned actors and flows, and they would not automatically organise themselves into increased process integration, despite the potential business value. Volvo used scenario development to explore possible alterations of the current aftermarket logistics structure. This scenario development served as an arena for reflection and was created according to details described in paper 3. A platform was established by gradually exploiting the installed base as well as new opportunities—in terms of both technology and relations—through an original implementation (see especially papers 2 and 4 for details of characteristics and implications). During discussions on how to develop and implement IS/IT, Volvo considered a range of aspects, but also encountered unforeseen obstacles, such as single sign-on and business process synchronisation.

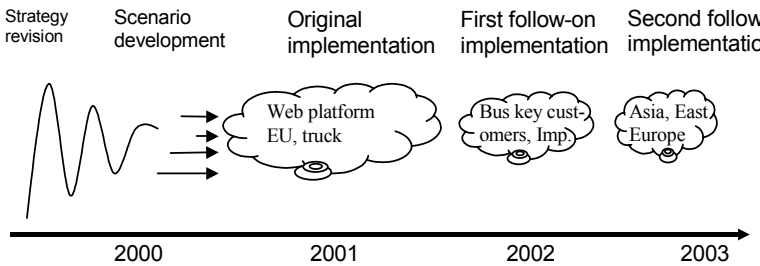

Figure 12 – Projects involving Web services and end-customers.

A follow-on project directly succeeded the original project; the two were thus almost regarded as a single activity flow within the organisation. Follow-on projects provided a gradual development and continuous implementation in which various actors collaborated. Volvo introduced the first Web platform within the EU for truck end-customers, and followed that by addressing bus key-customers as well as independent importers before taking on collaboration with supply-chain partners in Asia and Eastern-Europe (as described in papers 2 and 4). The team succeeded in reaching end-customers and establishing relations, and the new channel was named *Parts Online*. The projects were kept comprehendible and avoided detailed specifications in favour of a rapid realisation of benefits through actual usage on a global scale. Although large changes were needed, the project size was kept relatively small to avoid project escalation. Systems development and business implementation were tightly unified. Attention was focused on sensing and responding to unforeseen changes

in business conditions and technology performance. According to Volvo, this gradual development, combined with rapid and on-going implementations, provided agile capabilities. Both development and implementation are crucial to the act of managing and, in practice (as experienced at Volvo), they are practically inseparable on the global scene for IS/IT in aftermarket logistics. Parts Online used Web services both through Web portal access and as publish/subscribe services (see figure 13, taken from paper 2).

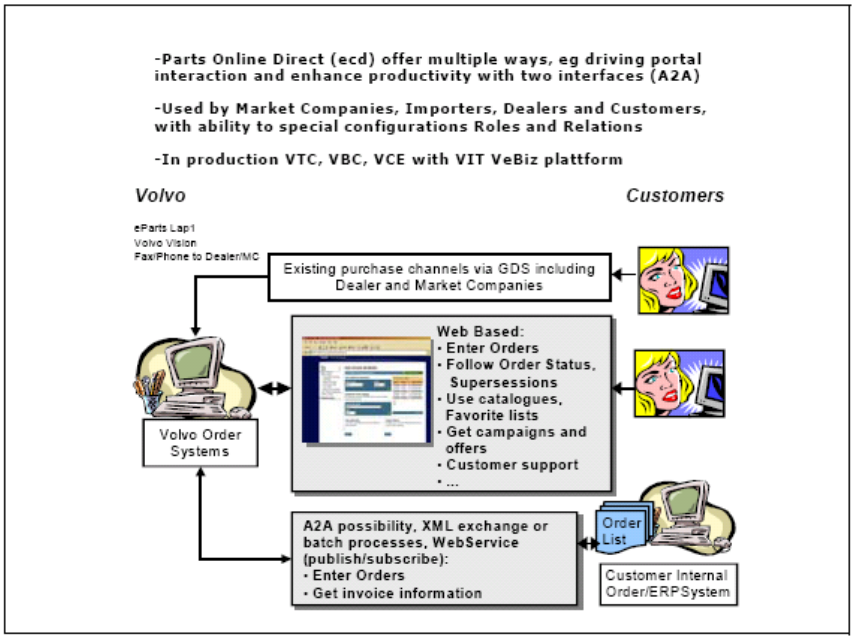

Figure 13 – Parts Online as presented on an internal slide.

Although not directly shown in the figure, paper 4 describes and discusses how a "win-win-win" concept between Volvo, dealers, and end-customers evolved. This innovation bears similarities to the work on RFID collaboration. However, instead of being mainly business-driven, the RFID case was more technology-driven, illustrating that business and IS/IT are integral elements when it comes to achieving agile and sustainable development and implementation in aftermarket logistics.

5.3. Case 2: Exploring RFID through Collaboration

Exploring RFID technology through collaboration with supply-chain actors provides further case specifics for this thesis. RFID is emerging as a technology in use which is utilised for automatic identification of products (items) and/or case/consignments in different contexts. The main components of RFID systems are tags, readers, and associated IS/IT to handle the collected data and integration needs. RFID can be described as a bar-code substitute; the main difference between them is that RFID technology offers extended data capacity (e.g., individual item identification instead of just article number) and extended data

capture possibilities (data collection without line-of-sight). RFID implementations are often associated with high start-up costs due to infrastructure requirements for readers, network communications, physical installations, control system, set-up tuning, software and integration, training, maintenance, organization, and workflow. Paper 5 enlarges on both the technology and business considerations (as an example, figure 2 gives an overview of the RFID arena).

In the RFID case that this thesis describes, Volvo set out to explore how a mobile RFID solution could leverage existing infrastructure, reduce integration needs, promote valuable usage, and simplify business implementations. The aim was to use collaboration to facilitate learning and possibly derive innovation. Using scenario development provided a basis for gradual development among stakeholders. Continuous implementation let the collaborating actors leverage Volvo's existing RFID usage experiences to explore usage along the supply chain, particularly in mobile set-ups. Figure 14 (taken from paper 5) shows the different possibilities of goods identification for case/consignment level versus item level. The volumes of data to be managed also differ considerably, influencing development and implementation.

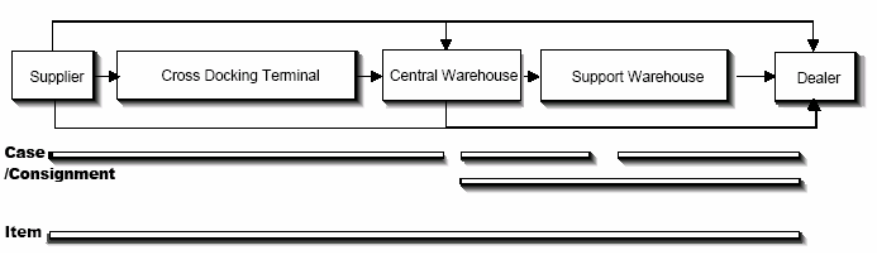

Figure 14 – Supply-chain actors and flows.

Collaboration enabled a quick and differentiated solution adoption. This allowed a shift from roll-out (i.e., the push for business implementation of solutions) to "roll-in" and "Get pull!" effects (i.e., organisations and users "pull" offered functionalities according to their actual usage and value). In terms of technology, the RFID tag was used to carry data, thus altering integration possibilities by having goods identification with "smart" features. "Smart goods" identification is more sophisticated than traditional goods identification. "Smart goods" provide information access, capture, usage, modification, dissemination, and verification. To explore RFID the collaborating supply-chain partners assessed specifics on:

- operational reliability, since new technology must meet critical demands to be considered for wide deployment;
- usability, since even if leveraging existing infrastructure, mobile devices must meet various requirements in many different situations; and
- productivity, since it is the bottom line that counts in a world with fierce competition and sensitive relationships among actors, thus any technology in use must have a supporting business case.

At Volvo, the collaboration approach has been described as enabling agile capabilities. It is not a situation in which it is possible to apply "one solution for everything"; instead there is a need for alternatives to the previous dominating approach based on one-time developments of "one complete and deployed" system (papers 4 and 5 provide further descriptions for case 1, and paper 2 includes a historical and social background).

Concluding chapter five

To conclude this chapter, it is worthwhile to reflect upon how Volvo has traditionally managed large-scale changes. Large changes have often resulted in large projects. Creating the original electronic spare-parts catalogue (exemplified in the thesis introduction) and the VIS project in paper 2 are two examples among many that can be seen as using a "conventional approach", rather than as project failures per se. Volvo has launched many large efforts to create detailed specifications—especially for large changes—rather than focusing efforts on securing usage of developments. Furthermore, implementation activities have suffered from an imbalance, with more resources put into systems development than into business implementation. Because the activity of developing have traditionally been distinctly separated and sequenced from the act of implementing (with systems development as one activity, ahead of the separate activity of business implementation), the imbalance has easily grown into situations of project escalation. Developing and implementing IS/IT in aftermarket logistics is not easy, especially when considering the characteristics involved. Nevertheless, the cases outlined here (and further described in the papers) show that there is still hope for those with a desire to manage change. It is now time to describe the thesis research contributions. First, however, readers are encouraged to read the individual papers in part B, so as to further enrich their understanding of the contextualisation of this research.

6. RESEARCH CONTRIBUTIONS

The research contributions aim to provide a better understanding of how to develop and implement IS/IT in aftermarket logistics. The chapter first offers a brief summary of the reprinted thesis research papers. It then outlines aftermarket logistics characteristics and discusses the implications for developing and implementing IS/IT in aftermarket logistics. The chapter concludes with an overview of the industrial effects of this research.

6.1. Thesis Papers Overview

Part B of this thesis contains a reprint of five related peer-reviewed papers that were published in journals or presented at international conferences. Table 1 (from the introduction) and figure 3 provide overviews of the publications. This section briefly highlights how the five papers contributed to this thesis.

Paper 1: Enterprise Wide Development
A Survey of Critical Factors for Coordinated Development in Complex Organisations: What Development Managers Consider. IEEE Proceedings of 36th HICSS, *2003.*

The first paper contains empirical evidence from outside the automotive and logistics sector. In relation to this thesis, the paper offers an outside-in view from managers in seven different organisations who confronted complex IT-Management situations. As part of the DELTA research project (see chapters 2 and 3, and Enquist et al. 2001), this paper outlines critical factors for coordinated development, highlighting key considerations for complex organisations. Based on the survey of such critical factors, the paper shows that managerial, rather than technical, issues impeded coordinated enterprise and IS/IT development. Cross-functional processes are discussed, as is the intensive dependence of IS/IT. The paper focuses on why coordinating development of enterprise and IS/IT is difficult, which is at least partially due to the lack of a process for managing coordinated development. Management, competence, and process development are emphasised, creating a foundation for the other thesis papers.

Paper 2: Process Integration and Web Services
A Case of Evolutional Development in a Supply Chain. Scandinavian Journal of Information Systems *16, 2004.*

The second paper provides a historical and social context for developing and implementing IS/IT in aftermarket logistics at Volvo. Characteristics of this context are presented, along with the evolution of IS/IT usage and interactions among supply-chain actors. The paper also describes process integration, focusing on a flow of continuous implementation projects that were executed to reach end-customers through the use of Web services. The paper shows that the "one solution for everything" approach should be carefully scrutinised; managing the situation requires careful consideration of the relationships among supply-chain

actors. Temporal aspects are important in matching technology and management with the installed base, and IS/IT and business need to work together. In aftermarket logistics, process integration takes time (often longer than expected) and it is important to acknowledge the complexity of managing development and implementation. However, it is equally essential not to be petrified and not to insist that comprehensive planning is imperative nor to assume that full improvisation is possible; instead engagement with gradual development and continuous implementation emerge as a practice.

While paper 1 stages IT-Management in a complex environment, paper 2 illuminates the intertwined relationship between development and implementation, emphasising characteristics of aftermarket logistics and the Volvo case contextualisation. Among these characteristics are the implications of establishing a platform, both through IS/IT and in business relations. Using Web services proves useful at the end of the supply chain because it leverages loosely coupled factors to handle heterogeneity and uncertainty. Paper 3 elaborates the case on scenario development, and paper 4 on achieving the continuous implementation. By penetrating the same case and providing further perspectives at different times, the case offers a foundation that contributes to how we can understand the process of developing and implementing IS/IT in aftermarket logistics.

Paper 3: The Logistical Consequences of e-commerce
Theoretical Scenarios for Spare-Parts Distribution. Elsevier Proceedings of 9th WCTR, *2001.*

The third paper, published in the midst of the e-business boom, contains different stakeholder perspectives and resulted from the original scenario development on the consequences for spare-parts distribution. The final paper was presented at the distinguished World Conference on Transportation Research, a conference that has contributed to logistics research for more than 30 years. The paper provides details on the changes entailed in the initial phases of managing the changes for developing and implementing IS/IT in aftermarket logistics outlined in paper 2. Reprinting the paper here is valuable as it presents another specific perspective, enforcing the overarching value derived through longitudinal assessments. It also further reveals differences among phases, addressing dealer and end-customer preferences relating to various development and implementation possibilities. These possibilities included implications and characteristics for scenarios such as bypassing established dealers to approach end-customers directly, offering direct deliveries from suppliers to end-customers, and so on. This paper shows how collaborative teams created and evaluated the different scenarios, thus facilitating strategic awareness, while paper 4 presents aspects of the scenario realisation through continuous implementation.

Paper 4: Agility through Scenario Development and Continuous Implementation
A Global Aftermarket Logistics Case. European Journal in Information Systems *15:2, 2006*.

The fourth paper penetrates follow-on implementation projects and thereby shows how direct actions and continuous implementation relate to strategic considerations. It shows how agile capabilities are achieved and the necessity of being able to sense and respond to changes. The paper also focuses on keeping projects comprehendible and, thereby, how we can develop and implement IS/IT in aftermarket logistics. Furthermore, it illustrates how scenario development can nurture a holistic view, although it is essential to emphasise that it is the intertwined aspects of development and implementation of IS/IT and business that drive progress. Paper 4 lets readers compare scenarios from paper 3 with actual outcomes, and the assumed consequences presented in previous papers with described characteristics. The papers show that gradual development and continuous implementation also contribute to learning. Taken together with the background presented in paper 2, paper 4 highlights the fact that creating a platform is difficult and establishing new relations among supply-chain actors is even more challenging. Follow-on implementation projects are beneficial in that they provide industrial effects and nurture innovation, such as extending services to new supply-chain actors and establishing a "win-win-win" collaboration concept.

Paper 5: "Smart Goods" and Mobile RFID
A Case with Innovation from Volvo. Journal of Business Logistics *27:2, 2006*.

The fifth paper shares experiences and results from a specific case on "smart goods" and mobile RFID. First presented at the 39th HICSS conference and then accepted for publication in a renowned logistics research journal, paper 5 is an example of bridging contributions between the informatics and logistics fields. This case discusses the same approach to change enforcement as those described in papers 2–4. The focus of paper 5 is on exploring and evaluating an emerging technology in use (RFID) and addresses both IS/IT and business impact. Collaboration among supply-chain actors enables learning through direct action as well as innovation. The case enriches the thesis by offering further implications for managing IS/IT development and implementation. Exploring RFID through collaboration provides detailed characteristics and a discussion that strengthens the thesis conclusions (reinforcing several findings from papers 2–4). Implications in the RFID case include how to approach new technology.

Currently, the costs of fixed infrastructure installations mean that many RFID solutions can be financially justified only in situations with high volumes and high value items. Paper 5 explores alternatives, scrutinising an innovative setup of sophisticated "smart goods" identification and mobile RFID involving cellular networks with data package communication (GSM/GPRS), Web technology integration, and collaboration. The solution is evaluated from the perspectives of operational reliability, usability, and productivity. The empirical evidence comes

from qualitative research, which—along with more than 3.000 readings from the operational setup—explores a unique mobility context that leverages the existing infrastructure. The advantages and disadvantages of the solution are summarised in business case characteristics. Recommendations include design constrains as well as considerations on managing IS/IT and business. While the main conclusion is that each business case must be individually assessed, the paper shows how collaboration can facilitate innovation when leveraged on the installed base. Among the outlined advantages are: lead-time gains and simplified roll-out ("Get pull!") through good usability, but there are also challenges for integration due to new data dimensions. Overall, the contents of the papers further contribute to the understanding of how to manage IS/IT development and implementation.

6.2. Aftermarket Logistics Characteristics

This section summarises the research contributions in relation to existing aftermarket logistics characteristics and their influence on the management of developing and implementing IS/IT. These contributions are derived from cases 1 and 2 and grounded in the thesis papers and chapter 5. Taken together, the contributions facilitate an assessment of how we can develop and implement IS/IT in aftermarket logistics. The cases include both business-driven ("reaching end-customers through Web services") and technology-driven ("explore RFID through collaboration") factors. The first case illuminates different characteristics in relation to process integration, Web services usage, and relations among actors (especially paper 2). It also highlights scenario development and actor preferences (especially paper 3) and continuous implementation and agility (especially paper 4). The second case supports and validates aspects from the first case and provides further details on developing and implementing IS/IT, including learnings and innovations derived through collaboration.

The aftermarket is growing in importance (Cohen et al. 2006) as is IS/IT usage in supply-chain transformation (Malone and Laubacher 1998, Christopher and Towill 2000). Both factors increase the need for organisations to understand the rise of organisational concepts and new technology diffusion (Earl 1993, Orlikowski and Iacono 2001, Rogers 2003). Unfortunately, there is little research on the aftermarket logistics area (Bijl et al. 2000, Farris et al. 2005, Cohen et al. 2006). Still, as this research shows, aftermarket logistics has business critical IS/IT dependence to such a degree that IS/IT is an integral part of aftermarket logistics. Figure 15 shows an overview of the process, actor, and product characteristics that create the predominant uncertainty and complexity in the contextualisation of this thesis.

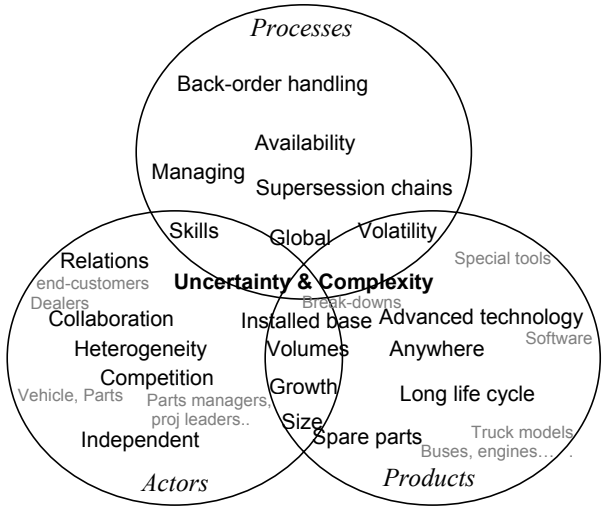

Figure 15 – Characteristics in aftermarket logistics.

Delivering aftermarket services is more complex than manufacturing a product for several reasons (Cohen et al. 2006). Characteristic differences include:

- Volumes are often more than 10 times as big and include multiple dimensions.
- Resources—spare parts, people, special tools, and systems—must be available at multiple locations.
- New products as well as past products must be maintained over their entire life cycle, as opposed to focusing exclusively on new product sales.
- Spare parts are both physical and virtual (software parts) and are a crucial element of service arrangements and wider business solutions.
- Mechanics need training to retain competence in servicing advanced technology, which requires 24/7 readiness all year around.
- Actors (such as dealers) are independent and heterogeneous, and they work in a business environment characterised by both competition and the need for collaboration.
- Volatility is high because products can breakdown anywhere.
- Availability is critical and has created a specific process for back-order handling as well as exceptional supersession chains formed by long product life cycle and advanced product technology advancements.

Morris and his co-authors (Cohen et al. 2006) note the dearth of aftermarket studies; they also cite uncertainty as one characteristic that distinguishes the aftermarket from other business functions. This thesis confirms these findings, and contributes further by exploring their implications for managing IS/IT development and implementation (table 3 in chapter 4 highlights how aftermarket logistics differs from other functions, and can be compared with table 4 in chapter 5 to see a Volvo-specific comparison).

To understand aftermarket logistics, it is essential to grasp the diverse relationships and interdependencies among processes, products, and actors as part of the installed IS/IT base. While diversity is desired by many, few like complexity. Aftermarket logistics is complex. Thus, we must not be content with too simple a view. Such a view not only complicates the developing and implementing of IS/IT, but leads to an underestimation of the challenges entailed in achieving the desired results. By acknowledging the aftermarket logistics context as characterised by complexity and uncertainty, we can understand how to contend with the identified implications.

6.3. Implications for Developing and Implementing IS/IT in Aftermarket Logistics

The research contributions of this thesis address implications derived from case findings and the literature. The thesis title, *Developing And Implementing IS/IT in Aftermarket Logistics*, puts intentional emphasis on both *Developing And Implementing*. Managing is an ongoing act; in the field of aftermarket logistics, the conventional distinction between development and implementation creates a divide that needs to be addressed. In this research, the objective is to contribute an understanding that helps to bridge this divide. This section therefore summarises and discusses certain IT-Management aspects and implications. First, it describes implications related to planning and alignment discussions. It then describes implications that can nurture essential discussions on development and implementation.

6.3.1. Implications for planning and alignment

One way to uncover implications is to discuss the theoretical background and findings of this research. Table 5 offers an overview of the findings and resulting implications.

Table 5 – Overview of findings and research implications.

Findings	Key implications
Formal and extensive planning can be questionable in uncertain and complex contexts.	Scenario development has shown that it can contribute to strategic awareness and learning among involved stakeholders. Thereby, it provides a basis for gradual development and collaboration, and enforces change in business and IS/IT together. However, change efforts require a clear direction like reaching end-customers (as in case 1) or exploring RFID through collaboration (as in case 2).
The strategic alignment model may nurture strategic decision-making, but thourough usage risks getting stuck in meta-activities.	
Although drift occurs, it is not a reason to abandon a desire to drive progress in the whole system.	

Planning and uncertainty

Researchers have suggested using comprehensive planning processes to control the systems planning process (Sambamurthy et al. 1994, Lederer and Salmela 1996). This is the basis for IT-Management discussions on whether there is too little or too much strategic planning (Newkirk et al. 2003). Hereto, the discussion mainly relates to the resources required to achieve valuable planning. Developing and implementing IS/IT in aftermarket logistics is dynamic in terms of the magnitude of actors, processes, and products involved. This implies that it is essential to further assess whether it is actually possible to achieve formal and thourough planning that delivers significant business value. Aftermarket logistics' prevailing uncertainty and complexity suggest that extensive planning is a questionable approach. Because change efforts often arise and exist simultaneously and involve multiple actors, there is a significant risk that comprehensive planning results will be outdated before reaching implementation in the dynamic area of aftermarket logistics. The case findings enforce the Peppard and Ward (2004) findings that attention to interactions between IS/IT and business influences change drivers. The implication, however, is that if we regard business as the demand side and IS/IT as the supply side, it can hinder the joint formation of the two (see also figure 5 from chapter 3). This will also be further discussed in relation to development and implementation in section 6.3.2.

Strategic alignment

Researchers introduced the strategic alignment as a way of leveraging IS/IT to transform organisations (Henderson and Venkatraman 1993). However, case findings illuminate that there are multiple organisations in many countries and cultures, and with a wide range of functions that influence strategic choices in business and IS/IT. Therefore, in reality, there is not "one business strategy" to align with "one IT strategy" (Pyburn 1983, Hanseth and Monteiro 1998). As this thesis illustrates, supply-chain flows change continuously; forms of collaboration take various directions; and alliances are made, broken, and reconstituted at dizzying speed. Integration, migration, and disintegration activities are needed and take time to achieve. At the same time, new technology and new business concepts are constantly emerging. There is not "one solution for everything." Multiple strategies exist simultaneously at different levels and in various forms, functions, geographies, and versions. Paper 1 discusses critical factors of coordinated efforts in several large and complex organisations, and the DELTA project has further illuminated the risk of getting stuck in meta-activities (Enquist et al. 2001). Furthermore, there are different levels of analysis: individual, operational, and strategic, to which recent research addresses adaptive coevolutionary dynamics and complexity theories as solutions to multi-level alignment challenges. (Benbya and McKelvey 2006). However, actual research on organisational usage has to be proven through future research. Consequently, the obvious implication here is that it is difficult to align multiple strategies, achieve strategic alignment over time, and conduct thorough planning. This thesis might thus contribute to an explanation for the lack of published research attempting to validate or describe the actual use and value of the strategic alignment model in

practice (Kearns and Lederer 2000, Avison et al. 2004). This lack seems particularly obvious in the field of aftermarket logistics.

Drift and direction

The aim of the "theory of improvisation" was to create a radical alternative to strategic alignment and comprehensive planning; Ciborra grounded his theory in effects such as drift and situated action (always catching the latest circumstances in order to solve IS/IT problems) (Ciborra 2002). Although drift and strategic alignment contrast each other, together they contribute valuable knowledge when facing the challenges of developing and implementing IS/IT in aftermarket logistics. As various examples show, drift occurs, and some researchers propose that drift, rather than control, reigns over the dynamics of developing and implementing IS/IT (Ciborra 2000). However, driving progress throughout the whole system of aftermarket logistics is still a valuable goal. As this research shows, it is not wise to adhere too much to drift and believe that all flows, processes, actors, products, systems, and relations will organise themselves successfully. While the evolutional process outpaces grand planning efforts, a fundamental faith in drift and unplanned actions might create adverse effects. Experience might prove worthless if unprecedented events occur and improvisation fails on a global scale. Again, the magnitude of aftermarket logistics dynamics calls for sustainable ways to manage developments and implementations. Therefore, even as Ciborra (1997, 2000, and 2002) strongly criticises formal strategic alignment approaches and extensive planning methodologies as lacking relevance, the implications of drift are still the same (Nandhakumar et al. 2003). Relevance is crucial in the multi-facetted world of aftermarket logistics, where efficiency in the whole supply chain sustains competitiveness and effectiveness demands valuable collaborations to drive progress. Consequently, strictly accepting the occurrence of drift in aftermarket logistics implies a loss of relevance. Reaching end-customers, exploring RFID or creating an electronic spare-parts catalogue, for example, requires focused efforts rather than tinkering. Clearly, developing and implementing IS/IT in aftermarket logistics involves determination and persistence, which result in mutual gains for those parties who see and share larger goals.

Scenario development as a solution

Scenario development is gaining attention as a response to the business environment's increasing uncertainty, interdependence, and complexity. One of the key implications of this research is that scenario development can contribute to strategic awareness, learning, and collaboration. Multiple scenario development has been described as an important innovation in strategic planning (Schoemaker 1993) and it can encourage and embrace change initiatives (Van Der Heijden et al. 2002). Both cases 1 and 2 initially used scenario development to create narratives of alternative futures for the challenges they faced. Bood and Postma (1997) address scenarios as an effective approach for dealing with the many long-run uncertainties that surround business. Nevertheless, developed scenarios must not become prescriptive, nor should their creation require extensive effort. Instead, they should be used for strategic considerations and inspiration, with an

understanding that early and pragmatic collaboration of IS/IT and business development and implementation is required. Project teams at Volvo have, together with involved stake-holders, come to regard scenario development as a valuable guideline that provides a basis for gradual development. The business dynamics remain, however, and strategic developments are not amenable to strict control for developing and implementing IS/IT in aftermarket logistics. Still, scenario development encourages collaboration among concerned actors in order to enforce change.

6.3.2. Implications for development and implementation

Table 6 shows key research findings and implications for development and implementation.

Table 6 – Overview of further findings and research implications.

Case findings	Key implications
The installed IS/IT base and relationships provide a foundation to be exploited, together with joining business and IS/IT.	Gradual development and continuous implementation have shown that it is possible to enable agile capabilities and learning. This nurtures a potential to derive innovation. By considering business and IS/IT together, their alignment becomes self-evident through execution of comprehendible projects.
There is an alternative to the conventional approach of delivering "one complete and deployed" system.	
Making projects comprehendible creates opportunities to influence results.	
There is a need for learning and agile capabilities.	

Exploiting the installed base

The installed base—in terms of IS/IT and relationships—is an important foundation in aftermarket logistics. The case studies of this research have shown the necessity of platforms to build further development on. As paper 2 in particular describes, it is not only a technical platform that is needed, but also a basic understanding of well-functioning relations among different supply-chain actors and how to handle them. Just as Web service compositions rely on heritage in the installed IS/IT base, end-customers should be approached with considerations of their existing dealer relationships. As Ciborra and Hanseth (1998 p.309) describe it, *"All elements are connected. … A whole infrastructure cannot be changed instantly—the new has to be connected to the old. The new version must be designed in a way making the old and the new linked together and "interoperable" in one way or another. Hence, the old—the installed base—heavily influences how the new can be designed."* One way to exemplify this is to set cases 1 and 2 in relation to the systems components map for IS/IT in aftermarket logistics (as illustrated in figure 11). Although the change efforts in both cases are specific in certain aspects, they are not stand-alone examples, but rather integral parts affecting the whole system. Process integration is characterised as an evolution and thereby influences the sustainable ways of developing and

implementing IS/IT in aftermarket logistics. Consequently, the installed base and relationships provide a foundation to be exploited along with the joint formation of IS/IT and business.

Beyond the "one complete and deployed" mindset

The conventional approach to systems development at Volvo has targeted "one complete and deployed" system. Many systems development approaches include detailed specifications derived from a sequential waterfall process, prototyping, or more iterative structuring (Wirth 1971, Dahlbom and Mathiassen 1993, Jacobsson et al. 1999, Jackson 2003). Some other (much less dominating) approaches are extreme programming and agile software development, which eliminate documentation requirements and attempt to involve users in specifications (Fitzgerald and Harnett 2005). The problem with the "one complete and deployed" mindset is that focusing on a single deployment situation inhibits the possibilities of incorporating changes and draws attention away from the necessity of widespread business implementation. Furthermore, assuming that large, global changes require large projects might provide a comforting feeling, but fixed project gates and milestone deliveries easily mismatch in the dynamics of changing conditions. Thereby, the risk of project escalation increases (Keil and Mann 2000). The efforts at Volvo to develop an electronic parts catalogue for dealers are an example of this. Although de-escalation tactics (Montealegre and Keil 2000) might be used if things grow out of control, it is better to avoid such a situation in the first place. Instead of one deployment of a complete system, the cases of this research show that it is possible to enable a consecutive flow of functions that gain early user adoption. As discussed below, gradual development and continuous implementation provide an alternative here.

Achieving comprehendible projects

Making a project comprehendible sounds like a sensible recommendation, but how is it possible to both comprehend it in mind and achieve it in practice? In fact, doing so requires a synthesis of the characteristics and implications for developing and implementing IS/IT in aftermarket logistics. A basic input is setting a clear direction that is as close to a measurable goal as possible. This input is influenced by previous output, confirming an evolutional process. Iterative use of scenario development and continuous implementation nurture a platform for the installed base and relationships. Accepting that there is not "one solution for everything" and that multiple strategies coexist**,** we need to manage multiple issues and contribute to an acceptance of gradual deliveries rather than scope increases. On the one hand, this directly relates to the timing in finding a match between business and IS/IT in specific situations. On the other hand, it comes on top of aftermarket logistics' unavoidable complexity and uncertainty.

Managing both systems development and business implementation helps keep projects comprehendible. As a result, organisations gain new output through "learning by doing" as well as industrial effects. The collaboration is important, as Hirscheim, Klein, and Lyytinen (1995, p. 110) point out: *"If planners, developers and users do not interact and find ways of sharing their concerns and conceptions,*

the discourse at the planning level creates meanings and interpretations that are felt to be of little relevance and meaning at the implementation level". Supporting continuous learning includes altering the need for detailed specifications in favour of realising development through usage, which is enabled by rapid implementations. "Roll-out" and dedicated "push" implementations shift to a "Get pull!" for continuous implementations (as described in paper 5). The studied cases involve global effects and strive to accomplish early realisation of developments through usage, thus further laying the foundations for a service-oriented architecture (Ferguson et al. 2003). Because organisations and users pull access to desired functionalities, the making of comprehendible projects facilitates quicker, yet still enabling differentiated adoption.

Increasing learning and agility

Aftermarket logistics have global and time-critical operations with high volatility, which necessitates agile capabilities. This is confirmed by this research and (not least) by SCM concepts, which are challenging the domination of "lean" (Benson et al. 1992, Kidd 1995, Christopher and Towill 2000). However, agile must not mean stout: the structure among actors, the competitive pressure, and the dependence of economies of scale and scope require a sense of the overall direction to be optimised. The cases have shown that as IS/IT functionality becomes an integral part of the organisational (and/or the inter-organisational) context—and as the operational context grows in complexity—the requirements on developing and implementing IS/IT in aftermarket logistics increase. Cases 1 and 2 both emphasise the need to bring IS/IT and business together to exploit the installed base and established relationships. In doing so, learning and agile capabilities are enabled. Creating and sustaining agile capabilities is a responsible way for organisations to sense and respond to changes (Dove 2001, Baskerville et al. 2005). An incremental and interactive approach between planning and execution is favourable due to the existing uncertainty and complexity prevailing in aftermarket logistics. Overall, it is possible to nurture agility in two ways:

- through scenario development, which provides a basis for gradual development and continuous implementation based on a strategic awareness; and
- by keeping projects to a comprehendible size that leads to progress.

Consequently, the incremental and interactive approach is also the basis for an implication of this research.

Gradual development and continuous implementation as a solution

The need for gradual development and continuous implementation is a key implication of this research. Developing and implementing IS/IT in aftermarket logistics has enabled Volvo to reach end-customers through Web services as well as to exploit RFID through collaboration. These results support a balance between transforming business relations and diffusing technology in use (Baskerville et al. 2005). The general interest in service-oriented architectures, which aim at loosely coupled services for ever-changing business conditions, is growing (Christensen et al. 2001, Ferguson et al. 2003). However, this research

explores one of the first advanced global implementations of Web services in aftermarket logistics. This implementation exploits both the established IS/IT base and relationships, and also yields implications for IT-Management. Papers 2 and 4 in particular discuss difficulties in achieving single sign-on and process synchronisation in the integration with legacy systems. The critical factors assessed in this research highlight:

- attention to management more than technology (although a match between the two is needed);
- attention to learning and execution more than extensive planning; and
- attention to retaining agile capabilities as a way to sense and respond more than trying to plan in order to dictate.

Approaching the end-customer stakeholder group has required time (to establish relationships) and the application of Web services. Furthermore, relationships have a large influence on both development and implementation where collaboration is an enabler. An example of this is in paper 5's findings on exploring RFID usage. In that case, the mobile RFID leverages existing infrastructure and derives innovation through supply-chain collaboration. Rather than launch exhausting efforts to try and gather "all requirements", the projects in cases 1 and case 2 took an alternative approach to managing the dynamics of aftermarket logistics.

Gradual development and continuous implementation enable learning and even facilitate derived innovation (such as "win-win-win" concept and solutions for importers described in paper 4, and the "smart goods" set-up involving mobile RFID outlined in paper 5). Implementation processes shape and are shaped by a wide range of contextual factors that are interrelated and contingent upon other conditions (Nandhakumar et al. 2003). In this thesis, continuous implementation is described as tight follow-on projects that can almost be regarded as a single flow of activities as well as in the shift from "push" to "Get pull!" effects. Revisiting and refining scenario development activities focus learning and provide a basis for gradual development. This, in turn, emphasises collaboration in order to manage complex and uncertain situations, thus enforcing change during continuous implementation. This implies an alternative to conventional freeze/unfreeze/refreeze implementation efforts that distinguish affected actors in order to pursue roll-out and push for adoption of solutions (Cooper and Zmud 1990, Lai and Mahapatra 1997, Wainwright and Waring 2004). Again, this offers an alternative to the "one complete and deployed" system view. Gradual development and continuous implementation are achieved by aligning business and IS/IT, which require joint formation and execution of comprehendible projects. Consequently, when considering business and IS/IT together, their alignment becomes self-evident.

6.3.3. Further generalisations in relation to literature

The empirical contributions of this research illustrate a way to develop and implement IS/IT that reinforces previous findings (Earl 1993, Bood and Postma 1997, Davenport 1998, Dove 2001, Peppard and Ward 2004, Baskerville et al. 2005).

- It confirms the empirical study concluded by Earl (1993) and addresses the intertwined aspects of developing and implementing IS/IT in a complex and uncertain context. Specifically, it adds to Earl's organisational perspective by embracing the importance of relationships (including supply-chain actors outside the organisation).
- It shows that scenario development contributes to strategic awareness and learning (Bood and Postma 1997), but also indicates that scenarios should not be prescriptive.
- It provides perspectives on how to integrate new solutions in combination with the installed base and relations (Davenport 1998).
- It supports the view that components (e.g., Web services, stakeholder relations, etc.) in the process should be reusable, reconfigurable, and scalable as one part of organisational and inter-organisational efforts to create and sustain agile capabilities (Dove 2001).
- It is in line with Peppard and Ward's (2004) search for IS capability and their outline of developing and implementing IS/IT and business together.
- It acknowledges that: *"In a world in which change and uncertainty drive the needs for business agility, and digital information drives business, agility in IT is critical for business success. We believe it is important to understand how… [agility] …is multifaceted."* (Baskerville et al. 2005, p. 9). And, again, it emphasises that IS/IT is an integral part of the business in aftermarket logistics.

Ultimately, understanding has much to do with our individual mindsets. The presented research contributions address implications that help us understand our current theoretical frameworks. Taking them together, we can conceptualise a need to simultaneously and continuously develop and implement IS/IT in various contexts, although complexity and uncertainty are inevitable. The derived insight that process integration takes time—often perceived as longer than expected (see papers 2 and 4)—can support essential self-confidence and persistence in individuals faced with the challenge of seriously taking on IT-Management.

6.4. Industrial Effects

This section highlights the industrial effects of the collaborative practice research process. Volvo is a large enterprise and its aftermarket logistics involves several actors along the supply chain. The industrial effects related to the research contributions therefore focus on direct results in effectiveness and efficiency. These involve Web services, RFID, and aspects of learning, innovation, lead-time gains, and resource utilisation.

6.4.1. Web services

When this research was initiated, Web services were rarely part of global and transaction-intensive business implementations. Today, however, Volvo continuously evolves its structure for global aftermarket logistics with a platform that integrates legacy and new Web services, as well as nurtures existing and new relationships—even with end-customers. Clearly, the further out into the supply chain it goes, the more heterogeneous the conditions. The loose coupling of Web services has therefore proven profitable, as has incremental integration through gradual development and continuous implementation. Figure 16 illustrates an internal slide of the approach (from paper 4). Valuable services are introduced in each part of the business cycle and expanded gradually (rather than trying to develop and implement "one complete and deployed" system).

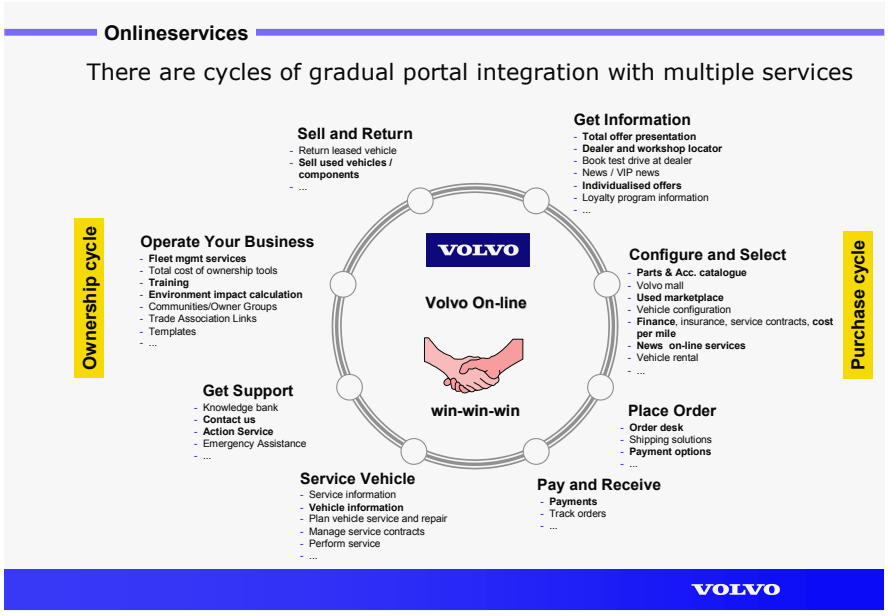

Figure 16 – Internal Volvo slide detailing a gradual approach.

"Get pull!" is a phrase that describes the part of continuous implementation in which supply-chain actors can "pull" and assimilate functionality, procedures, and business solutions according to their own needs. This reduces the need to push diffusion of new technology and/or other solutions. In other words, the approach offers sustainable pull effects rather than requires a push for usage and adoption. Thus, the traditional comprehensiveness of "roll-out planning" can be replaced by an evolving process of roll-in, measured in actual usage. Offering clearly valuable services contributes to organisations applying for usage of Web services subscriptions and to individuals within organisations arranging for self-service through Web portal access.

The greatest industrial effects reside internally and among involved supply-chain partners. However, some quantifiable examples are provided in the following section. Public Web pages from a Volvo Web portal are available at www.volvotrucks.com/onlineservices. The development and implementation of a single order interface (SOI) is an example of going from conceptual solution to usage with practical value (from paper 2). Figure 17 (from paper 2) shows a high-level structure for managing IS/IT capabilities to synchronise order process events through underlying legacy systems that have very different restrictions. Example restrictions include those on warehouse allocation, freight conditions, back-order handling, order class priorities, and service composition. The project was able to deliver an SOI with positive effects in terms of customer relations, financial impact, and elimination of potential business threats.

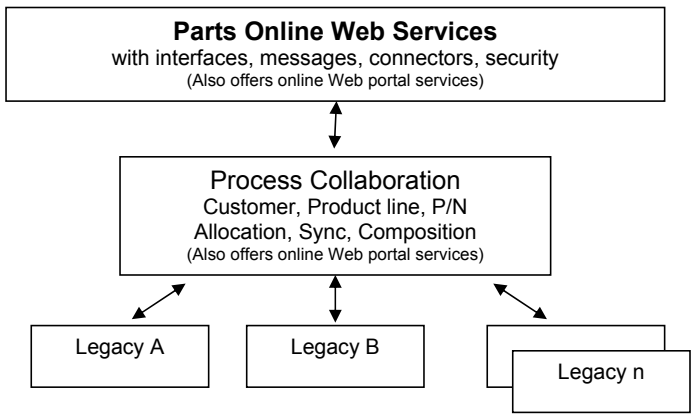

Figure 17 – High-level structure for SOI and process collaboration.

The Web services development and implementation have had industrial effects beyond the directly involved parties. Commercial recognition is one example, as when IBM presented part of the Volvo SOI Web services case as "Company of the month" on their global Web site in 2004. Mobile RFID has also gained recognition, including several key notes and appreciations at large professional conferences hosted by different organisations (see, for example, www.cscmp.com and www.rfidforum.com). A public magazine published by Volvo IT also highlights knowledge gained from building piece-by-piece and updating frequently (http://useit.volvoit.com, 2006, no. 2, "volvo.com developing in stages"). Rather than to spend several years at the drawing board and then make a gigantic launch, Volvo has chosen a gradual process.

6.4.2. RFID

Currently, RFID is surrounded by a certain hype that is somewhat similar to that surrounding e-business—and how it would change the world—a few years ago. At the same time, industrial effects are contemporary by nature and even if Volvo already has experience in the RFID field there are several new aspects to consider. Consequently, the industrial effects that coincide with this research

have different perspectives. As an example, a site manager at a cross-docking terminal describes how progress takes place in three waves. The first wave, he says, explores alternatives to bar-codes, focusing on costs of RFID tags and readers. Then, he says, *"the second wave can approach more of supply-chain collaboration and integration efforts. Most interesting, will naturally be a third wave, which will even bring innovative solutions that we currently cannot comprehend. Those are, unfortunately, not possible to directly derive. We must learn to handle the dynamics through the first and second wave—but it is also important not to use new technology with old ways of working, to look for new perspectives, new process flows, and gradually secure valuable actions. That is our strategy."* (Holmqvist 2006)

The mobile RFID initiative refined supply-chain collaboration and resulted in industrial effects. Results involved innovations through mobile technology usage, "smart goods" identification features, and integration based on leveraging existing infrastructure (Holmqvist and Stefansson 2006c). Gradual development and continuous implementation provided design constraints and insights into how to balance transitions between existing solutions and new aspects of applying RFID technology in business. Examples include design constraints of less than 10 readings/minute and no more than three data inputs/reading, thereby determining certain areas where it unsuitable for usage. To balance transitions from the existing installed base of the Odette label (which uses bar-coding) toward wide-scale RFID implementations, practical learning suggested incorporating the RFID tag into the Odette label. Thereby, different processes and supply-chain actors can transform and gain benefits slowly but surely. This approach also facilitated diffusion and adoption of new solutions.

To manage the massive amount of data, the development and implementation teams investigated the use of "smart goods" identification on the consignment and/or item level (Figure 14 from paper 5 outlines the concerned supply-chain actors and flows in which scenario development—together with selected supply-chain partners—derived usage on the consignment level). Industrial effects are mainly internal to Volvo and to directly involved supply-chain partners. Also, each business case requires individual assessment. The following section exemplifies the quantitative gains in terms of industrial effects. There are also industrial effects of the collaborative practice research, particularly in the scenario development and joint work on interfaces. An example from joint work on interfaces between supply-chain actors builds on Stefansson (2004), and refining adoption of Web services has utilised Ferguson et al. (2003). From an industrial perspective, the ability to combine the academic fields of informatics and logistics is highly beneficial as mixing the competences contributes new perspectives.

6.4.3. Learning, innovation, lead-time gains, and resource utilisation

The industrial effects of sustainable learning have in a sense been described above, in both learning to approach technology usage and learning to establish relationships. It is also discussed in learning to build competence in technologies and relationships as such (Web services, RFID, end-customers, and so on). Innovations are more distinct and have a priceless potential, although it takes

longer perspectives on history to assess their true value. Sustainable learning in teams at Volvo has nurtured innovation through the diversity of participating actors, which resulted in considerable industrial effects. In developing and implementing IS/IT in aftermarket logistics through comprehendible projects, it has been possible to deliver new business concepts and establish new relations among stakeholders. This produces unprecedented agility in how managing development and implementation can enable business value. Operations in this business show that IS/IT is an integral part of aftermarket logistics. The "win-win-win" concept described in paper 4 emerged as a profound innovation. This concept, along with opportunities for importers, had not been taken into account during the original scenario development. As a result of "win-win-win", global functions, market establishments, and dealers collaborate more easily, both cross-functionally and between different levels. Another effect is rapid realisation through usage, which entails less need for detailed specifications. Rapid realisation also contributes to high return on investment, with positive cash flow effects in relation to the minor follow-on investment required. In traditional terms, quantifiable industry effects are always appreciated in a competitive business.

The industrial effects in lead-time gains and resource utilisation are two-fold, relating to effects in both operations (output of the process) as well as in the process of development and implementation. The first effects are less difficult to assess because they can be compared to a previous situation for the operations. The latter is assessed mainly through data sources that compare similar experiences and make interpretations and conclusions accordingly. Consequently, the most valuable contributions of this thesis are not in the graphs or tables as such, but in the summary of facts they convey. These illustrations are provided to highlight examples of successful industrial effects at Volvo. Figure 18 shows the effects of using the "smart goods" and mobile RFID solution (as described in paper 5).

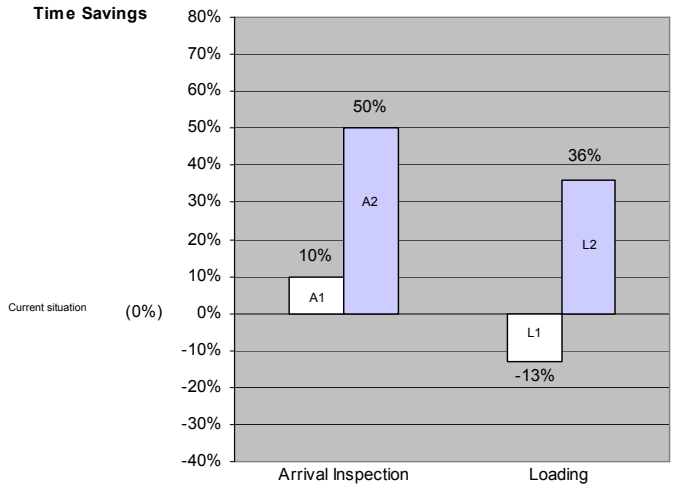

Figure 18 – Example of industrial effects on lead-time with mobile RFID.

The *Arrival inspection application* records consignments as they arrive, in order to increase productivity in data gathering activities. The *Loading application* enhances loading operations, where consignments should be assigned to specific cargo carriers. In arrival inspection, the resulting time savings compared to the previous situation ranged from around 10% (A1) up to as much as 50% (A2). The loading activity includes results of more than 30% lead-time reduction (L2). However, as paper 5 discusses, in some situations the mobile RFID solution contributed to productivity decreases. As such, it exemplifies that there is not one solution when managing the process of developing and implementing IS/IT in aftermarket logistics.

The case presented in papers 2–4 provides a good example of the industrial effects of collaborative research in IT-Management. Although any summary has advantages and disadvantages, table 7 (adopted from paper 4) attempts to highlight particular aspects—including quantifiable facts relating to the first three development and implementation efforts—which used Web services when approaching end-customers.

Table 7 – Summary of three development and implementation projects

	Original implementation	First follow-on implementation	Second follow-on implementation
Development cost (rel size)	1	1/5	<1/20
Lead time (rel)	1	½	¼
Challenges			
-Project process	Complex, because of the many functions involved, but with good focus	Easier, because of follow-on learning curve	Poor focus, because of less management attention
-Technology	New, complex	Stabilizing	Established
-Commercial relations	Existing, but new collaboration	Emerging, but new	Experience from former set-ups
-Logistics	Not focused	New	Existing
Results			
-Cost/benefit	Emerging value	Great value	Value as expected
-Innovation		Win-win-win relations	Extended reach and features

The table shows each project's development costs, lead-times, challenges, and achieved results. The development cost, including costs for competence and resource utilisation, is expressed in relative size compared with the original implementation project. Lead-times for executing development and implementation are also expressed relative to the original implementation. Challenges are expressed through key factors in four dimensions. The first dimension represents overall project process characteristics. The other three represent the dimensions of perceived maturity: Web and integration technology usage, commercial relations among supply-chain actors, and the implications in logistics set-up. The results achieved are expressed as the relation between

expected and delivered business value (cost/benefit) as well as through examples of derived innovation.

This example shows the industrial effects so far in relation to the expectations of what the project should deliver in various areas. For example: building the Web platform in the original implementation was more difficult than expected, and the number of end-customers that would connect was overestimated. Development cost and lead-time is set to one in order to relate them to follow-on implementations. The first follow-on implementation required only one-fifth of the development costs and half the lead-time (compared to the first implementation). This resulted in a quick, simple, and beneficial adoption, thus delivering much more value than expected. The second follow-on implementation required less than 1/20 of development costs compared to the original implementation, and was delivered in one-fourth the time. Overall, the first project under-delivered relative to its expectations, and the second follow-on project over-delivered. In hindsight, the impression is that the initial implementation project's work offered considerable payback in follow-on implementations. That said, we must always consider management attention, personal status, and communications as outstanding challenges in managing the process of gradual development and continuous implementation. Consequently, even if there are positive industrial effects, we cannot neglect existing difficulties and assume that the process is simple.

Concluding chapter six

To summarise this chapter on research contributions it is essential to acknowledge that developing and implementing IS/IT in aftermarket logistics is a valuable arena for IT-Management research. It is an arena that Orlikowski and Iacano seem to describe when they urge researchers to: "… *conceptualize and explain IT artefacts as multiple, fragmented, partial and provisional. Letting go of a monolithic view of technology implies recognizing that technologies such as the Internet and other distributed applications do not provide the same material and cultural properties in each local time or context of use. Differences in system configurations, infrastructures, bandwidth, interfaces, accessibility, standards, training, business models … arise as designers, developers, users, regulators and other stakeholders engage with evolving artefacts over time and across a variety of contexts. To better understand such evolving dynamics, on-going and longitudinal studies of information technology are particularly useful*" (Orlikowski and Iacono 2001 p. 132). The goal of this thesis is to support the research objective: *To contribute to a better understanding of how to develop and implement IS/IT in aftermarket logistics.* The industrial effects presented here are a result of the collaborative research approach undertaken to support this objective.

7. CONCLUSION

This chapter offers conclusions and completes part A of the thesis. Part B follows, presenting a reprint of selected papers.

This thesis is motivated by a quest for better knowledge of IT-Management. The objective is to improve the understanding of how to develop and implement IS/IT in aftermarket logistics. Collaborative practice research and interpretive case studies, coupled with in-depth access at Volvo, have been the basis for this thesis.

Although developing and implementing IS/IT in aftermarket logistics is not easy, it has become a necessity under current business conditions. Growing globalisation, product advancements, intensified IS/IT dependencies, and increasing transport demands due to heavy competition and regulation are all sharpening the requirements in aftermarket logistics, a dynamic area with direct importance for the world economy. Aftermarket logistics is concerned with getting parts and service information to the right place, at the right time, in the right way, which requires readily available information and intense collaboration. The number of actors, markets, products, and services involved—as well as the transaction volumes of goods, financials, resources, and information—are all accelerating, contributing to complexity and uncertainty. Today, IS/IT is an integral part of the aftermarket logistics business, with a critical mass of installed technologies and established business relationships. This thesis identifies main characteristics of aftermarket logistics imposing managerial problems in the light of this research:

- *Processes are based on a robust platform,*
  but they must also sense and respond to change.
  Process integration takes time and requires more management involvement than technology to find the right match and timing. Because parts availability is crucial, IS/IT is an integral part of the volatile aftermarket operations (as exemplified by complex back-order handling and supersession chains).
- *Actors are independent,*
  but they also need to collaborate.
  Although the supply chain is dominated by heterogeneity under competitive conditions, collaboration is needed to successfully manage change. Growth in the number and type of integrated actors is prevailing (as exemplified by manufacturers' increasing embrace of end-customers and new markets with IS/IT-dependent relations).
- *Products are mobile and technically advanced,*
  and consist of parts that can have break-downs anywhere.
  Service requires skills, resources, special tools, and access to online information everywhere in the world throughout a product's long life span. Also, an increasing share of perceived customer value is digital, since products have both physical and software spare parts and are dependent on integration and data capture
  (as exemplified by using Web services and RFID).

The two cases in this thesis encompass both business-driven issues (such as reaching end-customers through Web services) and technology-driven issues (such as exploring RFID through collaboration). In all, this research contributes to an understanding of how we can manage the present problems of IS/IT in aftermarket logistics. To address these problems, the thesis findings imply that we should:

- *Use Scenario Development*
  Scenario development contributes to strategic awareness and learning among stakeholders. This provides a basis for the gradual development and collaboration needed to enforce change with a clear direction.

- *Encourage Gradual Development and Continuous Implementation*
  Gradual development and continuous implementation enable agile capabilities and learning, both of which nurture the potential for innovation. By considering business and IS/IT together, their alignment becomes self-evident in the execution of comprehendible projects.

This thesis has also contributed to business value in terms of industrial effects. Compared with previous experiences, there are examples from Volvo that used fewer resources because they replaced thorough planning and detailed specification with a continuity of strategic change and focused on operational results. Earlier realisation of business value in operations has generated positive industrial effects in cash flow, return on investment, user-driven development, and direct adjustment capabilities, thus achieving agility through implementations. Beyond this is the priceless potential for sustainable learning and innovation. Nevertheless, developing and implementing IS/IT in aftermarket logistics remains challenging. As this research shows, however, scenario development in concert with gradual development and continuous implementation contributes to aligning business and IS/IT through comprehendible projects.

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Paper 1

Enterprise Wide Development
A survey of critical factors for co-ordinated development in complex organizations: What development managers consider

Magnus Holmqvist, Håkan Enquist
Volvo Parts *Aerotech Telub*
Viktoria Institute, Goteborg University
www.viktoria.se www.gu.se
E-mail: Magnus.Holmqvist@volvo.com Enquist@informatik.gu.se

Abstract

This paper describes critical factors for co-ordinated enterprise and IS/IT development and change in complex organizations in Sweden. These factors represent an answer on the crucial question: Why is co-ordinated development of enterprise and IS/IT difficult today? The survey is based upon in-depth interviews and concentrated workshops which present a current and qualitative view upon this area. 20 persons representing different development management roles from 6 large organizations with complex operations have participated. Responses relate to two main questions, which concern the problem generating factors and to what degree these are critical. The factors have been categorised into nine subject areas and certain factor groups within each area. A vast number of statements are included in the material.

In workshops, with invited experienced development managers, the responses were prioritised individually with regard to critical factors for co-ordinated enterprise and IS/IT development.

The result is a set of critical factors reflecting priorities of development managers in Sweden today, which can guide us in further research in management of co-ordinated enterprise and IS/IT development.

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1. Introduction and objective

Large and complex organizations are increasingly dependent on IT, which is integrated in business processes to sustain competitiveness in current markets and also in migration into new markets and/or branch structures.

During the 1990:s IT use has broadened and integration into human activities and business processes has increased in almost every area of society. Integration of IT has gone so far that the core of many business processes exists mostly in IS rather than in human activities. Today, in order to change, organizations have to manage social change and technical change in phase. Yet, difficulties in managing social and technical change are commonly seen in terms of failing projects and wasted investments. There is a need for theories and models, which better support continuos development of enterprise and IT systems in large organizations [1].

Especially large organizations constitute a complex environment for people and systems. Their enterprise demands large efforts to achieve change and involve situations where cause is hard to distinguish from effect. To co-ordinate development of both enterprise and IS/IT there are a number of critical factors that needs to be managed. But which are these factors, then?

There are suggestions on issues to manage in order to be successful with IS development in large organizations; A sequence of SIM Delphi studies during the last 15 years shows the changing interest of IT managers over time [2, 3]. For example, an area of increasing interest is the migration into new application areas based on Internet, like E-commerce. The SIM Delphi survey has been repeated on other continents and the results show that the key issues and their ranking also vary depending upon location [4]. However, the fact that an issue is interesting does not imply that it is difficult to manage. A survey with set questions has advantages for continuity but a draw-back regarding catching top-of-mind concerns and in-depth discussions.

Literature offers a vast set of solutions to IS development and use in organizations, such as: strategic IS/IT-planning, architectural frameworks, standard systems, and enterprise wide infrastructure and project management. Some studies take a project perspective [5], [6, 7], [8]. Another area of great concern for studies relates to the difficulty of measuring the value of Information Systems [9]. Other studies have investigated failures within Information Systems [10], [11]. There are extensive course books with an aim to enhance knowledge in the field [12], [13]. There are also

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classifications of existing studies [14]. If all these solutions exist, how come it's still so troublesome? Are the offered solutions not used? IT management, and theories in the field, lack unifying concepts and frameworks still leaving the field incomprehensible to researchers and practitioners [15].

Our interest is the co-ordination of enterprise and IS development, throughout large and complex organizations rather than in specific application areas or single projects. Consequently, we set out to clarify the specific critical factors in some Swedish organizations. Overall, there is an interest for the question: Why is co-ordinated enterprise and IS/IT development difficult today?

An important group that confronts the context are practitioners and we have given them some questions - Let's see what they consider…

2. Method of the survey

The survey was made through a combination of interviews and workshops with change managers from large Swedish organizations with complex operations. Delineation of scope and forming the questionnaire was made in workshops with support from senior researchers. The interviews were performed mostly at the interviewee's office by one or both researchers. The interview statements were compiled into lists of factors, problems and problem driving issues, as a basis for ranking and group-discussions in workshops.

2.1. Choice of approach

There are alternative approaches to address the issue at hand. The main advantage of the case studies and the context specific environments is the access to in-depth knowledge and understanding, something that is crucial when studying complex situations [16]. The main difficulty with a quantitative approach in a complex context would have been to formulate, gather and analyse data unless the research issue is well defined and understood among all respondents. Instead, such understanding is possible to achieve with a qualitative approach with in-depth interviews and workshops.

Repeating a previous study in a new setting would have had the advantage of reusing validated instruments and may have contributed to that research. For example, repeating the SIM Delphi study within Swedish organizations would be such an option. However, our main question concern about critical factors, which are difficult to handle rather than key issues of interest and furthermore we focus on the context of complex organizations.

By taking an inductive approach the possibility of discovering different phenomenas remains without being restrained to singular verification. A pure deductive standpoint would restrain the research to a fixed hypothesis [17].

In the interviews our approach is to be open-minded. It is essential to get a picture of what issues development managers in different organizations see as critical instead of analysing their reaction to a normative or prescriptive model. This is reflected in that the questions in the interviews are open and intended to let the interviewees form their answers in their own words and from their own thoughts.

Semi-standardized interviews, i.e. a number of presented questions, which can be adjusted and followed by individual questions, provide flexibility without losing the possibility to analyze similarities and differences [18].

The compilation of answers into groups is based on issues contained in the answers themselves, not on any pre-defined taxonomy. Workshops with participants were used for further validation and participants could influence factors listed in interviews.

This way we believe that the resulting list of areas and factors is a fairly good aggregation of the issues, which development managers are concerned with in large and complex Swedish organizations of today.

2.2. Framing the scope

To frame an original scope, construct interview questionnaire and select analysis/evaluation methods three preparatory workshops were performed with two senior researchers. This resulted in basic assumptions, definitions, main issues, organization scope, managerial roles and also ideas regarding subject areas for the research. We got some basic assumptions on the development situation today:

- more and more change requirements come from external stakeholders and affect the development work in a way uncontrollable to development management
- change requirements have dead-lines, best-before dates, for changes to be fully implemented and co-ordinated in enterprise and IS/IT, thus increasing the need for co-ordination of enterprise and IS/IT development/change
- there are managerial rather than technical issues hindering efficient co-ordination of enterprise and IS/IT development today

Enterprise in this context is not merely restricted to the corporate world but shall emphasize the organizational environment and operational settings. It exists also for public organizations, e.g. military units and the essence rests in ways of working, activities and "day to day business" (in Swedish the word "verksamhet" explains the meaning).

Complex in this context means entities that are constituted from a large number of elements with a large number of depending aspects. Complexity is increased from increase in dimensions such as diversity/heterogeneity of elements with dependencies, dynamic behavior and speed/phase of development and change. The main issues for this research are:

- To get a picture of what managers considered difficult and description of causes, situations and issues for co-ordinated enterprise and IS/IT development.
- To what degree are these concerns considered as critical factors by a group of experienced development managers.

The selection of organizations intended to cover a wide range of areas in society from public sector as well as from private to get a broad picture rather than a narrow one:

- Public: defense authority and a service administrating authority
- Private: manufacturing, system provider, transport and industry

Each of these organizations is considered large and complex in the sense that it dispersed geographically, has a large number of employees, a high knowledge content, advanced products and/or processes, and extensive IS/IT use in a variety of applications.

The following management levels and managerial roles were defined to support the survey:

- Enterprise role, a manager that has a role in the enterprise perspective, e.g. CEO, head of division or manager, change projects manager.
- IS/IT role, a manager that has a role in the IS/IT perspective, e.g. CIO, IT manager or IS/IT project manager.

- Overall management, that is the level that has to direct the organization as a whole, co-ordinate internal aspects to meet external aspects e.g. expectations, competition and development.
- Executing management, that is the level responsible for executing development activities and co-ordinating development and change work associated with the activity.

The division into enterprise and IS/IT perspective is intentional to reflect that this split of responsibility is often applied in large organizations. The survey is focused on development managers, thus, development workers and enterprise people at large have not been included. These groups may of course have other views on what makes co-ordinated enterprise and development difficult. Therefore, when interpreting the result from this survey, one must bear in mind this delineation. It is a survey of what development managers consider.

2.3. Interviews and workshops

The selection of interviewees was based on the four categories described in the previous section. The choice of candidates was made in collaboration with a senior representative from each organization, relying on their knowledge of personnel within the organization.

The interviews were conducted at the interviewee's location, normally in their office premises. The interviewees' could chose the time and date to their convenience and the atmosphere was relaxed. The interviews were documented with a tape recorder and notes. Over 200 critical factors were registered in a database, both short ones like "Long lead times" and sentences like: " We dont have a process for co-ordinated evolutionary enterprise and information systems development".

The workshops were arranged by the researchers through an invitation procedure. Workshops were held at two different locations to enable as many participants as possible from the invited group. Each workshop started with a brief introduction to the problem domain and was followed by an individual critical factor ranking of statements before an open discussion finalized the workshop days. The results were all the time collected and registered in a database by the researchers.

3. Survey results

This part will first give a brief description of the participants, present the structure of interview statements in subject areas of the critical factors and finally present some ranking results together with their implications.

3.1. Participants

The following six organizations participated in the interviews and were all invited to the workshops.

Public sector:
Riksförsäkringsverket – www.rfv.se
Försvarsmakten - www.mil.se

Private sector:
Volvo Parts AB – www.volvo.com
Tietoenator AB – www.tietoenator.se
STENA AB – www.stena.com
SKF AB – www.skf.com

The interviewees were asked to point out their main role according to the table 1 to confirm the correctness of the selection. There is an under-representation from Development management in IS/IT. Selecting one respondent per role and organization would have given the theoretical number of 24 respondents. However we did not get qualified persons in every category from all the organizations.

Table 1. Representation of participants

	Enterprise	IS/IT
Overall management	**6**	**6**
Executing management	**5**	**3**

The workshop had two purposes: to prioritise the individual and aggregated results from the interviews and to analyse and discuss critical factors. The workshop participants were invited from the same organizations that took part in interviews. The workshop was set up at two occasions in order to get as many participants as possible. Since the prioritization of the critical factors was performed individually we believe that this split does not affect the result in any critical way. Altogether also 20 valid priority lists were collected.

Workshop participants represent all categories of management.

3.2. Structuring of statements

The statements from interviews constitute a rich and vast material. However, it would not be suitable for consideration and evaluation with the limited time of a one-day workshop. Therefore, in order to produce a comprehensible material, the statements from two core questions were selected and structured into 10 subject areas. The two questions were:

- What do you consider to be the biggest difficulties/ problems in co-ordinated enterprise and IS/IT development in your organization?
- What critical factors are generating problems in co-ordinated enterprise and IS/IT development?

Subject areas (see figure 1) were induced by the researchers from the statements themselves and not based on any predefined theoretical taxonomy. The reason for this is to minimize possible bias introduced by the underlying scope and perspective of a given taxonomy. The negative aspect of this may be that those encountering the material are led into thoughts around subject areas that they would not have if they see the material without being structured into subject areas. However, the participants perceived the subject areas as general and natural and no workshop participant reacted upon the issue.

In sorting the statements a notion of subject was used as a guideline, i.e.: "What is the subject that is addressed in this statement?" rather than "What is the issue that is addressed in this statement?". Of course, also this kind of vague guideline is open to bias from the researcher but we still believe that it gives us an opportunity to find other issues than those that have been found by following a defined structure. We also have the possibility to compare the subjects found with other taxonomies and thereby enrich them.

It is essential to note that statements may differ slightly in perceived meaning between Swedish and English. All interviews and rankings were made in Swedish. Also, the statistics shall be regarded as an indication of the statement and subject importance rather than strict statistical conclusions.

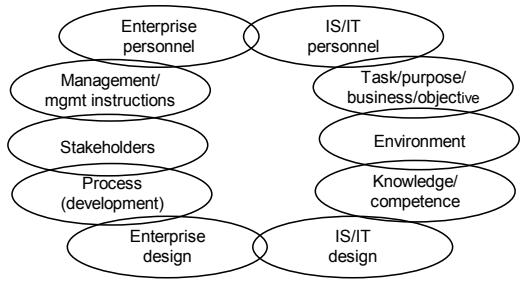

Figure 1. Overview of Subject Areas

3.3. Subject Areas, statements and factors

As stated, the structuring of statements into subject areas was made to illustrate and make the vast interview material comprehensible in a short time. The Subject Areas are out-lined in figure 1. The areas cover universal subjects, such as Knowledge / Competence and Environment, but also more specific subjects like Enterprise design. Some areas were given primary headings in order to represent factors indicated by similar statements. An example would be Process, which contains primary headings for Long lead-times and Co-ordinated development. Similar factors may occur within

different areas and it is equally essential to be aware of that there is a variation in number of factors per area. Nevertheless, that should not influence the analysis.

3.3.1. Environment covers aspects external to the organization such as technology change at large. These may range from major political shifts/events, the European Union and the internal market to globalisation and merger trends. An interesting note, which may well be subject to further research, is that these large and complex organizations have expressed a focus upon internal issues rather than external. An example of a statement comes from a CFO explaining the introduction of a common currency in Europe as: "It is critical to solve 'the Euro issue' both in terms of system and organization."

3.3.2. Stakeholders cover external actors with an interest in, and/or means available to affect the development and change process of an organization. Such actors may be customers, suppliers, government, authorities etc. A specific statement illustrates the context for the stakeholder subject area: "Markets, geographically spread, have different stakeholders which are difficult to handle."

3.3.3. Enterprise personnel regard aspects concerning the status, availability, influence etc of personnel in the organization. The factors relate to the availability of enterprise personnel with statements such as: "Everyone cant be part of process design", "Enterprise personnel have such a workload that they can't be part of the development" etc.

3.3.4 IS/IT personnel cover issues concerning the status, availability, influence etc of IT personnel developing IS/IT systems for the organization. It relates to factors like availability of IS/IT personnel with issues such as: lack of time, difficult to keep competent personnel etc. Among the statements is a remark from a system development manager: "The number of consultants within projects, which later disappear together with all their knowledge".

3.3.5. Knowledge/competence relate to aspects of knowledge, competence, language, behavioural patterns (cultural or role related). The expressed views include a factor of Attitudes and statements such as "Patience and understanding in order to establish a new way of working, including the infrastructure". Factors relate to "Lack of knowledge for the operations among IT-personnel", "Get the holistic view and roles among people", "Lack of knowledge" and "Language and interpretation differences between actors".

3.3.6. Process (development) cover aspects concerning the development process such as lead-time, smoothness etc. Statements address the process of phasing out old systems, "The organizational boxes are designed first, before IS/IT possibilities are investigated" and "Complexity! Large enterprise, which involve lots of people e.g. 100 project leaders with their own priorities". Other statements were gathered under the factors for: "Long lead-time" and "Co-ordinated development.

3.3.7. Enterprise design regard issues of the design of an organization/enterprise, both in its current form and future form. The factor "Co-ordinated enterprise design" was significant and include statements on geographical differences and the legal factors. An example of a statement from a project manager: "Our legal set-up is a hinder to let the system deliver desired project result."

3.3.8 IS/IT design cover aspects of the design of IT-systems both legacy and future systems. The statements range from e.g. "User approval", "Security solutions which restrain external co-operation and shared networks/ IT systems" and "Timing aspects, when is it profitable to let in new technology" to factors like "Complexity and Inflexibility in legacy systems" and "Co-ordination of development".

3.3.9 Task/purpose/business/objectives relate to aspects of purpose, objectives and business of the enterprise. A statement expresses the difficulty to capitalise upon enterprise changes, to really realise the expected effects; "To actually achieve effects in terms of enterprise changes". During one of the workshops a quote may further explain the situation: "Due to unclear alignment we have many tasks that are blurry. In calculations there are often a unhealthy re-use of potential benefits, e.g. if all potential head-count reductions were actually given a red cap, we would find that there are now a lot of persons with several red caps and also a whole bunch of ones which do not have any person at all to wear it."

3.3.10 Management/management instruments cover aspects concerning management, such as organizing processes, decision making and resources as well as management instruments such as planning, control and follow-up instruments. Factors include the balance between Central-Local, Unclear responsibilities, Time span, Co-ordinated development, Comprehensibility and Top-management interest and commitment, e.g. "Lack of follow-up".

4. Critical factor priorities

We believe that it is possible to draw some conclusions from the distribution of statements as they were gathered and discussed in subject areas. The number of statements reflects the concern of the interviewees. A subject area with a high number of statements is an area of large concern and contains critical factors.

We can present some tables with results based upon the rankings made in the workshops. Therefore, we can also illustrate some conclusions concerning the critical factors for co-ordinated enterprise and IS/IT development. Table 2 gives an overall view with comments below. Column 1 shows the number of statement rows from the individual interviews and column 2 the more comprehensible structure with primary headings used in the workshops together with subject areas. Column 3 presents the total number of ranks received in the workshops and column 4 represents the total number of high ranks (5-point rankings on a scale from 1-5 and 5 equals very important) received.

The first column with all the statements gives an indication of *Concern*, column five can represent *Importance* and column six *Relevance* of the critical factors discussed.

Table 2 Overall view of ranking

Subject Area	Col 1 No of state-ment rows	Col 2 No of prim head-ings	Col 3 No of ranks recei-ved	Col 4 No of high ranks (5) recei-ved	Col 5 High ranks (5) for prim head-ings (in %)	Col 6 No of ranks per prim head-ing
	Concern				*Importance*	*Relevance*
Envir-onment	2	2	36	2	6%	18,0
Stake-Holders	8	8	137	19	14%	17,1
Enterpr. Pers	20	12	213	36	21%	17,8
IS/IT Pers	8	5	86	15	17%	17,2
Knowl/ Compet	37	15	260	49	27%	17,3
Process (dev)	34	15	257	52	22%	17,1
Enterpr. Design	6	2	35	9	26%	17,5
IS/IT Design	28	12	211	51	27%	17,6
Task/ Busin...	1	1	14	6	43%	14,0
Mgmt/ Instrum	64	30	486	112	30%	16,2
	208	102				

Interviews | Comprehensive Structure | Workshops

In the statement list for critical factor rankings, some were grouped into a primary heading. Due to the grouping of certain statements into primary headings the respondents had the option to only rank the primary heading and leave the single statements in the group unranked. They also had the option to rank both the factor row and statements of their choice within the group. In the overall ranking of subjects (column 5 in table 2) the statistics is based on values from primary ranking rows only. If all rankings are included the result is slightly different (i.e. column 4 divided by column 3).

The number of rankings per primary heading tell us whether workshop participants paid attention to the statement or not which can be interpreted as a measure of relevance. The number of high ranks divided by the number of rankings tell us whether workshop participants consider it a critical factor or not, which can be interpreted as a measure of importance.

The allocation of statements into subject area (made by the researcher) directly impacts the aggregated priorities for the individual subject. Thus, it is also important to look at the individual statements when interpreting this material. There is also a possibility that subject areas with few statements get more attention from respondents since it is easier to overview and decide on a few statements.

'Management/management instruments' (64) is the area that clearly has most statements and it also has one of the highest high-rank figures. The number of rankings per row is a little bit lower than other areas but the difference is small. The high number of statements and the high importance indicate that both the interviewees and the workshop participants consider this to be the area with most difficulties/ problem generators today and also very important for co-ordinated development. The interpretation is that Management is indeed a subject of large interest for further research, at the same time being aware of the fact that the respondents here represent management themselves.

Management/management instruments (64), Knowledge/competence (37), Process (development) (34), IS/IT design (28) are all of large concern and relatively high importance (No of high rankings). The three highest ranked are all people oriented subjects. Management is pursued by people and addresses people. Knowledge, competence and culture are all attributes of people and groups of people. The development process is performed by people, managed by people within the knowledge and cultural frames of these people. There

are, of course, interrelations between these three subjects that are not further investigated in this paper.

The obvious interpretation is that the main bulk of difficulties and problem generators are contained within these four subjects and their interrelations not excluding though that there may be significant single factors within other subject areas too.

These subjects are all mainly internal to an enterprise, which is quite interesting from a research point of view. Does this represent a delineation of development manager's interest and scope within large organizations? Or is it a reflection of a reality where most difficulties in co-ordinated enterprise and IS/IT development actually are internal affairs? Further research may give an answer.

Environment and Stakeholders both contain few statements and are considered of minor importance, although relevance appears to be average. The interpretation is that development managers are not very concerned about difficulties and problem generators in these areas and do not consider them critical to manage.

Task/purpose/business/objective, seams to be of minor concern, just one statement. However, it has the highest score on importance of all. Since there are so few statements it is difficult to draw other conclusions than that this single factor is important. We have decided not to draw any conclusions on the subject at this stage.

We find it very interesting that internal subjects are ranked high from all aspects, whereas externally oriented/ dependent subjects are ranked very low. In the debate and also in American and international surveys [2, 3] [19], a number of external issues are ranked high regarding interest, relevance and degree of critical success factors. Such factors are outsourcing, responsiveness to market changes, competitiveness etc. One interpretation is that all these factors are handled excellently by large Swedish organizations and that that is the reason they are not considered to be a problem. Another interpretation is that external factors are not visible once you are inside a large organization! This would then contradict the presence of current topics in debate such as the networking enterprise, interorganizational processes and value adding chains. A third interpretation is that there is a bias towards 'internal' people in the respondent group but that would only affect the critical factor ranking, not the number of statements since they were received in the interviews.

It is also worthwhile to present the outcome of individual statements as they also represent a part of how to handle critical factors. In this way it is also possible to see if the overall ranking is consistent with the single statements or if there are high-ranked statements within low-ranked subject areas. Table 3 presents the Top-12 statements according to average ranking score.

Table 3. Top statements by average ranking

	Statement	Subject Area	Aver ranking
1	We dont have a process for co-ordinated evolutionary enterprise and information systems development	Mgmt/Instr	4,5
2	Unclear relationships for management and responsibilities	Mgmt/Instr	4,4
3	Long lead time	Proc (dev)	4,2
4	Management of development	Mgmt/Instr	4,2
5	Holistic understanding, own role and that of others	Knowledge/ Competence	4,2
6	Comprehensibility (Swe: Överblickbarhet)	Mgmt/Instr	4,2
7	Commitment of overall management	Mgmt/Instr	4,1
8	Security and secrecy	IS/IT design	4,1
9	Difficulties with holism (Swe: Svårt att se helhet)	Enterp personnel	4,1
10	Complexity! Large enterprise with many involved e.g. 100 project leaders with their own priorities	Proc (dev)	4,0
11	Security aspects	Stakeholders	4,0
12	To actually achieve effects in terms of enterprise change	Task/business	4,0

From the table we can see that all statements except three, at the lower end, represent the top subject areas. Also, the top subject area Management/management instruments is represented in five rows of twelve.

The interpretation is that the average ranking score of individual statements, at large, confirms the overall indications from table 2 of subject area concern and importance of critical factors. Table 4 below presents Top-12 of individual statements according to number of highest rankings (5).

Table 4. Top statements by No. of high-ranks

	Statement	Subject Area	Number of high-ranks
1	Unclear relationships for management and responsibilities	Mgmt/Instr	11
2	We dont have a process for co-ordinated evolutionary enterprise and information systems development	Mgmt/Instr	11
3	Commitment of overall management	Mgmt/Instr	10
4	Complexity and inflexibility in legacy systems	IS/IT design	9
5	Comprehensibility (Swe: Överblickbarhet)	Mgmt/Instr	8
6	Long lead time	Proc (dev)	8
7	Guarding special preserves (Swe: Inpinkade revir)	Enterp personnel	8
8	Security and secrecy	IS/IT design	8
9	Security solutions which	IS/IT design	8

	restrain external co-operation and shared networks/IT systems		
10	Holistic understanding, own role and that of others	Knowledge/ Competence	7
11	The organizational boxes are designed first, before IS/IT possibilities are investigated	Mgmt/Instr	7
12	Follow-up (of development projects) by the enterprise is poor. Better follow-up is needed and also revision of targets along the way	Mgmt/Instr	7

The table contains those statements that got the highest critical factor priority (five on a scale to five), by seven respondents or more. The number of high-rankings also confirms the top positions of the four subjects in top in the overall ranking (table 2). Only one statement (7) is from another subject area. The subject Management/ management instruments is represented in six of the Top-12 , confirming its top ranking.

The interpretation is that there are very few statements from other areas than the top four that actually have been ranked high by many respondents, which confirms the positions of the overall top subjects.

This can not be interpreted so that all other statements are unimportant or could not be a critical factor in a specific organization or situation. Nevertheless, it is an indication of where this group of development managers thinks that the most important difficulties and problem generators are.

5. Concluding remarks

This may be a step in the search of "Why is co-ordinated enterprise and IS/IT development difficult today?". Together with the sub-sets of questions regarding; difficulties/problems and "What critical factors are generating problems in co-ordinated enterprise and IS/IT development?"

We have found that the subjects of Management/ management instruments, Knowledge/ competence, Process (development), IS/IT design are all of large concern and high importance to the responding development managers. This confirms our assumption that managerial issues rather than technical are the most important difficulties in co-ordinated enterprise and IS/IT development. The need may also increase as the need for cross-functional processes increase and the dependence of IS/IT support is intensified [20].

However, we have found that subjects with external orientation, such as Environment, Stakeholders, Task/purpose/business/objective have received little attention and low ranking with regard to being a critical factor. This indicates that our basic assumption that requirements from external stakeholders being a problematic change drivers ought to be questioned. In fact this ratings indicate that external factors play a minor role in development work in complex organisations. Nevertheless, we once again admit the ambiguity regarding Task/purpose/business/objective which call for further investigation and no strong conclusions at this point.

An initial assumption on externally set dead-lines for co-ordinated changes in enterprise and IS/IT-systems has not been confirmed although long lead-times in development work is a problematic issue.

Will this survey result help us investigate relevance of existing management theories and concepts? The list of subject areas, statements and critical factors is a result in itself. Considering size and delineation of the sample it seems a good idea to further define subjects and factors and to compare them to other taxonomies. We believe though that this set of subjects and the rankings are a valid basis for further research into an empirical and methodological foundation for co-ordinated enterprise and IS/IT development. There are research that suggests the opposite; That the solution is less co-ordination, that by introducing slack and allowing organizational drift the organization would prosper [21]. However, the reality is rather that different organizations need different solutions, at different times and the need for management, competence and process development are building blocks that matters for managers in complex organizations.

Consequently the results of this paper reflect the current mindset of development managers, i.e. what is important to them today. Therefore, there is a need also to address the issue of future difficulties and needs.

6. Further research

The above concluding remarks motivate our future research activities within the DELTA project at University of Gothenburg.

Firstly: The domination of internal subjects and the very low rating of subjects with external orientation is puzzling. It would be interesting to investigate if this conclusion is valid for complex organizations in general, and in that case the reasons for it.

Secondly: To investigate relations between the different subject areas and the potential impacts they have on each other. Furthermore, to emphasize the management actions that are put in place to deal with the existing challenges.

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Paper 2

Process Integration and Web Services

A Case of Evolutional Development in a Supply Chain

Magnus Holmqvist

Volvo and Viktoria Institute, Göteborg, Sweden
Magnus.Holmqvist@volvo.com

Kalevi Pessi

Göteborg University and Viktoria Institute, Göteborg, Sweden
pessi@informatik.gu.se

Abstract. Many situations of rapid emergence of a phenomenon are characterised by the fact that a lot of what is written and said is based on ideas, though the discussion may be flavoured by hype rather than anchored in reality - at least in the beginning. Still, there are also situations that constitute real changes. Extensive experiences from spare parts logistics at Volvo are the basis for an up-to-date view of development and use of web services.

This paper provides results and experiences from implementations of advanced web service solutions. The origin of these solutions is a desire to improve process integration between supply chain actors. Therefore, the context for business-to-business process integration between suppliers, manufacturers, dealers and customers is also presented. Focus is made on how the usage of IS/IT and management concepts can give extended reach and create closer customer relationships. It is an evolutional development that has often exploited existing strengths and timing of opportunities provided by linking technology and organisational conditions between different actors.

The case gives a perspective of Volvos global supply chain, aspects

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of its evolution and findings concerning timing, culture, installed base and stakeholder relations. The paper provides a general case to the discussion of process integration and in particular, it shares experiences and results from implementation of advanced web services.

Key words: process integration, web services, implementation, case, evolution, supply chain management

1 Introduction

New technology has always been used in order to achieve business impact, that is, to increase efficiency, enable strategic imperatives and extend reach and scope for products and services. At the same time new management concepts are continuously presented to achieve the same objectives. Some become larger in significance or faster in speed of change in the business context. Classical examples are the introduction of the power loom, the railroads, the telephone and the Internet as well as concepts and thoughts like Scientific Management, JIT (Just-in-Time), BPR (Business Process Re-engineering) and SCM (Supply Chain Management).

However, there are many situations with rapid emergence of a technology or management concept that are characterised by the fact that a lot of what is written and said is based on ideas, though the discussion may be flavoured by hype rather than anchored in reality—at least in the beginning. Still, there are also situations which constitute real business impact.

This paper focuses on process integration with development of web services in general and illustrates a case from spare parts logistics at Volvo in particular. It illustrates how the interplay between management and technological opportunities can be seen as an evolution within a large organisation. With in-depth experiences and results from the implementation of advanced web services two intertwined issues underlie this research:

- Characteristics of process integration
- Influence of the historical and concurrent context on the supply chain actors

The objective is to contribute to a better understanding of how development and usage of web services are placed into a practical context. This context can illustrate how prior integration efforts relate to each other and that it is not a case of ‘one solution for everything’. Furthermore, in order to enrich the case,

a historical background is provided. The background illuminates the influence of stakeholder relations and installed base. By sharing details and width the case presents how actors in the supply chain relate to each other and to the usage of web services, thus providing insights into current discussions in this area.

The paper will first introduce a view on technology and management, web services and spare parts logistics. Then the need for this research will be motivated and followed by a presentation of the research method. The case will initially provide a historical background that highlights parts of the evolution for integration. Then web service implementations will be discussed and analysed in relation to each actor in the supply chain. The paper ends with concluding remarks and further research.

1.1 Technology and Management

Current technology provides new possibilities for networks, the distribution of information and the design of business logic. An array of digital products and services is brought into the markets. This is combined with an increasing use of the Internet, more open standards and new mobile web technologies. The trends of globalisation and deregulation are equally important. The recent commercial behaviour has commonly been referred to as an era of "e-" where e-business, e-procurement and e-logistics often implie quite radical changes (Kalakota and Robinson 1999; Bayles 2001). Competition drives resource optimisation and standardisation for economies of scale on one hand. On the other hand, business innovation contributes to differentiation. Managers need to confront both of these and have to consider several critical factors, for example if new concepts and/or technologies can actually be utilised with effect or if they are more temporary (Holmqvist and Enquist 2003). This may be difficult since new trends and technologies are often presented with a lot of hype and simplifications, especially in terms of their implementation, e.g., BPR and PC-introduction (Strassman 1990; Hammer and Champy 1993).

Web services are currently being widely presented and to give a universal definition of web services is not easy. This paper draws upon the W3C technical reports from 2001 and joint presentations of Microsoft´s Bill Gates and IBM's Steve Mills (17 September 2003) where web services are used: "For specifically distributed services that process XML encoded SOAP messages, sent over HTTP, and described using Web Services Description Language (WSDL)" (Christensen et al. 2001; Ferguson et al. 2003). Though the objective of this paper is to share experiences rather than to sharpen technological

definitions, figure 1 below depicts a good view of current areas of interest for advanced web service development.

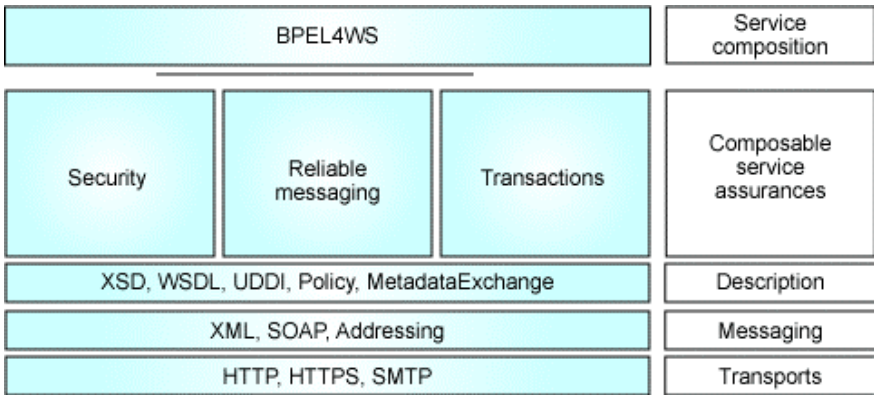

Figure 1. Web service groupings (Ferguson et al. 2003)

Web services deliver message interoperability and interface exchange. It may be simple, stand-alone connectivity or complex transaction chains that need to address security, reliability, versioning and business process activities. The composition of services provides interoperability between software components and support integration activities. In one way it is a collaborative result of underlying concepts that date back to the 1970s, when the thoughts of boundaries around software and providing access to that software only through well-defined interfaces arose (Jackson 2003). This concept of encapsulation can now use guidelines of web services to develop, deploy and maintain a service oriented architecture that fits in loosely coupled and ever changing business conditions.

Speed of change is important and Orlikowski (1993) discusses types of changes as: "Incremental change represents an extension of the status quo, that is, adjustments or refinements in current products, practices, relationships, skills and norms. ... Radical change goes beyond augmenting the status quo, requiring a shift to fundamentally different products, practices, relationships, skills and norms" (p. 331). In operations with an installed base of IS/IT-intensive operations, such as logistics, it takes time to change existing structures and it may be risky (Henderson and Venkatramen 1993; Lumsden 1998; Ciborra and Hanseth 1998; Holmqvist et al. 2001; Howard et al. 2001). Therefore, it is worthwhile to review events in this specific context in order to illustrate how management concepts and technologies have been applied.

1.2 Spare Parts Logistics

Large vehicle manufacturers have traditionally come to play a major role in the after market supply chain (Jones et al. 1990). The role originates from the control of product development and sourcing as well as influence upon the distribution network, dealers and customer offer. This has contributed to a two-fold perspective of Inbound and Outbound logistics and an urge to integrate partners along the value chain in order to reach efficiency (Porter 1985; Motwani et al. 2000). The vehicle manufacturer has led the development and been seen as the major hub of the supply chain—controlling the flow of goods, information and financials towards suppliers on one hand and towards customers on the other. Not least, the complexity of the products and a lack of information transparency have contributed to a situation with stable relationships between different actors in the supply chain (see figure 2).

From the perspective of the Vehicle manufacturer, the Parts manufacturer represents the supplier from which spare parts are bought. Equally, Dealers have been the actor that buys spare parts from the Vehicle manufacturer and then sells them on to vehicle owners. Therefore, vehicle manufacturers refer to vehicle owners and operators as End-Customers.

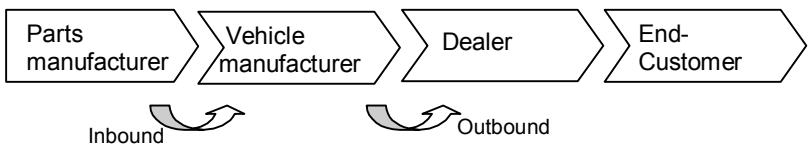

Figure 2. Current supply chain actors.

The fierce competition in the transport sector pushes business-to-business relations to focus on bottom-line results in a reality of diminishing margins. This at the same time as exploiting core competencies and finding new business propositions seem even more important. With high volume flows of physical goods as well as many stakeholders of information, logistics is by many means growing into one of the most complex business functions (Ericsson 2003; Lumsden 1998). The rise of the Supply Chain Management area, systems and consulting is one example of this development.

To out-line strategies which involve highly dynamic factors is difficult, management must often act in a situation where control of operations and technology is drifting (Ciborra 2000). Multiple interrelations on one hand and significant differences between actors on the other hand are a common situation in the field of logistics. ‘Agile logistics’ is a concept that has been used to

describe as a strategy to meet this situation by introducing some slack to increase flexibility (Christopher and Towill 2000; Ericsson 1996; 2003). In this sense there is a similarity and natural attraction to the loosely coupled architecture that surround web services.

1.3 Justifying a Practical Case

This paper is anchored in the business context of spare parts logistics at Volvo and one of its objectives is to describe the case environment. With results and experiences from the implementation of web services the importance of relationships between actors are highlighted. An extensive practical case may illustrate how both management and IS/IT issues as well as the operational context play an important role for integration. In many ways we need better explanations, as Monteiro states: "A more satisfactory account to the interwoven relationship between IT and organisational transformation is lacking. More specifically we need to learn, not just that this interplay exists, but how it works" (Monteiro 2000, p. 74). Most theoretical frameworks (independent of whether they contain detailed or broad argumentation) deal with issues like implementation or integration quite commonly without providing examples and insights from a context where these issues are confronted.

In a special edition of MIS Quarterly this discussion is highlighted at length and for example does Tom Davenport together with Lynne Markus argue that more case material is essential to make IS/IT research more accessible to professionals (Davenport and Markus 1999). There is little literature on IS/IT in logistics and even less in the field of spare parts, despite the facts that it constitutes a major share of transactions in the automotive industry (Tilanus 1997; Bayles 2001).

Actual implementation experiences and results from advanced web services are so far scarce. The commercial value and interest is vivid. An example is that IBM is using one of the implementation projects that is included in this research as a 'Case study' for Web Services as well as presenting it in the 'Company of the month' section[1]. Still, in many ways it presents a simplified and commercialised view of the objective, the implementation and not least the origin. This paper provides a background that may illuminate how recent results are part of an evolutionary development of integration while it also presents specific characteristics of web service implementation, for example where in the supply chain it can be most appropriate to develop web services.

1.4 Research Method

The Volvo case environment has characteristics in terms of size, scope and content to become relevant (Yin 2003). Through in-depth knowledge and open access the aim of this research is to share context in order to contribute to a discussion on IS/IT-management issues. The first author of this paper has an extensive background within Volvo and may thus enhance the relevance to practice. There is a main advantage to have extensive access to the case context, something that is crucial when studying complex situations that need comprehensive descriptions.

There are basically two parts of this research: one part provides a historical view of the development at Volvo from a perspective relating to IS/IT usage and process integration, and one part based on a case study that has been conducted in conjunction with specific implementation projects with web services.

The objective with the historical view is to share the context and show how general developments of IS/IT and management concepts have been applied by Volvo. This is made in alignment with the contextualisation principle of Klein and Myers: "The contextualisation principle requires that the subject matter be set in its social and historical context so that the intended audience can see how the current situation under investigation emerged" (Klein and Myers 1999, p. 73). The historical view was created through interviews and collaboration with six key people. All together these six people represent more than 200 man-years of Volvo experience.

They represent the management positions of: CIO, Warehousing, Strategic management, Distribution, Finance (four are today active, two are recently retired but active in teaching at the IT-University in Göteborg). Section 2 of this paper was, prior to submission, also 'proof-read' by these six people. There have been no objections, which would indicate that the description of the context environment would impact the research rigor, instead the objective is to enrich the case (Yin 1984; Applegate 1999). Furthermore, reviews of company documentation validate descriptions of especially ERP and Importer integration efforts, e.g. white books and operational guidelines.

The second part of this research concerns the study of four implementation projects:

1. Establishing platform and approaching Truck Dealers and End-Customers in selected European markets.
2. Refinements for Bus Key Customers and stand-alone Truck importers.
3. Developments for Truck Dealers and End-Customers in Asia and East Europe.

4. Single Order Interface for Construction Equipment Dealers.

The first specific web service implementation project for this case originated in late 2001 and the latest implementation (4th project) was deployed September 2003.

The methodology basically involves interpretive case study (Walsham 1995), where in-depth access to the case has been facilitated through the IS/IT manager position that the first author has at Volvo. Walsham has described how the topic of interest is in focus for exploration (In this paper: process integration and web services) and applies appropriate methods for conducting a research project based on this. In this case the data collection has mainly been carried out through observations, semi-structured interviews and workshops with stakeholders, decision makers and designers/developers.

All implementation projects have involved interviews with the Steering Group chairman, the Project Sponsor and the person in charge of the pilot site (these represent the CIO, the After Market management, the Dealer principal or equivalent). On several occations other representatives have been interviewed in order to include all supply chain actors. User feedback from each implementation project has been collected and analysed. As projects have been deployed, the first structured feedback has been conducted via a user satisfaction survey after three months and then continuously executed. Specific user interviews, phone interviews and user group workshops have been conducted (for example on: Access and Security with Single Sign-On and Application-to-Application services; Multi-language standards and Service design). Two master thesis studies have also contributed with user impressions from three of the projects.

It may be argued that case studies in general lacks replicability, that generalisations are difficult to make, that self-critisism is omitted and that the research rigor may be easy to question.

However, the main objective of this case is to increase the understanding of process integration and web service implementation by sharing experiences of a practical context. The research in this paper is based on collaborative involvement and together with a rigorous process the objective is to provide contributions to both organizational development and scientific knowledge (Braa and Vidgen 1999).

This paper will now provide a view of the evolution of integration through the Volvo spare parts supply chain. Thereafter, the paper presents current developments and web service implementations together with a discussion. The paper elaborates upon experiences and implementation results before concluding remarks are presented.

2 Case History: Evolution towards End-Customers

Volvo is a world-class provider of transport solutions, services and products. With global presence and sales exceeding 185bn Sek its more than 75.000 employees focus on business-to-business operations in the areas of Trucks, Buses, Construction Equipment, Marine Engines and Aerospace. Spare parts logistics is a complex operation characterised by intensive information exchange between several stakeholders, in the case of Volvo 1.000s of suppliers and 10.000s of distribution points towards 100.000s of end-customers. Every day ('365&24/7') around 70.000 order lines are handled towards more than 185 markets. The industrial product families contain 100.000s of parts, which demand both a long-term service responsibility and management of complicated supersession chains. The "parts" also increase in complexity, as they are no longer just physical but also digital as well as part of service arrangements and wider business solutions.

In many ways any case description of the context for global business-to-business spare parts logistics is doomed to be a shortcoming. Nevertheless, table 1 is just an initial view, while elaboration below may illustrate the continuous development of integration and expansion of operations.

	1970s	*1980s*	*Early 1990s*	*Late 1990s*
Example of change at Volvo	Automating stock control	Establishing market set-ups	Consolidating accounting	Reaching End-Customers
Base of change (Volvo/Actor)	Integration within Head-quarter	Integration with Importers	Integration with Dealers	Integrated supply chain towards End-Customers
Volvo characteristics (change driver, culture and organisational focus)	Get statistics to secure quality, Central logistics function, Founder management	Growth and cooperation with Renault and others, Conglomerate business, Strong CEO	Consolidation, Back to core competence, EDI with suppliers, VMI with dealers	Merger expansions, Centres of excellence, Value added services

Table 1. Volvo historical case characteristics and context

Logistics focus	Production	JIT	3PL outsourcing	"e-logistics"
Management trends	Automation, origin in Scientific Management	Internationalisation and decentralisation	Business Process Reengineering	Globalise and customise SCM, CRM
Technology	Mainframe	Client/Server	ERP modules	www / "e"
Macro environment	Oil crisis, restrictions, GATT rise	Boom, deregulation, Japan productivity increase	Recession in estates, Europe's common market	Boom, Merger & Acquisitions, Innovation and mobile communications

Table 1. Volvo historical case characteristics and context

2.1 The Seventies

Volvo had more than 40 years of experience of manufacturing vehicles when, during the 1970s, the use of information systems started to evolve. The after market population, both in terms of population size and range, was considerable. Hence, as computerisation possibilities emerged, one of the first areas to reap benefits was the control of stock balances in order to maintain quality. The management was still much influenced by the two Swedish founders and managed from its original domains dominated by production facilities. A clear break-point for the development was the introduction of mainframe technology, however, limited to a certain area. What was really achieved was automation, instead of keeping logbooks, doing manual recounts, awaiting status etc the first computer could programmes released resources at the headquarter giving possibilities for further expansion and internationalisation.

A former CIO, working with stock balance administration in 1977, recalls that: "The introduction of 'Quantities On-hand' made it possible to re-organise a whole working group, a basic sales support was built-up."

In the beginning, importers were mainly ad hoc set-ups of an entrepreneurial spirit, which helped establishing market presence. These have then transformed into sophisticated systems for after market services. Of course, this was due much to utilising technology that it became possible (from the headquarter's perspective) to embrace and integrate information further out in the supply chain, i.e., as close as possible to the original information provider.

2.2 The Eighties

Fast build-up and international establishments created diversity and decentralisation. This happened although management trends of JIT advocated coordination and Client/Server technology could have provided central control. JIT influenced the production systems at Volvo but as spare parts logistics is dominated by higher volatility new system functionality focused on handling of further volume increases and the establishment of importer systems. The Operational Guide from 1986 describes VIPS (Volvo Parts Importer System) as: "VIPS manages the parts business and warehouse administration of the market company/importer. It is built on modern client/server technology. The applications are continuously developed, improved and maintained in order to support the distribution structure as well as business- and service level demands. The systems are extensively integrated with central functions and support warehouse." This highlights the process integration between the headquarter and importers.

Overall, the Volvo Group expanded and at times the group was a wide-ranging conglomerate with Pehr Gyllenhammar as a strong CEO. Some grand attempts, like VIS (Volvo Integrated Systems), were started with the objective to deliver very comprehensive process integration but simply had to be abandoned due to a lack of relations between actors as well as due to technical incapabilites. However, relationships grew stronger between spare parts importers and the headquarter, which was a pre-requisite for gradual system and supply chain integration.

2.3 The Early Nineties

During the early 1990s, fast growth together with a tougher business climate had made times right at Volvo for greater rationalisations and improved control. Furthermore, the ERP (Enterprise Resource Planning) and BPR trends were dominating the scene. However, neither has given that radical 'business impact' that it was often labelled with. At Volvo, it is possible to show that both ERP and BRP have rather been used only in certain areas. Of course, some internal pre-studies as well as management consultants suggested complete changes of the systems structure and radical redesign of processes.

Nevertheless, considering the amount of stakeholders, the amount of transactions, the wide-spread and in many areas decentralised functionality that made up the Volvo after market it would have been a too large area to change all at once, not the least because there were serious considerations about the business risks. Furthermore, ERP and 3PL (3rd Party Logistics for outsourc-

ing) providers were at this time not able to support the special characteristics of state-of-the-art spare parts logistics.

Instead, it was in one of the non-core processes, accounting, that the ERP modules from SAP R/3 were introduced. At the same time as international relations were maturing towards the importers, there were also opportunities for both rationalisation and improved control. Common ways of working could be introduced with one system consolidating the whole chain, however, just with regard to financial transactions. Even if it was limited to the accounting area the Volvo Group ERP project was still one of the largest projects in the administrative area with both pros and cons among the lessons learned. Characteristically, an extensive white book (internally published with paper back) relates to "… integration work during the implementation phase required 30% more than estimated. Several times it could possibly have been better to scale down the ambitions. The scope was sometimes so large that it was difficult to comprehend and implement good solutions." Still, as mentioned, this ERP project was only concerned with the financial modules.

At the same time, after market management drove both overall business consolidation and system integration with suppliers as well as emerging towards dealers. With suppliers it was mainly EDI but with dealers thoughts and practice of the extended enterprise grew, for example through the introduction of VMI (Vendor Managed Inventory).

2.4 The Late Nineties

Seen as a whole and over a 30-year period one can discern a large difference, with a much larger, international company, with growth phases leading to diversification but in certain areas again becoming centralised. It is a perpetual and incremental shift towards End-Customers, accomplished when culture is ready and technology available. The late 1990s has been characterised by further globalisation and mergers together with an upswing in innovations and utilisation of communication technologies. In the case of Volvo, cooperation with Mitsubishi, Schmitz and Renault/Mack has either been intensified into mergers or dis-invested. Better process understanding and established relations as well as the *de facto* spread and adoption of web technologies have provided opportunities for further integration along the supply chain. However, challenges in terms of scale and scope of operation have been larger than any technical obstacle.

Consequently, the largest transformation demand has concerned adaptations within existing legacy systems. Again, these practical restrictions have only made gradual changes possible.

To address the organisational complexity one step that facilitated a comprehensive overview (during a growth period) was the creation of a centre of excellence for spare parts logistics. Furthermore, value added services such as call centres and diagnostics with the help of telematics have been recent examples from Volvo in the process of evolving towards End-Customers.

2.5 Thirty Years of Evolutional Systems Integration

Given a brief historic view of the integration efforts at Volvo, section 2.5 will summarise parts of this evolution of developments. This will provide a basis for the discussion and analysis of web services implementation projects that will follow in section 3. With this span of time it is essential to both depict unquestionable facts and interpret the stories that the organisation culture shares through artefacts (Dahlbom et al. 2002). Consequently, it is essential to be aware of the fact that the case can only convey simplified parts as illustrative explanations. It has been an evolution especially by means of an increasingly integrated supply chain as conceptually illustrated in figure 3 and described below. It depicts how Volvo has evolved focusing on the outbound relations. Of course, inbound relations towards suppliers have also developed, with more than 80% of purchase value being handled electronically already in the 1980's and currently reaching above 95%.

The system platform originally handled only internal transactions, exemplified as; "once shipped to France, it became the problems of the French importer". However, during the "era" of client/servers, importers were integrated into the in-house developed logistics systems platform through implementation of local systems connected to the central platform. Coinciding with this technology shift was a time of general internationalisation and decentralisation (Johansson and Vahlne 1977). Even though it was decentralised in many ways it became possible for Volvo headquarters to capture the information and over time build-up a knowledge that could influence the importers in a new way.

To refer to an "era" of technology may be misleading and it is important to bear in mind that it is equally adequate to refer to: an affordable cost for development of systems, the possibility to provide tools such as Terminals/PCs or that the introduction of new technology not exclusively replaces the existing technology. It is also relevant to see what sort of architecture and what possibilities there are for change (Magoulas and Pessi 1998). And not least important is the ability to extract as well as to understand the value of integrated operations through a common platform.

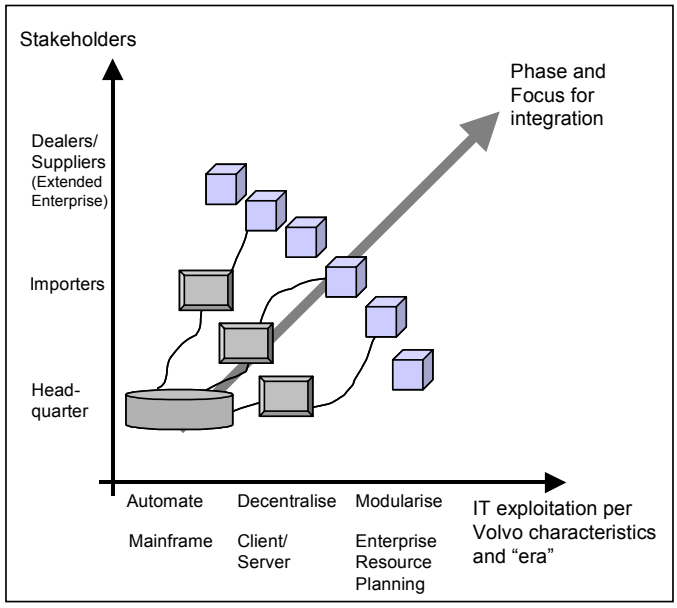

Figure 3. Evolutional systems integration

Alongside with growth of ERP providers, modularisation and customisation have been driving forces for further integration. The use of standard packages may reduce the need for in-house development and resources can be used for other purposes or with the objective of saving costs. There are advantages of integration and enterprise wide collaboration as well as inter-organisational cooperation for example with 3PLs, however, the lock-in effect, risks and conflicts in business interest is also considerable (Ciborra and Hanseth 2002; Holmqvist and Enquist 2003). The boundaries of the organisation have become more fuzzy and in some ways the term Extended Enterprise is relevant as parts become not only out/in-sourced but advanced forms for business transactions have evolved gradually as relations mature (Malone et al. 1998; Slywotzky et al. 2000).

In section 3, figure 3 will be further expanded to incorporate the integration towards End-Customers as a way of introducing specific experiences from web service implementation projects in relation to the supply chain actors.

3 Case Analysis: Implementations, Web Services and Relations

Currently, there are relatively affordable, transparent, simple-to-access and real-time on-line solutions. Management concepts suggest that Supply Chain Management is about seamless links and collaborative replenishment. Web service technology delivers a more loosely coupled integration form than earlier integration architectures. In highly heterogeneous distributed environments this is beneficial but also provides new challenges.

This section will first outline a conceptual view of the integration process within Volvo after market and then focus on experiences from four web service implementation projects. These will be discussed together with main issues and alternatives by presenting the context for each actor in the supply chain. This will provide integration process characteristics as well as present how each supply chain actor has been influenced by the context.

3.1 Integration towards End-Customers

Figure 4 builds upon figure 3 and embraces the reach towards End-Customers. In order to benefit from improved order behaviour in the supply chain as well as to reduce inventories it is necessary to have relevant information from the supply chain actors (Holten et al. 2002). However, it still takes a long time to build relations with trust enough to let partners control stock levels and reach agreements on how to handle shortages as well as surpluses. Similarly, no matter how quick XML and WSDL standards are to comprehend and set-up, different parties must still decide upon how to work and how real-time access is to be supported by underlying data input (Weitzel et al. 2000). Nevertheless, a main feature that is challenging the existing structures is a shift from major cost focus towards higher flexibility and increased networking. There is a need to change from solely focusing on lean resource utilisation to becoming agile, since the further out in the supply chain one reaches the higher the volatility (Ericsson 2003). Individual order volumes also become smaller closer to the End-Customers, since the former consolidations of volumes (buffer stocks) are eliminated.

Expectations from End-Customers have grown with improved access and information availability, caused by the broad reach and the universal usage of Internet. New requirements upon support and response occur, for example End-Customers more commonly expect round-the-clock service. As opportunities increase in terms of availability new demands are created for scalability.

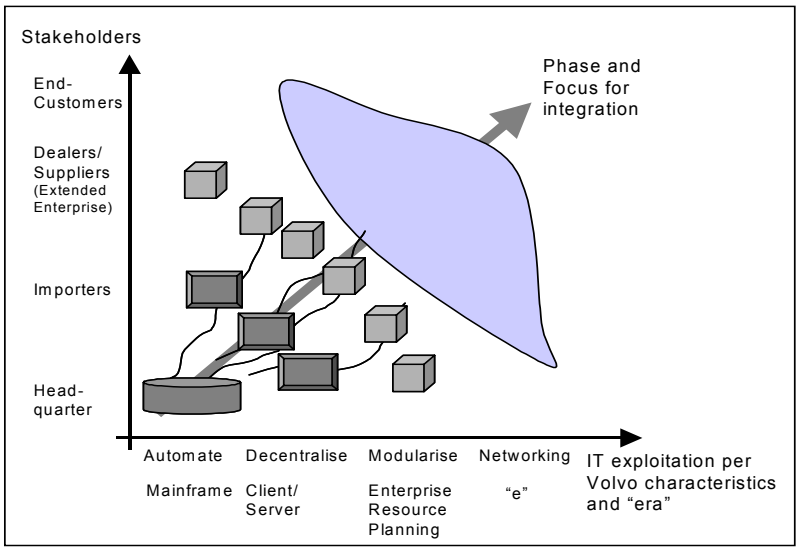

Figure 4. Integration towards End-Customers

Even if there are de facto standards and transparency between platforms there are also a number of practical obstacles in distributed technologies. The opportunities of getting the customer order point closer to the source give rationalisation gains through placing information input at the source which in turn allows automatic inquiry possibilities (self-service). However, obstacles that were formerly eliminated through central (and time-consuming) roll-outs now re-occur as End-Customers may experience problems due to differences in process and activity design, message broker and browser engines, character recognition, security protocols, connection speeds and ISP of various quality.

Volvo has been working on implementing concept offers and web services in accordance with creation of value chain scenarios as outlined in (Holmqvist et al. 2001) in order to meet different requirements thus being able to differentiate the level of integration depending upon relationship. The existing business context consists of four rather clear-cut organisational relations, which have also created the set-up of current logistics solutions (As seen in figure 2 and 3). However, this structure is challenged in several ways, for example by its actors, management consultants and by opportunities in technology. This section will discuss implementation characteristics per supply chain actor. It

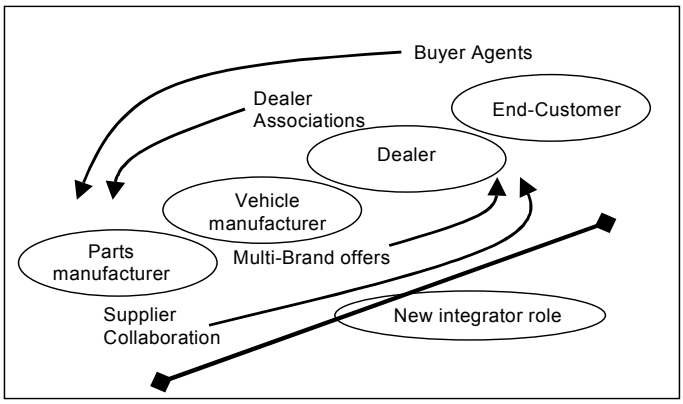

Figure 5. Supply chain actors and alternative relations (building on figure 2)

will also outline integration efforts and relations between actors in the supply chain (see figure 5 as building on figure 2).

The stability between the existing players also opens up large opportunities for a new integrator role that can exploit the situation. It could be set-up by an existing player or by a new entrance, independent or in alliance, "e-Mediator.com" (EIS Survey 1999). A start-up, in the form of an e-Mediator, provides an opportunity to exploit selected segments and focus on attractive high-margin services (Rayport and Sviokla 1995). It can also start with state-of-the-art technology, web service compositions and design processes without any heritage from installed base or inflexible legacy systems. However, it is not possible to neglect the strong requirements that End-Customers have in order to optimise their operations. To a large extent those requirements connect to physical locations and objects.

Major issues relate to; Requirements upon availability of spare parts that optimise service level and costs, Requirements upon service points that are "on the way" hence creating large variations in the flows due to mobility (since vehicles may break down anywhere), Requirements upon tools that can handle the increasingly complex trouble-shooting to find problems in vehicle configurations, Requirements upon highly-skilled technicians that can optimise vehicle productivity and provide professional as well as flexible administration dependent on the terms of interaction. Finally, it would also require a substantial purchase volume before a new actor would get actual discounts on purchase from parts manufacturers. Existing initiatives, in form of basic spare parts web portals, have so far not impacted the market in a considerable way

and there have been no practical interactions in the web service solutions, which has been implemented so far.

3.2 Parts Manufacturer

The circumstances, which make it worthwhile for parts manufacturers to restructure the existing supply chain relationships, relate to their ability to join together to form attractive offers for End-Customers by for example creating supplier portals enabling integrated relationships. Their objective would be to exploit higher margins by reducing the number of actors in the supply chain for after market products. Vehicle manufacturers are increasingly placing their product development at system suppliers (i.e., systems in the sense of a complete axis, air condition etc.) rather than development and supply of isolated parts. This has created different perspectives upon and possibilities for sourcing.

Suppliers are becoming large, consolidated, global and increasingly interested in getting closer to the Dealers and/or End-Customers of their products. Nevertheless, it would be a tremendous change to transform into managing interactions and operations with 100.000s of End-Customers compared with the current situation of a small number of vehicle manufacturers. Furthermore, such a transformation may risk the existing relation with vehicle manufacturers. Introductions of Key Customer Accounts and support from CRM techniques would be pre-requisites for adaptation of the logistical set-up.

However, there is a very heterogeneous structure and multiple segments among the parts manufacturers that need to join together and meet comprehensive End-Customer requirements in logistics (1.000s of different suppliers to the after market for each product family). The experiences of supplier collaborations are so far relatively scarce. There have been contacts in the last implementation project with selected suppliers to provide web services for Direct Deliveries. However, the current results are excluded from presentation in this research. Nevertheless, as opportunities emerge vehicle manufacturers need to also consider in which way supplier relations will exist with End-Customers.

3.3 Vehicle Manufacturer

One of the main strategic choices for a vehicle manufacturer concerns the possibility of providing after market offers for other than their own manufactured brand, in other words, to become a multi-brand provider. These opportunities are increasing as the number of standardised spare parts are growing (ie same spare part fits to several brands). In the USA, multi-brand transactions already

constitute a large share of the business. In the EU there are recent legal changes, regarding Block Exemption regulations, that promote similar conditions to those that exist in the US market[2].

Segmentation of the range of service and parts is a key issue in terms of providing comprehensive logistics and probably the best opportunities are to exploit high-frequent, easy-to-fit and fits-all parts.

The most probable change of the existing supply chain is that a vehicle manufacturer takes on a new integrator role for multi-brands in order to serve more dealers and End-Customers. However, there are also risks with a venture that would alter existing stability, such as brand image impact. There is also increased complexity in handling multi-brand due to wider information and product distribution. Current implementation projects have directly avoided deploying web services that include multi-brand capabilities but have readiness to exploit possible business opportunities.

The implementation projects at Volvo have developed web services for a service oriented architecture providing 'publish-and-subscribe' possibilities for different actors based on business roles and relations. The Volvo implementation projects have used web services for interface exchange and interoperability. This has started with simple, ad hoc application services and ranged into large-scale efforts that manage complex transaction chains. The latter focuses on business process activities with major issues on: versioning, security, reliability and synchronisation. Concurrently, web portal services are providing user interfaces into different business portals. An example of a screen shoot is attached below, see figure 6.

The web services that currently exists in the area of spare part logistics can be divided into three main categories: Find parts, Order parts, Use parts. These categories contain multiple services and service compositions for example: Find part in catalogue, Get customer status, Place order, Get order status, Get order status part detail, Parts master and Supersession master, Invoice workflow set-up and Vendor Managed Inventory set-up.

3.4 Dealer and End-Customer

The decreasing barriers of entry, in terms of access to information and collaboration costs, enable dealers to form associations and directly approach suppliers in order to cut layers in the supply chain. Dealers own much of the End-Customer relation and have local presence as well as the competence to provide service. However, the traditional barriers of entry tend to be lower the further out in the supply chain one gets due to lower operational complexity as well as lower capital requirements. Consequently, there is an over capacity in

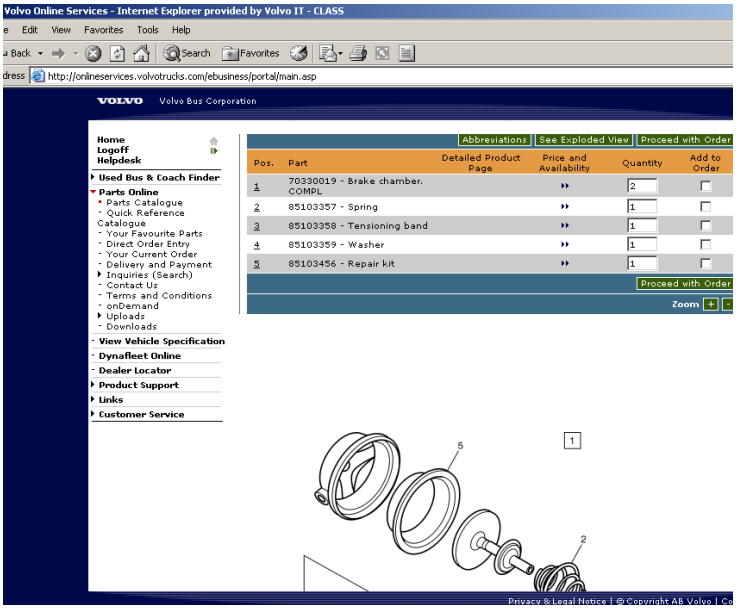

Figure 6. Example of web portal screen

the dealer structure, fierce and heterogeneous competition, and this results in lack of cooperation together with financial weakness. This makes it less probable that dealer associations will become a dominating force of development. On the other hand there has been a great interest and appreciation for the web service initiatives that Volvo has introduced. Especially among technology mature dealers there has been efforts to meet up and make adjustments to benefit from integration of the services. As opposed to earlier solutions it is not 'all or nothing', the flexibility has proven to be a good enabler for faster roll-out with focus on roles and relations (See figure 7 as an example from internal Volvo presentation). The largest obstacles among dealers have been in terms of competence, financial capability and time/priority for these activities in relation to daily operations.

In the same way, the probability of effective formations of End-Customers into buyer agents directly approaching suppliers is less likely to happen than other scenarios.

This is mainly due to the existing heterogeneity, fierce competition and the domination of small-scale operations. Consequently, End-Customers are more frequently users of web portal services. The exception is, of course, mega-cor-

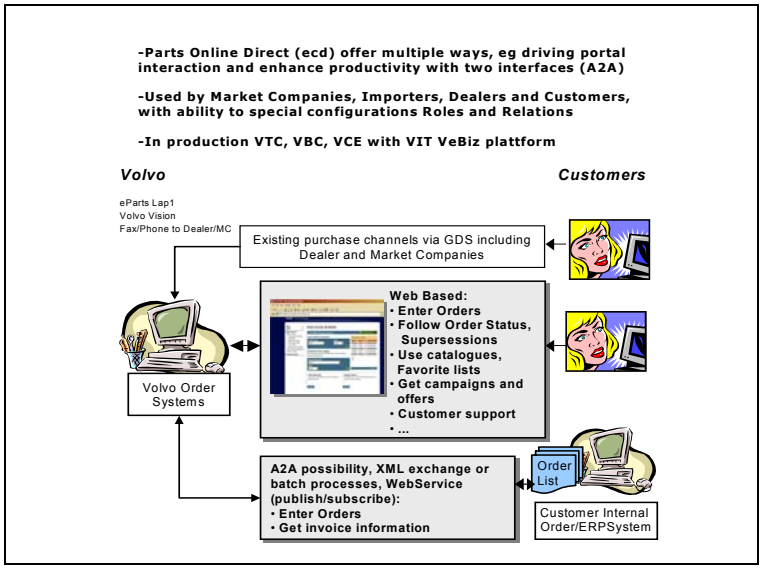

Figure 7. Example from Volvo internal presentation of web services.

porations (such as Key Customers) that already largely influence the logistic set-up and relations within the generalised supply chain described above.

Key Customers represent an important part within the End-Customer segment. Several Key Customers have been interacting intensively in the web services area. Sometimes they have their own initiatives to which Volvo has adapted, sometimes they participate in partnership developments (delivering e.g., invoicing flows and advanced application-to-application features) and sometimes they enter as subscribers when the services have been deployed. The second implementation project focused on Bus Key Customers and confronted many of the challenges with the synchronisation of processes. Bus Key Customers are often very large organisations with operations in many fields and an installed base of legacy systems.

Furthermore, in the fourth implementation project (the first in the construction equipment area) there has been a build-up of experience to confront a very complex and heterogeneous business structure. Consequently, the scope of web services for the construction equipment set-up initially excluded catalogues and invoicing services and focused on providing process integration into a Single Order Interface (See figure 8).

The Single Order Interface has capabilities to synchronise order process events though underlying legacy systems may have very different restrictions,

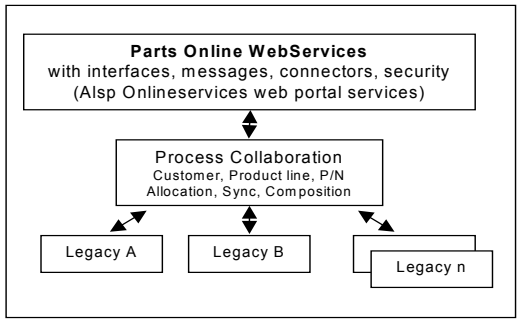

Figure 8. High-level structure for Single Order Interface and process collaboration

for example in terms of warehouse allocation, freight conditions, order priority handling, service composition etc.

This case has also gained commercial recognition by for example IBM (as referred to earlier, e.g. presented as 'Company of the month') but this would not have been possible without prior platform and project implementations.

To conclude this section table II below gives a high-level overview per implementation project. It shows the lead-time, development efforts, result achieved, target groups and services for each project. The development efforts (cost, resources, competence etc) are expressed in relative size compared with the first implementation project, i.e. the platform project. Results achieved are expressed as the relation between expected and delivered business value.

This means what has so far been achieved in relation to the expectations on what the project should deliver, for example: building the platform was more difficult than expected and the number of End-Customers that would connect was over estimated—Project 1 (0,5). East Europe roll-out resulted in a very quick, simple and beneficial adoption, thus delivering much more value than expected—Project 3 (2). Simplified one can say that the first project under-delivered relative to its expectations, and the third project over-delivered. The

target groups and main service content and functionality are also outlined in a summarised view.

Implementation project #	*Lead time*	*Development effort*	*Result achieved in relation to expectations*	*Target group*	*Services (content and functionalities)*
1	>1 yr	1	0,5	Selected Truck Dealers and End-Customers in some EU markets (small vol/site)	Establishing platform. Mainly web portal services; • Catalogue • Price & Availability • Order parts • Order history
2	6 m	1/5	1	Bus Key Customers and stand-alone Truck importers (large vol/site)	Many catalogue selections Publish/subscribe of web services; • Invoice • Order handling
3	3 m	1/20	2	Truck Dealers and End-Customers in Asia and East Europe	Service composition; • Advanced supersessions • Importation data • Service instructions
4	6 m	1/5	1	Construction equipment Dealers	Mainly web service development; • Single Order Interface • Allocation rules • Process synchronisation • Security

Table 2. High-level summary according to implementation project

4 Concluding Remarks

The objective of this paper is to contribute to a better understanding of how the development and use of web services are placed into a practical context. The practical context can illustrate how prior integration efforts influence each other and that it is not a case of 'one solution for everything'. In a way, integration has always been on the agenda in spare parts logistics and in the case of Volvo the last 30 years can be seen as an evolution.

The case illustrates the need for installed platforms to build further development upon. This implies that initial efforts are mainly establishing a base that further implementations can utilise. The integration process is characterised not only by a technical platform but also by a basic understanding for and handling of relations between different supply chain actors. It seems to a large extent to be a question of relation timing, i.e. to match management ideas and technology and continuously assess risks. It is clear that the further out in the supply chain, the more heterogeneous conditions are. The loose coupling of web services has therefore shown to be beneficial. So far the implementation of web services has proven to be fruitful in several integration efforts, but it is not less crucial to assign competence, have financial capability and work gradually.

Global spare parts logistics with large volumes, a considerable installed base and a dependence on economies of scale have provided a pressure to improve performance as well as to be innovative. Still, despite this, in the light of industry maturity and competition, it is difficult to achieve radical changes. Instead, it is important to apply opportunities where they fit and are applicable rather than to believe that there are 'everything/everywhere solutions'. Development projects need a size that is possible to comprehend and in that way increase possibilities to influence implementation results. This may especially be the case since scope may drift due to different objectives among the supply chain actors.

An integration process that is characterised by several implementation projects where each one has clear target groups and can re-use the platform and web services is clearly beneficial. Initial work with scenario development may prove more fruitful than trying to make detailed development plans. Large leverage of results can be achieved through a sequence of tight follow-on projects, rather than having single and large-scale projects with larger scope. Evolutionary development seems to require persistence and an ability to handle mismatch between IS/IT and business structures. Even with an awareness of that it takes time to change, it is equally important to regard and assess how different actors can act upon available opportunities.

The influence of the historical and concurrent context on the supply chain actors plays a vital role. It seems as though the Vehicle manufacturers will still dominate the scene for spare parts logistics although there is no clear evidence. Consequently, they will continue to drive how web service developments are applied in this sector. At the same time, it will depend on their continuous ability to deliver operational excellence and superior information availability, since supply chain actors are challenging current relations. However, strong End-Customer requirements and complex product and business structures make it less likely that a completely new actor will enter the scene to successfully take on an integrator role. It does not seem likely that such actors will become strong enough to influence the forms for web service content and functionality.

Parts manufacturers are likely to be active in the after market, not least in examples of direct deliveries to Dealers and End-Customers. Dealers and especially large End-Customers will continue to be important actors, mainly as subscribers of web services. Integration with smaller End-Customers has been more difficult than originally estimated.

Finally, considering the characteristics of the integration process in large-scale spare parts logistics changes will not take place in any radical way. Overall integration takes time, often longer than expected. It is a question of how valuable improvements can be made and how integration may change relations influenced by management and technology. Current use of web services has proven to be successfully applied in supply chain areas that are close to End-Customers, but less used for internal applications. By sharing actual case characteristics the aim is to contribute to discussions and further research as well as spread an interest for research to practitioners.

Notes

1. http://www-306.ibm.com/software/ebusiness/jstart/casestudies/volvo.shtml.
2. http://europa.eu.int/comm/competition/antitrust/legislation/.

Acknowledgements

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Paper 3

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Authors:

Magnus HOLMQVIST
Viktoria Institute, Department of Informatics, University of Gothenburg, SE-412 96 Gothenburg, Sweden, Tel: +46 31 765 0120, E-mail: Magnus.Holmqvist@volvo.com
Ola HULTKRANTZ and Gunnar STEFANSSON
Department of Transportation and Logistics, Chalmers University of Technology, SE-412 96 Gothenburg, Sweden, Tel: +46 31 772 1333/ 5157, E-mail: OHz@mot.chalmers.se and
Anders WINGQVIST
Department of Transportation and Logistics, Chalmers University of Technology, SE-412 96 Gothenburg, Sweden, Tel: +46 31 66 52 26, E-mail: Anders.Wingqvist@volvo.com.

Title:

The logistical consequences of e-commerce - theoretical scenarios for spare -part distribution

Abstract:
In this work, some of the logistical consequences of the development of e-business and ecommerce for physical products have been examined. The method applied incorporates a theoretical study of the consequences in the areas where the movement of physical goods has mainly been affected and the associated problems analyzed. The study of the theoretical framework constitutes a basis for further investigation of the effects in a practical context. To study this, an analysis of the spare-part distribution of the Volvo Corporation has been carried out.

The analysis was based on existing supply chains and scenario development for how the distribution may evolve when affected by future implementations of the e-commerce concept. This was done in terms of the relation between the product flow structures and the information systems, location of inventories, and changes in customer relations. Empirical evidence was collected from face-to-face interviews with both Volvo and independent truck and spare-part dealers and transport operators, with the aim of identifying pros and cons of the different distribution scenarios.

Key words: E-business, supply chain management, truck spare parts, Internet portal.

1. INTRODUCTION

1.1. Background

In conventional international distribution, the products pass through several nodes before reaching the customer or final consumer. A very common procedure is that the products proceed through several levels of warehouses. First, after production, and possibly storage at the factory, the products are delivered to some distribution center. There the products are stored, consolidated and reloaded, and then sent on to the next warehouse, which is regional or local. If regional, the products might be sent to a local warehouse before delivery to the retailer, where they are ultimately sold to the customer.

There is little doubt that changes in buying behaviour, especially through the emergence of ecommerce, will necessitate changes in the way products are distributed from manufacturer to customers. Although what these changes will be is difficult to foresee now, it is still possible to distinguish the forthcoming changes in upstream and downstream consequences. The main upstream consequence is that the customer order point will be moved upstream towards the producer, and the system will therefore change toward a "pull strategy". This will demand a more efficient information system and will lead to reduced inventory levels, thereby reducing tied-up capital. The consequences that are expected to be downstream are the ones that concern the actual distribution of the products to the customers. The most clearly predictable outcome of widespread commerce over the Internet is that the consignment sizes will be reduced.

The advent of e-commerce raises several possibilities for new ways of distributing goods, and presumably there will be different ways of distribution for different types of physical products. The delivery time will be of great importance when deciding on what type of distribution model to use. The faster and easier flow of information using the Internet will make it possible to bypass one or more levels in the distribution system and thereby increase the speed of individual deliveries. For example, in the future, products might be delivered to the customer directly from the producer or from a central or regional distribution warehouse. In step with the entry and expansion of these new ways of doing commerce, it will be necessary to make significant changes in companies' distribution processes. As the customer order point is moved upstream in the distribution channel, the distribution processes need to be changed and several types of distribution channels can be seen as possible future solutions.

The first alternative to a simpler distribution system for products sold by e-commerce is to remove the retailer and instead distribute goods directly from the warehouses to the customer. Another possible alternative is to remove the local warehouse from the distribution channel and use a "postal-like" service to distribute the goods from the national warehouse to the customer. A third alternative is to distribute the goods from the national distribution centers to the customers within one's own distribution system. The last alternative is to have direct distribution from the production site to the final customer. A likely scenario is also that customers will have the possibility to choose how fast and in what manner they want their products to be delivered. The more the customers are willing to pay, the faster they can receive their products, and the distribution models will then be different according to the lead time allowed. The same may apply to the environmental impact – the customer will probably be able to affect the impact level.

1.2. Scope

The scope of this work varies in extent. First, the theoretical study covers distribution systems in general, where different types of distribution systems are described and analyzed. This applies to finished goods intended for final consumers, and not intermediate goods departing from one producer to another. Secondly, the empirical study only covers the Volvo spare-part distribution in Europe and the consequences of an e-commerce implementation for some important product categories. The main emphasis is on an analysis of the potential of implementing e-commerce portals for spare-part marketing and the logistical consequences of this, as well as on investigating some organizational consequences that will evidently arise.

Today there are only a few e-commerce pilot projects implemented at Volvo. These will of course be evaluated, but the main focus will be to build up a number of possible e-commerce scenarios and analyze their implications for customers, for the Volvo organization and for the logistics system as a whole.

1.3. Goal

The main goal of the work is to increase the understanding of:

- the obstacles and the potential in implementing a marketing and sale Internet portal for operators to buy products through;
- what effects such a marketing portal will have on customer relations;
- the changes in physical movement of the products that have been sold by means of e-commerce.

It is also intended to show:

- what consequences the e-commerce concept has for the physical flow and what logistical models can be applied that fit the needs of these new ways of conducting commerce and delivering products.

1.4. Limitations

The underlying theory for the work applies in general to the changes that can occur in logistical structures for many product groups and many industries due to implementation of e-commerce services. However, the empirical study and the scenario design will be limited to the Volvo sparepart distribution and the possible effects that electronic commerce can have on the company's distribution and relations with its end customers.

2. METHODOLOGY

In this study, some of the logistical consequences of the development of e-business and ecommerce for physical products will be examined. The methods used incorporate a theoretical study of the consequences in the areas where the movement of physical goods has mainly been affected and the associated problems analyzed. This is done with a supply chain perspective where a section of a supply chain, from the supplier through several distribution structures to the end consumer, is studied. The interrelation between the physical flow structures and the information systems along the supply chain are also to be outlined and analyzed. The study of the theoretical framework constitutes a basis for further investigations of the effects in a practical context. To study this, an analysis of the worldwide spare-part distribution of the Swedish Volvo Corporation will be carried out.

The analysis is based on existing supply chains and scenarios for how the distribution may evolve when affected by future implementations of the e-business concept. This will be done in terms of the relation between the product flow structures and the information systems, location of inventories, and changes in customer relations. For instance, the analysis outlines the effects of:

- organizational structure;
- costs;
- physical flow;
- information flow;
- customer relations;
- service level.

The empirical evidence has been collected from face-to-face interviews with two different categories of internal and external customers: the dealers of trucks and spare parts, and the transport operators which are the customers of the dealers. The interviews have been supported by studies of internal reports carried out for Volvo Truck, as well as by discussion with specialists and employees who are involved in developing some new concepts of e-commerce and use of Internet for the Volvo group.

Since e-business is not yet used extensively within Volvo, the analysis will be based on the existing Volvo spare-part supply chain and scenarios for how it can evolve as a result of implementing future e-business systems and concepts.

3. DISTRIBUTION STRUCTURES AND THE EFFECTS OF E-COMMERCE

In this chapter an underlying framework for distribution will be presented. The treatment describes general distribution systems, effects of Internet buying and the consequences for logistical activities.

3.1. Conventional distribution systems

In conventional international distribution, goods pass through several nodes, or stops, before reaching the customer. After production, and possibly storage at the factory, the goods are delivered to the Distribution Center (DC). Here they are stored, consolidated and reloaded, and then sent on to the next stop, the local DC. The goods are handled in the same way as at the national DC, and are thereafter sent on to the retailer, where they are sold to the customer (Mattsson, 2000). This is pictured in Figure 1. Since most of the time that goods spend at nodes does not add value, the more nodes there are in a distribution channel the less efficient it generally is (Lumsden, 1998).

The point where the goods change from being delivered to stock to being delivered to order is called the Customer Order Point (COP). In conventional distribution, the COP is at the retailer, where the customers order and buy the products. This is called a "push" system, since the company predicts the demand and the goods are pushed through the distribution channel (Coyle et al., 1996).

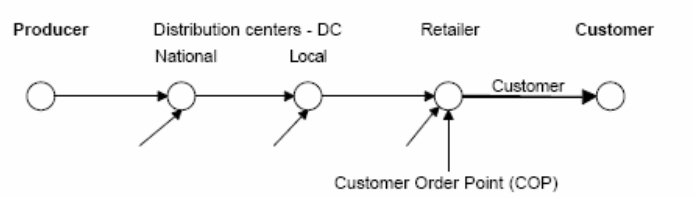

Figure 1. Conventional distribution structure

With e-commerce there are several possibilities for new ways of distributing goods, and presumably there will be different ways of distribution for different types of goods. Time will be of great importance when deciding on what type of distribution model to use. The faster and more direct flow of information on the Internet will make it possible to skip one or more nodes in the distribution channel and thereby increase delivery speed. For example, in the future products might be delivered to the customer directly from the producer or from a national distribution warehouse. One likely scenario is that customers will have the possibility to choose how quickly they want their products delivered. The more the customers are willing to pay, the faster they can receive their products, and the distribution models will then be different according to the lead time allowed (Hultkrantz & Lumsden, 2000a).

3.2. Changing distribution systems

Several different conditions affect the creation and alteration of a distribution network. There are the ideological, political or strategic aspects. There are the abstract network components such as information flow (Hultkrantz, 1999). There are the physical network components such as mobile resources, and there is the physical network, or infrastructure (Wandel & Ruijgrok, 1995).

When implementing changes in physical distribution, which will probably be necessary to maximize the benefits of e-commerce, the time for changing the different aspects mentioned above will vary. The ideological changes are fairly quick and easy to implement; these are often a politician's words and, as we all know, those can often change from day to day. Changes in the infrastructure, on the other hand, take a lot of time and cost a lot of money; see Figure 2. This figure also shows that making changes in information systems, which is in a way what ecommerce is all about, is a fairly quick process. But it requires a change in behavior of all actors in the distribution chain, which is more difficult and probably takes a longer time too. This, together with the likely need for new types of infrastructure to fully utilize the benefits created from e-commerce, renders it a rather safe assumption that some time will pass before we see the whole potential of e-commerce. The complexities and differences in these changes are among the factors that make it interesting and important to investigate how different actors will reshape their networks to adapt to the new demands of e-commerce.

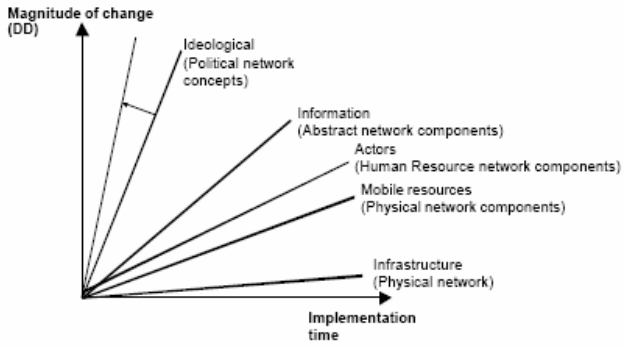

Figure 2. Logistics systems' changeability

3.3. Distribution structures for Internet buying

Along with the advent and expansion of e-commerce, it will be both possible and essential to make large changes in companies' distribution processes. This is because the COP will be moved upstream in the distribution channel, in some cases all the way up to the producing company. Consequently, the distribution process can be simplified to consist only of direct distribution from the producing company to the customer.

Several different distribution channels can be seen as possible future solutions, as shown in Figure 3. The base alternative is the conventional distribution, which is described earlier in this chapter. An example from the food industry could be that the food producer is located in France, from where the groceries are shipped in full truckloads or trains to a national distribution center (DC) located somewhere in southern Sweden or in Denmark, e.g. Dancargo's national warehouse at Arendal, Sweden. At the DC the groceries are stored, reloaded and consolidated with other products, and later shipped on to a local DC in full truckloads. This DC may for example be ICA West, located in Kungalv, Sweden. At ICA West the goods are again stored, reloaded and consolidated, before being transported to the retailer ICA Maxi in either full or partial truckloads. Customers then purchase the groceries at ICA Maxi.

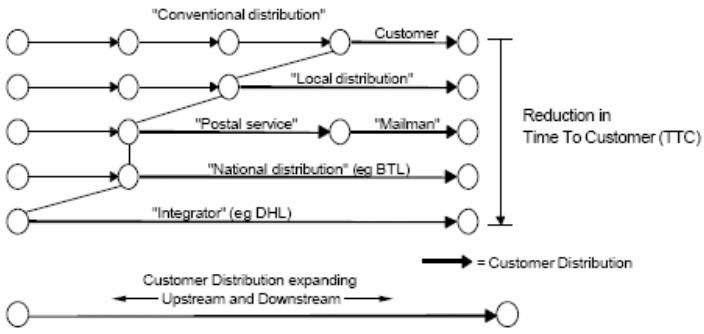

Figure 3. Distribution processes for Internet buying

3.4. Distribution channels

The first alternative of a simpler distribution system for e-commerce products is to remove the retailer and distribute goods directly from local warehouses to customers. This is called home delivery, and an example could be the purchasing of tulips over the Internet. The tulips are grown in the Netherlands and are shipped to a national DC in Sweden in refrigerated trucks, since the goods are perishable. At this warehouse the tulips are consolidated into smaller consignments and then transported to the retailers, for example an Interflora store. The customer now places an order at the Interflora store over the Internet, and the florist arranges the bouquet. The flowers are distributed to the customers either in Interflora's own vehicles or in a courier's van.

Another alternative is to remove the local warehouse from the distribution channel and use the postal service to distribute the goods from the national warehouse to the customer. This is called mail-order shopping and works as follows. Using an example from the clothing trade, clothes are manufactured in Asia and transported to a national DC in Boras in Sweden. The customer places an order over the Internet to the mail-order company, and the clothes are packed in parcels. These parcels are then distributed to the local post office by the national postal service, and are finally delivered to the customer by the mailman.

A third alternative is to distribute goods from the national distribution centers to the customers. A good example here is Tamro's distribution of incontinence protection articles for elderly people. The products are produced in Germany and transported to Tamro's national DC in Backebol, Gothenburg. There they are stored and packed, and finally distributed directly to the customers by Schenker-BTL.

The last alternative is to have direct distribution from the producing company to the final customer. This could, for example, be the distribution of tailor-made clothes by the company Tailoronline. The customers state their measurements and place an order over the Internet. The order is then sent to the factory in Estonia where the garments are produced and packed in parcels. The finished products are distributed to the customer by mail. Another example is Bokus.com's (see www.bokus.com) selling and distribution of books, which go directly from the printing house to the customer.

Amazon.com is also a well-known company selling books via the Internet. They started their business with distribution directly from the printing house, but have had to switch logistics strategy to one in which they must build warehouses in order to support the demand for shorter delivery time from the customers in the US (Hulten, 1999).

3.5. Upstream and downstream consequences

There is little doubt that e-commerce will necessitate changes in the way products are distributed from manufacturer to customer. What these changes will be is uncertain, but it is possible to distinguish the "upstream" and "downstream" consequences, as shown in Figure 4. Consequences are said to be upstream when they concern changes in the distribution channel from the customer to the producer. The only thing that is sent in that direction is information, and upstream consequences therefore mainly arise from changes in the flow of information.

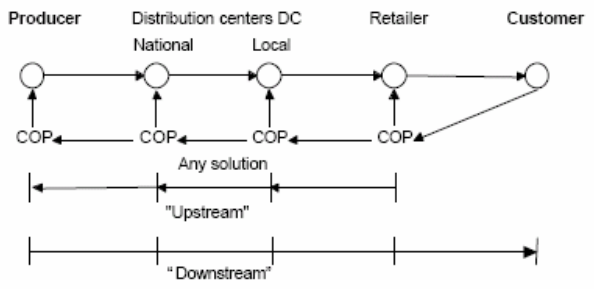

Figure 4. Upstream and downstream consequences for Internet buying

The main upstream consequence is that the customer order point (COP) will be moved upstream towards the producer, and the system will therefore change toward a pull strategy. This will demand a more efficient information system, but will lead to reduced inventory levels and thereby reduced capital tie-up (Lumsden, 1998).

The consequences that are said to be downstream are those that concern the actual distribution of the products to the customers. The most clearly foreseeable outcome from widespread commerce over the Internet is that consignment sizes will be reduced . The reason for this is that the distribution channels will stretch all the way to the final customer, and since private consumers do not need the same volumes as for example a retailer, the sizes will be smaller. Since the total consumption in society will remain the same, or probably even increase, the number of consignments and the number of delivery addresses will increase (Frej & Rosengren, 1999), and this in turn will lead to more complex distribution systems and more assignments for transportation and logistics companies (Hultkrantz & Lumsden, 2000b).

4. TRANSPORT INDUSTRY TRENDS

For Volvo, a number of trends are affecting the spare-part distribution. There are structural changes in the industry, e.g. mergers and acquisitions (Bijl et al., 2000), and there are trends connected with an increased demand on productivity. One trend, though it is not solely related to the parts business, is that many companies revise their strategy regarding the number of distribution centers and warehouses (Stefansson et al., 1998). A global survey indicates for example that distribution networks in more than 71% of world-class companies are considerably different today as compared to five years ago (CLM, 1995). Another survey showed that more than 90% of the companies planned to restructure their distribution network and reduce the number of warehouses (O'Sullivan, 1997). As a consequence the number of direct deliveries to retailers and end customers is increasing, as in the case of scenarios in Chapter 6. This process has continued, and will continue in the years to come. Some other trends are highlighted in the following sections.

4.1. New Internet Competitors redefine the industry structure

There is a strong movement towards e-business and utilization of the Internet in the transport industry today. New "e-companies" are targeting spaces between the traditional companies and their customers. These companies are redefining the way logistics and transport products and services are bought and sold, as well as the way the products are distributed. Both transport companies and the truck manufacturers are faced with these new Internet competitors. Figure 5 shows the new structure of the market.

For the transport and logistical companies, some examples of these new competitors and their services are:

- Virtual Marketplaces – Connecting buyers and sellers via information-clearing houses and auction processes (see www.ChemConnect.com).
- Carrier Selection – Purchasing via a sellers' web site with carrier selection at the time of transaction (see www.Amazon.com).
- Freight exchanges – Matching shipper demand with hauler capacity (see www.Delego.com).
- 3PL – e-fulfillment companies emerging to fill e-commerce transactions (see www.SubmitOrder.com).
- Transport Information Systems – Haulers get navigation capabilities via Internet (see www.cargoweb.nl).

Also for selling trucks and services related to the vehicles, there are new competitors, and some examples of their services are:

- parts supply (see www.mixertrucks.net);
- new/used truck sales (see www.equipmentsearch.com);
- insurance services (see www.truckinsuranceusa.com);
- financial services (see www.quality-enterprises.com/lucid/).

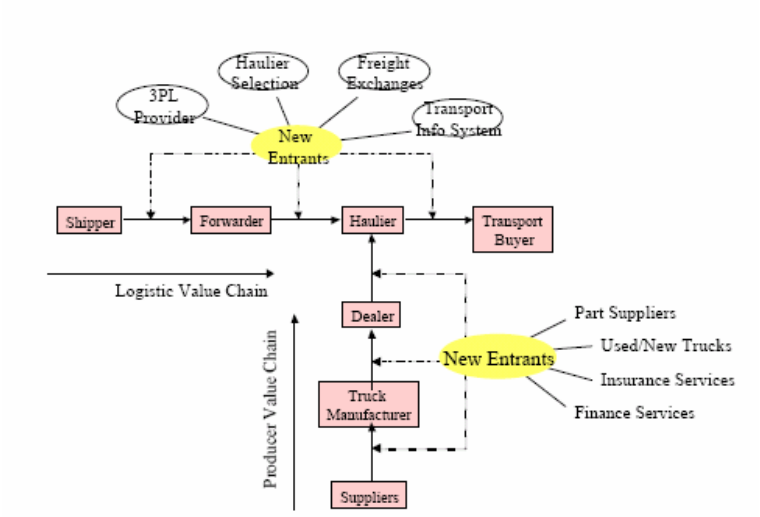

Figure 5. The new structure of the transport market

4.2. Traditional companies redefine their business models

These new entrants are also forcing traditional companies to create new ways of doing business. The new ways often lead to redefining the supply chain. Some of the most common services the traditional transport companies are offering on the Internet are (see www.ups.com, www.yellowfreight.com, www.danzas.com):

- rates;
- schedule pickups;
- sending Bills of Lading;
- tracing shipments;
- pulling invoices;
- making payments electronically.

As for truck manufacturers, they are now offering (see www.scania.com, www.volvo.com, www.paccar.com):

- information about new truck models;
- truck configurations;
- new and used truck sales;
- financial information;
- freight exchange;
- driver navigation.

In the future, many of the truck manufacturers will also offer spare parts on the Internet.

4.3. Trends that influence the Internet spare-part distribution

Besides these structural changes in the industry, various other trends influence the Internet sparepart distribution. Some of these are highlighted below. There is an increasing share of the customers that are using contract maintenance today. This means that Volvo is doing the service and repair of the trucks. In Great Britain and Benelux this trend is stronger than in, for example, Scandinavia where many of the transport companies are still maintaining trucks in their own workshops. A low share of custom workshops lowers the benefits of offering spare parts on the Internet for transport companies.

In addition, transport companies are becoming more international and are creating networks with other transport companies through alliances and joint ventures. This increases the importance of having a flexible spare-part system where customers are able to order a spare part in one country and get it delivered at a service point in another country. On-site maintenance is also increasing. This means that Volvo has to be able to repair and service the trucks at the customer terminals, which in some cases will require spare-part distribution directly to customers. Internet increases access to spare-part prices. A common European currency is also making it easier to compare prices of trucks and spare parts between different countries. Today many transport companies have a demand on 24-hour operation and every hour spent in the workshop is seen as lost income. Increased demand on uptime and truck utilization increases the demand on fast and precise supply of spare parts.

5. VOLVO SPARE-PART DISTRIBUTION

Globally Volvo has several thousands of suppliers of spare parts situated all around the world. These suppliers provide hundreds of thousands of articles for trucks, buses, construction equipment and industrial engines. In this section Volvo's spare-part distribution system will be described.

5.1. The distribution system

A Central Warehouse is used in Europe as a main storage point, with a focus on being the hub in an inbound and outbound flow of goods. Several millions of order lines are received at the Central Warehouse, which is operated with a balance of providing very high availability without becoming inefficient in terms of operational costs. By means of tied-up capital and suppression of stock, the strategy is to have increasing turnover the farther away in the distribution chain one gets from the Central Warehouse, while also providing a decreasing range of spare parts off-the-shelf. The structure of the distribution is shown in Figure 6.

Besides the Central Warehouse, Volvo has Support Warehouses. These are situated close to the market and have a broad stock of parts in order to optimize availability, lead time and costs. From the Central Warehouse and the Support Warehouses, which are fully controlled by the Volvo structure, there are over 1,000 distribution points in the form of independent dealers and service points. Today the delivery points are mainly Volvo dealer locations or dealer-owned workshops.

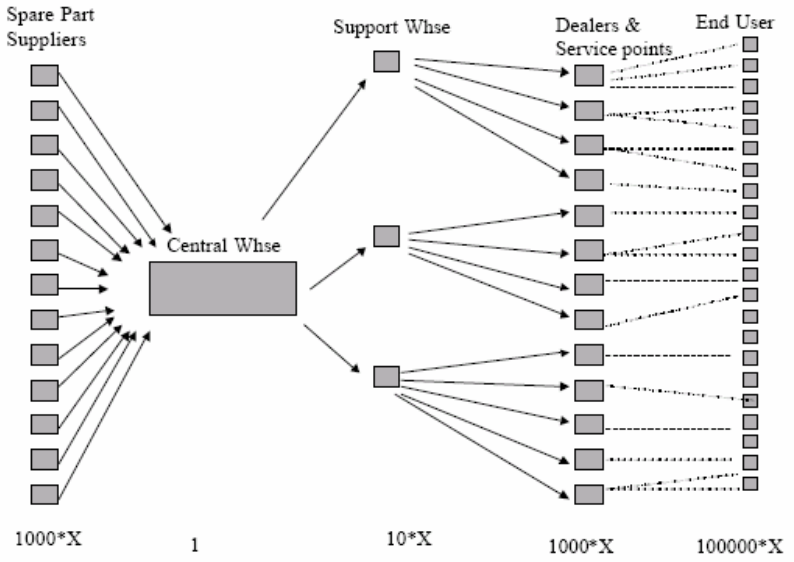

Figure 6. Volvo's spare-part distribution

5.2. Order types

There are mainly two different order types with different levels of service: day orders and bulk orders. A day order is a customer order of a specific article needed for a customer with availability overnight. This order is placed from the dealer to the Support Warehouse. The article is delivered to the dealer. If the article is not available at the Support Warehouse the day order is passed on to the Central Warehouse and delivered directly to the dealer. A bulk order is a replenishment order to a dealer warehouse from the Central Warehouse.

5.3. Marketing channels (upstream)

Today there are a number of channels for ordering spare parts. However, there are exclusively dealers that can order from spare-part systems. The dealer may place his order by using EDI, Volvo-developed terminal emulsions, or by phone or fax.

5.4. Physical flow (downstream)

From supplier to Central Warehouse

From the suppliers, transporters contracted mainly by Volvo Transport pick up the spare parts by using route schemes. The supplier is pre-advised of the order size, and is visited 1-2 times per week depending on how large the volumes of the articles are and how frequently the articles are replenished.

From Central Warehouse direct to dealer or other service point
A majority of the contracts with forwarders are made on a volume basis especially with the bulk order history as input. "Milk rounds" are widely implemented to improve efficiency. The direct deliveries are more *ad hoc* as they are negotiated instantaneously with the outgoing goods demand according to need.

From support or regional warehouse to service point
Support Warehouses are serving as the collection points of an aggregated demand for a broad range of parts in a certain region. The Support Warehouses have possibilities to negotiate transport volumes to a certain degree, although this must remain flexible as the demand is volatile.

6. SCENARIO DEVELOPMENT AND DISCUSSION

In this chapter some possible scenarios will be developed and the consequences discussed on the basis of the results from the conducted interviews. Not only are the logistical consequences evaluated, but also the potential spare-part providers are identified as the marketing structure can easily be changed when the e-commerce market channels emerge. When evaluating the consequences, we follow the same framework as in the background discussion in Chapters 3 and 4.

6.1. Different possible spare -part providers

Even though the main spare-part providers today are the truck manufacturers themselves and their dealers, there are several providers of non-original spare parts and sellers of original parts who have no dealership or workshop. It will be easier for such actors to establish their businesses as the Internet provides increased international transparency, especially when it comes to price, but also in availability, lead time, service etc.

One of the most critical factors relates to the existing power balance and the initiatives and possibilities to change it. Therefore, it is vital to identify the potential actors involved and position these according to an appropriate e-commerce model. Figure 7 outlines the main stakeholders in an e-strategy business model.

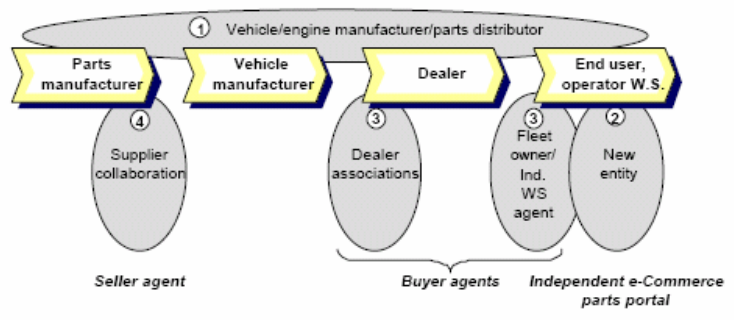

Figure 7. The main stakeholders in the e-strategy business model

The actors that may begin e-commerce in the spare-part business are numbered from 1 to 4 in Figure 7. E-commerce and the Internet will function as facilitators challenging the existing logic through four new business models. Cooperation will increase, mainly vertically with suppliers and manufacturers becoming closer in order to serve end users. There are several potential providers in sight, but the truck manufacturers have a great potential to lead the process since they represent:

- a holistic legacy;
- purchasing power;
- a product development driver;
- a distribution provider.

Systems' importance will increase, mainly in two respects: integration/collaboration and planning for complexity (smaller and multiple shipments/more changes). Figure 8 shows the entry barrier for e-commerce and indicates the potential winners to be the established players, since these can be early out with an e-commerce alternative.

With more actors providing parts, it will be more complex to buy parts and the buyer must have a knowledge of the supply system. Increased volatility demands quicker response times, as it is of utmost importance to gather feedback fast to be able to compare price, service, etc. A dealer stock turnover rate of 6 still means keeping a stock of about 10 weeks – prolonging the response time before the supply chain may react. This is not acceptable for all kinds of spare parts, and some must be delivered within hours, others in days or weeks.

An implication is that different types of spare parts and accessories are more suited than others for provision by specific distribution channels. The e-commerce segment of the assortment that is most suitable to the end user comprises parts which are:

- standard (fitting many makes);
- high in frequency/wear;
- easy to exchange (workshop not needed);
- preferably small in size.

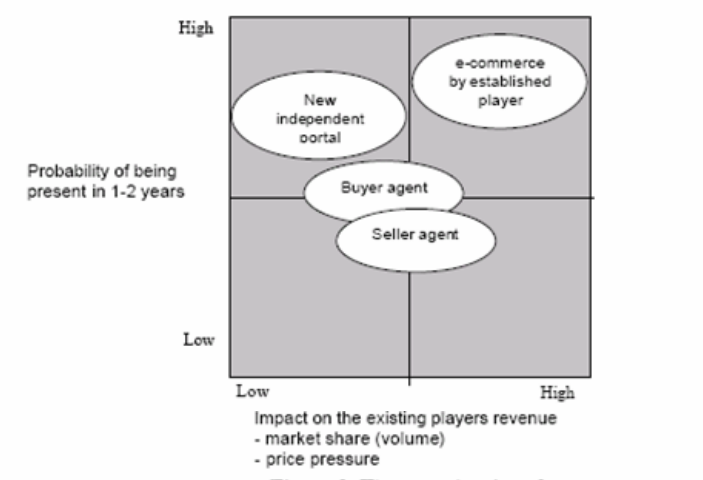

Figure 8. The entry barrier of e-commerce

Manufacturers may still not forget the first comer's leap, and thus it is important to generate ecommerce strategy early and see how it can fit into the existing distribution structure, or how the existing distribution structure must be adapted to the new buying behavior. This must be followed with an implementation strategy that takes into account all possible effects, not only on logistics and distribution operations but also on the existing actors such as the dealers and the truck operators. One way of generating such a strategy is to develop several scenarios and evaluate the logistical consequences as well as the effects on the different actors; this is discussed in the next section.

6.2. Possible scenarios

To realize the distribution of spare parts there are different ways of executing the physical transport. The scenarios we build up evaluate a number of ways in which this distribution could occur. Based on the distribution model for Internet buying introduced in Chapter 3, we have identified four possible ways of carrying out the distribution, as shown in Figure 9. Here the physical distribution of the parts is indicated; it is not necessary, and in many cases it does not happen, that the information flow goes the same way. Separating the physical flow and the information flow is an increasingly significant strategy for companies that aim to improve cost efficiency and reduce inventories while maintaining high customer service, particularly as ebusiness and the World Wide Web continue to facilitate communication between customers and suppliers (Mattsson, 2000). The scenarios are:

Scenario 1 - In this scenario the dealer is bypassed and the spare parts are distributed directly from the support warehouse to the final customer.
Scenario 2 - In this scenario the support warehouse is bypassed and the spare parts will be shipped directly from the central warehouse to the dealer and then from the dealer to the final customer.
Scenario 3 - The shipment will be sent directly from the central warehouse to the end customer.

Scenario 4 - In this scenario the spare parts are sent directly from the supplier to the end customer.

While the four scenarios describe the physical flow of the goods and the information flow may take other routes, it is also possible that all involved actors will share the information, as well as that there will be different solutions for different part numbers.

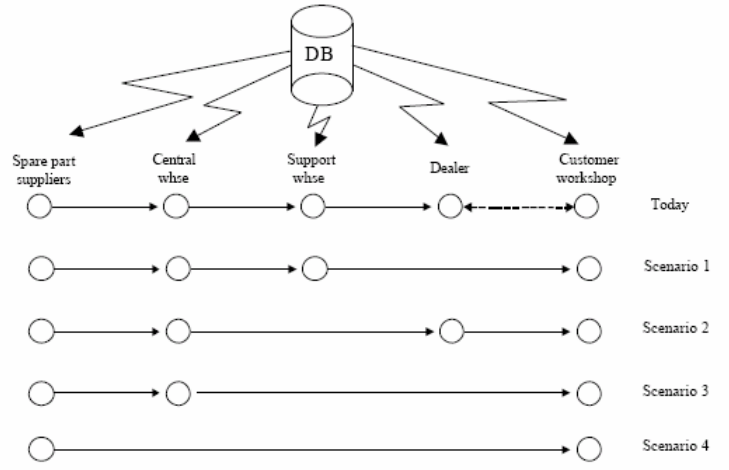

Figure 9. The four scenarios

An influential force in any transformation towards the different scenarios will be the dynamics and opinions of the dealers and, not least, the truck operators. Their diversity and heterogeneous structure makes sufficient quantitative data gathering and analysis time-consuming and difficult to base strategic decisions upon. Instead, in-depth face-to-face interviews and group discussions have revealed a number of opinions and given input to the logistical consequences foreseen, depending on the scenario. These views are summarized in Table 1 below, with the expressions of "+" (more likely), "–" (less likely) or "0" (neutral) wherever feasible. In cases of irrelevant opinion about the scenario or of insufficient background material, a blank is left. The "+", "–" or "0" is limited to representing an aggregate of factors that favour or oppose the likelihood of the scenario.

The individual factors, which are to be further analyzed and presented in coming research, are for example: Cost to implement and operate, Lead time of transport, Stakeholder interest, Stakeholder power, Possibility to execute. Although these factors have not been investigated, the current "+", "–" and "0" do at this stage provide valuable insights on the probabilities of different scenarios for spare-part distribution and thus form a foundation for further strategy formulation as well as study. A "+" (or "–") implies that the scenario is more (or less) likely in relation to the other scenarios, but not necessarily that the scenario would not improve (or reduce) the outcome in relation to the opinion. A "0" implies that the opinion is neutral in relation to today's structure. The opinions are gathered from both operators (specified as actor O in the table) and dealers (specified as actor D).

Table 1. Opinions and logistical consequences on introducing a portal for parts business

Actor	Opinion	Consequence in Logistics	1	2	3	4
D	Expecting overall benefits	Expectations of having shorter delivery times, reductions in costs and a better image, as well as making it easier to order parts. 1,3) + Rationalizations in the dealer network will take place due to competition; that the more advanced products will have more preventive maintenance programs increases the ability and performance of delivery.	+		+	
D	Increased internal competition	Dealers see each other, as well as the independent workshops, as competitors. 2) – Dealers are too small and lack power to be a driving force and leading development in the competitive race. 4) – Suppliers are too heterogeneous and unfocused for the spare-part segment.		-		-
D	Advantage and disadvantage with parts on-line business	Opinions vary strongly among countries. Some say "*Yes, go full scale*" while others say *"Absolutely not"*. For example, those in favor want to lead the change and those opposing think it will increase competition and let new entrants in. 2) – Contradictory opinions give less force to change		-		
D	Small changes in order system are desired	The cost and time for developing and implementing changes occur in an operation which is small-scale and low-margin at each individual. 2) + Stability and similarity to existing process 3) + May act as driver for change since it forms a web of many relations and has power to drive a change 4) – Large-scale changes and multiple interactions are demanded		+	+	-
D	Small resources to accomplish change	1,3,4) + Actors have resources for accomplishment as well as freeing the dealer from involvement 2) - Demands greater involvement of dealers in the delivery process	+	-	+	+
O	Advantages and disadvantages of parts on-line business	Three categories have been distinguished: * The fairly specialized, management-oriented operators with no own repair/service facilities: "Ordering parts on-line would be just great, but only for consumption material". * The operators with full or partial repair facilities: "It is easier, quicker and probably better just to pick up the phone". * The operators who are too small to have their own facilities and see no incentives to buy either parts or accessories on-line. 1,3) The operation opinion does not influence the scenario. 2) + If dealers take the chance to lead the change, they are the ones with the best view of how to segment customer offers, e.g. of who should offer direct delivery. 4) –/+ There are small possibilities for suppliers to realize the relatively complex picture of fulfilling spare-part demands, with the exception of simple parts for high-consumption material.	0	+	0	-/+
O	Confirmation is needed	Operators find it crucial to receive the order confirmation. 1) + Capable of managing the increase in number of relations. 2) + In ownership of today' s relation, thus feasible to develop. 4) – The risk of something going wrong increases with the number of relations.	+	+		-
O	"Real prices" must be available	Coordination of individual price after discount is crucial for operators. 1,3,4) + When one owner can be in control of the actors continuously, there exists only one price per end customer. 2) – The independence of dealers creates different prices (discounts) depending e.g. on how much they buy per occasion.	+	-	+	+

Actor	Opinion	Consequence in Logistics	1	2	3	4
O	Better purchasing support	To be interested in buying on-line, one needs very good guidance on which parts to buy. "Schematic drawings are a must." Also, the same type of recommendations that a person would be able to give over the phone. 2) + The close relationship can give back-up and personal support. 3) + The central coordination hub has the ability to collect and distribute proper information, and the financial strength to develop solutions. 4) – The continuous flow and differences of parts make a decentralized coordination offer very complicated and expensive.		+	+	-
O	Direct and free deliveries	Any parts ordered over the Internet should, ideally, be delivered either to the office or to a designated depot; this saves time and resources for those ordering the parts. This should be *"free"* although the respondents recognized that *"you pay for it in the end"*. 1,2) Smaller capability to achieve economically viable volumes. 3,4) + Cutting intermediaries may yield volumes to coordinate.	-	-	+	+
O	Maximum 24-hour delivery lead time	The longer the distance from source to operator, the more difficult the order fulfillment, in terms of distance and instances to go through. Assortment balanced with tied-up capital and availability will be the most critical determinant, so there are many possibilities. 1) – Negative in terms of the mix, with a wide assortment but still considerable distance in relation to expected volumes. 2) 0 As today, with a risk of overstocking due to lack of aggregated demand. 3) + Likely since it can determine a balance of assortment mix and aggregated demand volumes. 4) + Favorable for certain suppliers, i.e. desirable assortments.	-	0	+	+
O	Rather a central solution than a dealer solution	The consistency and support, as well as the more holistic view, are critical aspects in development of solutions. 1,3) + The central system can coordinate and offer reliability and control. 2,4) – The security is an important issue for reliability reasons, and is thus also negative for direct supplier interactions.	+	-	+	-
O	No further actors to interact with	For example, regarding the number of instances to receive invoices, delivery notes and other interactions. 2) + Remaining as today 3) + Just a change of actor from dealer to central warehouse. 4) - Extra administration due to the added work of having a link to suppliers centrally as well as locally.		+	+	-
D/O	Limited Internet experience	Internet (and computer) literacy vary extremely within the dealers' as well as the operators' populations. Although the majority of the operators do have access to Internet, they use it to a very small extent in their business. 2) + The slow technology adoption makes it harder to change relationships, and existing technology will have advantages. 3) + Small volumes of customers are expected, but central warehouse can get sufficient accumulated volumes. 4) – The number of relationships that need to be coordinated is a disadvantage, and personalized relations are important.		+	+	-
D/O	A lot of obstacles reduce the Internet usage	The lack of experience creates obstacles. In addition: lack of time in terms of both usage and learning; well-established contact patterns/business procedures in existing ways; no perceived benefits from Internet; the very important generic advantages of personal contact; general attitudes and cultural alienation among the actors. 2) + Benefits from being the closest "back-up", part of the culture. 3) + Resources and competence to develop central training packages. 4) – Harder to coordinate several sources.		+	+	-

7. CONCLUSIONS

Many companies today are redefining their supply chains, especially the distribution structure and distribution channels towards their customers. This has been catalyzed for several years now by demand for less assets tied up in inventories, increase in efficiency, merging of companies and globalization, etc. In addition, the advent of Internet and e-commerce concepts has further pushed companies into structural changes and redesigning their physical flow of products from production or warehouse facilities to customers.

In conventional distribution, the products are passing through several warehouses and distribution centers before reaching the customer or final consumer. An on-going trend is that many companies revise their strategy regarding the number of warehouses and distribution centers. With the entry of e-commerce there are several new ways of distributing goods, and presumably there will be different kinds of distribution model used for different types of products, where some go straight from production to end customer while others go through various distribution centers to break up volume, increase service, and minimize lead time.

The truck spare-part business is no exception in this regard. Volvo Truck spare-part distribution will probably undergo changes towards utilization of the Internet, and probably some categories of spare parts and accessories will be available through e-commerce channels in the near future. To be able to study the impact of this new way of marketing and selling spare parts, some projects are being carried out where logistical consequences of e-commerce are evaluated. In this particular work a theoretical study has been conducted and supported by an empirical study. The theoretical study covers distribution systems in general, where different types of distribution systems are described and analyzed. From this part of the study, some four different scenarios were developed. The scenarios describe different ways of distributing products from producer to customer, and involve different numbers of warehouses and participating actors. The empirical study covers Volvo spare-part distribution in Europe and the consequences of an e-commerce implementation for some important product categories. The study included several interviews with truck and spare-part dealers as well as truck operators. The input from these empirical studies has been used to evaluate four scenarios:

> **Scenario 1** - where the dealer is bypassed and the spare parts are distributed directly from the support warehouse to the final customer.
> **Scenario 2** - where the support warehouse is bypassed and the spare parts will be shipped directly from the central warehouse to the dealer and then from the dealer to the final customer.
> **Scenario 3** - where the shipment will be sent directly from the central warehouse to the end customer.
> **Scenario 4** - where the spare parts are sent directly from the supplier (producer) to the end customer.

Scenario 1 was the one with the least indications of how likely or unlikely it is, according to the interview results. As the delivery point is moved upstream, to the support warehouse, there are some benefits involved but also some drawbacks in the dealers' and truck operators' minds. To mention some benefits, the dealers expect shorter delivery time and reduction in cost. The operators are also in favour of the more central solution as it can more easily be coordinated and offer stable reliability. A drawback of Scenario 1 is that the amount of parts going from the

support warehouse to each operator will be small, which makes it difficult to achieve economical operation in direct deliveries. This also reduces the possibilities of express service within 24 hours from order to delivery, as the distances increase and the volume is low.

Scenario 2 had many more indications than the earlier one. The operators thought that continuing with the dealer structure would facilitate the personal relations and purchase support, and that the delivery of on-stock spare parts would be faster and more reliable. This direct delivery would, however, cost more as the volume is low, perhaps with only one part each time, so it would be difficult to get efficient direct-delivery service. The dealers in this scenario have a chance to lead the development of the changes and fit it into their operations. This must be seen as a benefit to the dealers, but not necessarily to other actors in the supply chain.

Scenario 3 is unlike the others in having a preponderance of "more likely" indications. This is mainly because circumstances of economics of scope can be attained in many respects and the financial strength to develop an effective distribution system exists. It will also be easier to establish a proper structure for gathering and spreading information to support sales activities and coordinate customer requests. Direct deliveries within some adequate time limit should be possible as the volume is much higher than in the previous scenarios.

Finally, Scenario 4 is the one that has the most "less likely" indications. The reason is that the coordination is complex, transparency of the system is poor, the number of customer relations is enormous, and the risk of something going wrong is high. Additionally, personal relationships are difficult to establish and much maintenance work requires parts from several suppliers. A benefit is that direct deliveries should be possible within 24 hours for most assortments to a large portion of the customers, as the stock will be complete and the volume high in the distribution system.

One common factor that affects the opinion of all the above scenarios is that the interviews revealed that the Internet and computer usage of both dealers' and truck operators' personnel is very limited, especially for business purposes. This does, of course, affect their opinion of using Internet, mainly because they are unfamiliar with it and have never experienced any benefits from utilizing such a tool for purchase. Both dealers and operators find this unlikely to change in the near future, as the available working hours do not allow any additional education. Nevertheless, this barrier must be overcome as the usage of Internet is the key factor and the user must find himself at ease with the tool. Otherwise the success of the implemented changes may be jeopardized.

Manufacturers must realize that it is important to generate e-commerce strategy early and react to the demand, to be able to gain the first comer's leap. The strategy has to be developed and analyzed to see how it can fit into the existing distribution structure, or how the latter must be adapted to the new marketing and distribution strategies. This must be followed with an implementation strategy that takes into account all possible effects, not only on logistics and distribution operations but also on the existing actors such as the dealers and the truck operators.

With the results of this study in hand, it can be concluded that the opinions of both dealers and truck operators vary greatly. Even with some scenarios more likely than others, it is probable that some categories of spare parts suit a given distribution structure better than others do. Future work will reveal the criteria for this, and probably more than one, or even all, of the above scenarios will exist in Volvo's future spare-part distribution strategy.

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Paper 4

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Agility through scenario development and continuous implementation: a global aftermarket logistics case

Magnus Holmqvist[1] and Kalevi Pessi[2]

[1]Volvo IT, University of Göteborg and Viktoria Institute, Göteborg, Sweden; [2]IT-University of Göteborg and Viktoria Institute, Göteborg, Sweden

Correspondence:
Magnus Holmqvist, Volvo IT, University of Goteborg and Viktoria Institute, Horselgangen 4, Göteborg SE-417 56, Sweden.
Tel: +46 31 32 22733;
Fax: +46 31 77 28963;
E-mail: Magnus.Holmqvist@volvo.com, www.viktoria.se, www.volvo.com, www.gu.se, www.ituniv.se

Abstract
This paper examines a business and IS/IT initiative at Volvo that involves managing the development and implementation of an agile aftermarket supply chain. The case is based on Volvo's global initiative to create a platform, Web services, and a Web portal for selling spare parts over the Internet. Creating and integrating a new platform is difficult, and establishing new relations in global aftermarket logistics is even more challenging. Agility relates to an organisation's ability to sense and respond rapidly to unpredictable events in order to satisfy changing customer demands. Volvo's effort illustrates agility as achieved by working continuously with scenario development and keeping implementation projects to a comprehendible size in order to nurture learning. The effort involved direct actions to manage both the technology and the relations among supply chain actors. As this case shows, continuous implementation projects can deliver innovation in new relations and through new channels – particularly if projects address agility from the start.
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Introduction

Agility gives organisations the ability to sense and respond rapidly to unpredictable events and thus satisfy changing customer demands. This capability is critical in today's business world. New technologies and new ways of doing business are constantly introduced to create or alter global marketplace demands. At the same time, organisations have existing investments in both their IS/IT base and established business relations that can neither be ignored nor abandoned. To further complicate the situation, difficulties of technology diffusion contribute to a paradox of trying both to explore and to implement new technology in an unpredictable business context.

In global aftermarket logistics, managers contend with multiple interrelations and significant differences among actors. Both logistics research and IT research address agility (Christopher & Towill, 2000; Agile Manifesto, 2001; Dove, 2001). In the introduction to Business Agility and Information Technology Diffusion, Baskerville, Mathiassen, and Pries-Heje state that: 'In a world in which change and uncertainty drive the needs for business agility, and digital information drives business, agility in IT is critical for business success. We believe it is important to understand how… [agility] …is multifaceted' (Baskerville *et al.*, 2005, p. 9). Logistics

research suggests that supply chain management requires agile characteristics in order to manage complex situations (Christopher & Towill, 2000).

The research question of this paper concern how organisations can achieve agility in practice. It examines a business and IS/IT initiative at Volvo. The paper's goal is to highlight and enhance the understanding of management issues related to development and implementation in the complex context of global aftermarket logistics. The case illustrates why business-to-business integration requires agility, and how Volvo implemented it within a complex supply chain.

The case is centred on a Volvo initiative to establish a Web portal for selling spare parts over the Internet. The case starts with a scenario development, and then addresses the technology and business issues involved in creating a platform for global aftermarket logistics. We then cover the process of introducing Web services and building new relations through implementation projects. Implementing IT solutions to create net-enabled business is not easy; implementing such solutions globally is even more difficult. This paper shows how Volvo focused on agility by working continuously with scenario development and implementation projects. This process involved direct actions to manage both IS/IT and relations between supply chain actors.

There are few global, comprehensive implementations that include advanced Web services. However, the commercial value and interest in the subject are high. For example, IBM is using one of the implementation projects within this research as a case study for Web services and has presented it in their 'Company of the month' section (IBM, 2004). Although IBM presents project work from only one single implementation, it gives a simplified and commercialised view of the objective, the implementation itself, and (not least) the origin of the overall developments.

The next section offers an overview of related literature, followed by a summary of the research method and an outline of the case context. We then present three specific implementation projects and their relation to enabling agility. Following this, we discuss practical and theoretical considerations, and conclude with comments on IT management and agility as delivered through implementation.

Business agility and IT management

The agility concept was introduced into IS research some years ago (Overby *et al.*, 2005). In times of increasing uncertainty and turbulence in the business environment, we need a concept that extends adaptability and flexibility to include speed and scalability (Baskerville *et al.*, 2005). Outside-in perspectives of agility are '… primarily concerned with the ability of enterprises to cope with unexpected changes, to survive unprecedented threats from the business environment, and to take advantage of changes as opportunities' (Sharifi & Zhang, 2000, p. 496). Yusuf *et al.* (1999, p. 37) present more of an inside-out perspective: 'Agility is the successful exploration of competitive bases (speed, flexibility, innovation pro-activity, quality, and profitability) through the integration of reconfigurable resources and best practices in a knowledge-rich environment to provide customer-driven products and services in a fast changing market'. Furthermore, some software development approaches emphasise productivity rather than process rigor, and seek to deliver business value quickly in spite of changing user requirements (Fitzgerald & Harnett, 2005).

The agility concept is challenging 'lean' concepts, which have dominated manufacturing and supply chain management for the past several years (Benson *et al.*, 1992; Kidd, 1995; Christopher & Towill, 2000). Research in supply chain management covers both supply and demand concerns (Ericsson, 2003). Aftermarket logistics, with global and time-critical operations that rely on economies of scale, require a sense of the overall direction in order to be optimised. The numerous supply chain actors and the reliance on IS/IT support contribute to a complex scene (Lumsden, 1998).

Researchers have suggested several distinguishing characteristics of the agile supply chain (Christopher & Towill, 2000). First, it should be market sensitive in terms of its ability to read and respond to real demand. Second, it should use IS/IT to share data between customers and suppliers. Shared data between supply chain actors can only be fully leveraged through process integration, which is the third distinguishing characteristic. Finally, a new style of relationship is essential. In the 'extended enterprise' or 'net-enabled business', a confederation of partners with indistinct boundaries is linked together based on increasing trust and commitment. Christoffer and Towill argue that in the era of 'network competition', competitive advantage will be achieved through better structuring, co-ordination, and management of relationships with partners, as well as closer and more agile relationships with customers.

A net-enabled business has been defined as an organisation that coordinates its activities and interacts with its stakeholders by exchanging messages over electronic networks (Malone *et al.*, 1987; Rayport & Sviokla, 1995; Görsch & Kühn Pedersen, 2000; Straub & Watson, 2001; Hackbarth & Kettinger, 2004). Such a business uses technology and associated architectures to access customers online and integrate supply chain partners. Christensen *et al.* (2001) present Web services as a loosely coupled architecture for integration, which may provide a natural arena for better understanding agility. Web services can provide solutions to integration, migration, and IT management evolution (Holmqvist & Pessi, 2004). Rogers's diffusion of innovation theory (2003) can nurture an understanding for implementation challenges, especially if it is combined with attention to organisational learning, information infrastructures, and the installed base in large-scale operations (Ciborra & Hanseth, 1998; Finnegan *et al.*, 2003; Changsu & Galliers, 2004; Mustonen-Ollila & Lyytinen, 2004).

IT management has been a key issue for a long time (Zachman, 1978; Brancheau & Werthebe, 1987; Niederman *et al.*, 1991; Gottshalk, 2000). Research range from attempts to create theoretical frameworks (Zachman, 1978; Bowman *et al.*, 1983; Sullivan, 1985; Earl, 1989; van der Poel & van der Waes, 1989) to empirical research on IT management practice (Galliers, 1987; Lederer & Sethi, 1988; Earl, 1993; Flynn & Goleniewska, 1993; Sabherwal, 1999) to the recent debate on strategic alignment (Ciborra, 1997; Avison *et al.*, 2004). Strategic alignment focuses on how to align business strategies and IS/IT strategies, often in order to drive IT effectiveness (Avison *et al.*, 2004). The four fundamental domains of strategic choice related to alignment concern: business strategy, IT strategy, organisational infrastructure and processes, and IT infrastructure and processes (Henderson & Venkatraman, 1993). Critics argue that the dominance of a structured strategy process is questionable in a context where uncertainty and ambiguity predominate and where it is difficult to articulate strategic intent (Ciborra, 1997). In contrast to Ciborra, Salmela *et al.* (2000) assert that even in turbulent environments, comprehensive planning can be beneficial. Turbulence is relative to context and changes over time requiring perspectives of continuous development that are broader and more fundamental than continuous quality improvement (Orlikowski, 1993; Santhanam & Guimaraes, 1995; Tan & Pan, 2003).

IT management researchers have debated the effectiveness of too little or too much strategic IS planning (Premkumar & King, 1992; Sambamurthy *et al.*, 1994; Newkirk *et al.*, 2003). Too little planning results in insufficient understanding of the planning context, while too much planning requires too much time. The agility concept – that is, the ability to detect and seize market opportunities with speed and surprise (Sambamurthy *et al.*, 2003) – can further nurture the discussion as to which approach is more successful: comprehensive planning, or less planning and more action.

In response to increasing uncertainty, interdependence, and complexity in the business environment, some researchers and practitioners have turned to scenario planning approaches. Scenario planning has been seen as an important corporate innovation in strategic planning (Schoemaker, 1993). Multiple scenario analysis is an effective approach for dealing with the many long-run uncertainties that surround business organisations (Bood & Postma, 1997). Scenarios are narratives of alternative future environments. They are like hypotheses of different futures specifically designed to highlight the risks and opportunities in strategic issues. As Wack (1985, p. 74) states: 'Scenarios help managers structure uncertainty when (1) they are based on a sound analysis of reality, and (2) they change the decision makers' assumptions about how the world works and compel them to reorganise their mental models of reality'.

Research method

Progress in IT management research and practice can benefit from '…the drawing of specific implications, and the contribution of rich insight' (Walsham, 1995, p. 79). The characteristics of this Volvo case are relevant in terms of size, scope, and content (Yin, 2003). It is also advantageous in that we had extensive access to the case context, which is crucial when studying complex situations that require comprehensive descriptions. The research has been inspired by collaborative practice research (Mathiassen, 2002) and its inside/outside perspectives. The first author of this paper is employed by and works 'inside' Volvo, but is also involved in research at the Viktoria Institute. The second author is a full-time academic researcher and provides 'outside perspective', which allows for more critical assessment and reflection. The collaboration included participation during interviews and workshops, as well as reflective discussions and theoretical considerations (for more on this, see Holmqvist *et al.*, 2001, 2003; Holmqvist & Pessi, 2004).

This paper reports on a study of three implementation projects: (1) establishing a platform and approaching truck dealers and end-customers in selected European markets; (2) refinements for key bus customers and stand-alone truck importers; and (3) developments for truck dealers and end-customers in Asia and Eastern Europe. Figure 1 shows the timeline for these implementations. The process of scenario development and details of the implementation projects are further addressed in later sections.

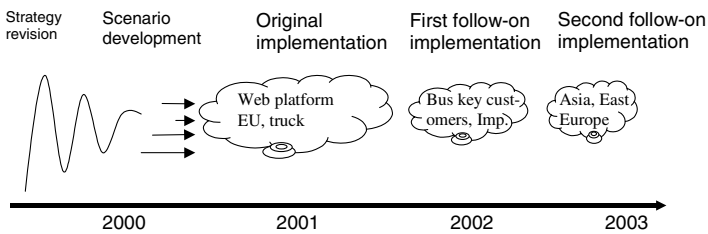

Figure 1 Timeline for implementation projects.

The research methodology is essentially interpretive case study (Walsham, 1995). The context, with an emphasis on the research setting's social and historical background (Klein & Myers, 1999), is described further in Holmqvist & Pessi (2004). We carried out data collection primarily through observations, semi-structured interviews, and workshops with stakeholders, decision-makers, designers/developers, and users. Observations and activities were recorded in a research diary. All implementation projects included interviews with the steering group chairperson, the project sponsor, and the person in charge of the pilot site (that is, the CIO, the aftermarket manager, and the dealer principal or equivalent). Furthermore, we interviewed other representatives in order to include all supply chain actors, gather different perspectives, and enrich understanding. Interviews ranged from 1 to 3 h, and began with open-ended questions to give the respondents a chance to elaborate as much as possible. The questions centred on the project, process, context, relation with other actors, etc., and we took notes throughout. These factors were also important during data analysis and comparisons between sources.

Once projects were deployed, we collected supplementary data via a user satisfaction survey. The first survey occurred 3 months after deployment, followed by new ones every quarter. Each survey consisted of an email with multiple-choice questions about existing services and the option to suggest improvements. The user feedback from each implementation project has been collected and analysed. Analysis and comparison between data sources were facilitated by the extensive context access, which let us reconfirm issues. This both strengthens validity and minimises biases. We used workshops to validate findings and refine our understanding of certain issues, such as 'revisiting' the scenario development during follow-on projects.

Research rigor is a question in any case study; typical critiques target the validity of generalisation or the lack of self-criticism. However, the main objective in this case is to increase the understanding of agility and Web service implementation by providing practical experiences and context characteristics. Given the rigorous process based on collaborative involvement, this paper can contribute to both organisational development and scientific knowledge (Schön, 1983; Applegate, 1999; Braa & Vidgen, 1999; Mathiassen, 2002; Bhattacharjee & Paul, 2004). Critical assessment and awareness of differences in roles during research can be challenging, but the interactions provide learning for both parties.

We now present the case context, current developments and implementations, thereby introducing aspects of agility in terms of both technology and business.

Case context and aftermarket logistics

This case is anchored in the real business context of aftermarket logistics at Volvo, a world-class provider of transport solutions, services, and products. With global presence and sales exceeding 170 billion SEK, Volvo's more than 85,000 employees focus on business-to-business operations in the areas of trucks, buses, construction equipment, marine and industrial engines, and aero (www.volvo.com).

Logistics is a complex operation characterised not least by intensive information exchange between several stakeholders. Aftermarket logistics with spare-parts distribution at Volvo involves thousands of suppliers and tens of thousands of distribution points to hundreds of thousands of end-customers (truck and vehicle owners and operators). The industrial product families contain more than 100,000 parts, which demand both a long-term service responsibility and complicated super-session chains.

Parts have become increasingly complex, both physically and because they are included in service arrangements and wider business solutions. Complexity has also increased as digital parts have been introduced and increased in volume. Fierce competition in the transport sector induces the business-to-business relations to focus on bottom-line results in the context of diminishing margins. At the same time, exploiting core competencies and finding new business propositions through innovations seem to be even more important.

Agility through implementation projects

The implementation projects we focus on in this case originated in the review and development of an ebusiness strategy initiated in 2000. Existing business-to-business relations were challenged in many ways. Still, in a mature and large-scale industry, things do not change overnight. Overall, business-to-business relations are strongly driven by business considerations rather than consumer behaviour – that is, productivity and bottom-line results matter more than image and appearance. At the turn of the millennium, it was time to change Volvo's Internet solutions from being simply a website that offered product and service information into a tool for conducting business with customers and dealers.

A main driver at this time was the common automotive industry view that the Internet, as a new technology, provided an opportunity to create an efficient channel to reach and conduct business with existing and new customers. Three main issues were identified as incentives for change:

- *Competitors*: Existing truck manufacturers or new entrants to the market might establish superiority on the Web. Special attention was given to the possibility of third-party Internet companies setting up to sell spare parts. This could develop into a potentially significant threat to the company's aftermarket business.
- *Cost reductions*: Internet and ebusiness could increase productivity in existing processes, as well as improve support for customers and especially for dealers. Services for the latter might include online training for mechanics, information and document distribution, spare-part look up, and so on.

- *New services*: The Internet provided an opportunity to broaden and expand the total offering, which might include simplified telematics services, load matching, and vendor-managed spare-parts replenishment.

Overall, Volvo's objective was set on establishing relations with end-customers. This represented a fundamental change, as the existing aftermarket relations were aimed at dealers, who in turn managed the end-customer business. The magnitude of this challenge was a concern, and the company viewed IT as an enabler. While the direction was clear – 'To reach end-customers, establish relations, and create a new channel', according to the Vice President of Volvo Trucks commercial development – it was also unconventional.

Given the widespread awareness and acceptance of uncertainty and unpredictability, it was difficult to set a large scope for the forthcoming change management efforts. In an attempt to avoid escalation effects, the management selected an untraditional approach in the Volvo context. The company decided upon a gradual development approach, which would gain agility through continuous action. This contrasted with the common refrain, 'Large change equals large project'. It can also be seen as an example of how to intentionally deliver agility. Previously, large change efforts at Volvo often resulted in large-scale projects. One example is Volvo's introduction of an electronic spare-parts catalogue for dealers. During the 1990s, relationships with dealers were well established, but it required a large IT effort to create electronic catalogue functionality. Furthermore, getting the solution rolled-out and implemented worldwide was a huge project. This single large development project had difficulties in specifying all functionality; it did not get input on needed context changes during development; and it rarely sought user feedback. It took more than 10 years to reach an acceptable status, incurring significant cost and lead-time over-runs. This paper focuses an initiative to reach end-customers, which is obviously even more challenging since establishing new relationships is a critical factor. Among the key issues here are the possibilities and implications of financial and legal relations (such as terms of payment and contract agreements) as the basis for trust and collaboration. Establishing a basic comfort zone is important when approaching both IS/IT issues and other business considerations. In this research, we had the opportunity to study an agile approach, enabled through incremental implementations.

Here, we present the implementation projects in separate sections. However, each is still part of an intertwined reality, just as IT and business aspects are closely connected. Regarding agility, one business manager at Volvo offered the following perspective: 'The elephant can not be a ballerina'. Asked to elaborate, he went on to explain that traditional strategic projects usually operate like large elephants to create impact, but then have difficultly finding their balance and fine-tuning during implementation. One of the biggest assumed advantage of keeping the initial implementation project relatively small – and thus more comprehendible – was that project participants would gain considerable knowledge from taking practical actions at an early stage. Striving for a perspicuous project size was a focus throughout the implementation process.

Scenario development

Along with an initial value-chain analysis and assessment of the supply chain actors, a number of hypothetical scenarios developed at Volvo. Four scenarios were developed for the online services project's imminent introduction, as Figure 2 shows (adopted from Holmqvist *et al.*, 2001). The arrows show the physical distribution path based on the order flow, which would be affected through the Web portals with relation to the customer order point. For example, the 'Today scenario' showed that there was no online connection between the dealer and the end-customer workshop, nor was there management of the distribution between the two (therefore the dashed arrow).

Scenario 1: The spare parts are distributed directly from the support warehouse to the end-customer, which is the customer's workshop in all scenarios.

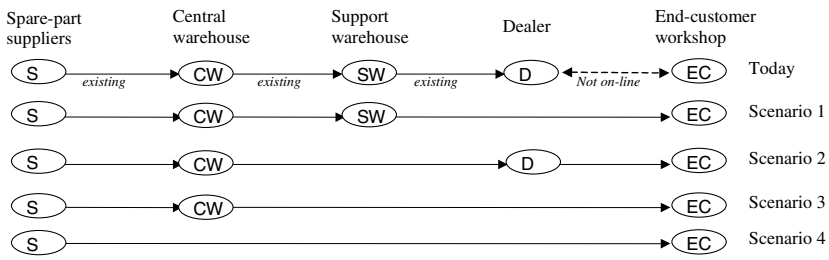

Figure 2 Overview of various scenarios.

Scenario 2: The spare parts are shipped directly from the central warehouse to the dealer and then from the dealer to the end-customer.
Scenario 3: The shipments are sent directly from the central warehouse to the end-customer, bypassing both the support warehouse and the dealer.
Scenario 4: The spare parts are sent directly from the supplier to the end-customer, bypassing all traditional distribution centres.

Vehicle manufacturers like Volvo have traditionally played a major role in the aftermarket supply chain. Their dominating position originates from their control of product development, large purchasing power, command in the distribution network, and influence on dealers and customers. From Volvo's perspective, the spare-parts manufacturer represents the supplier from which to buy spare parts. Dealers are the actors who buy spare parts from the vehicle manufacturer, and then service vehicles themselves or sell the parts to vehicle owners. Consequently, vehicle manufacturers refer to vehicle owners and operators as customers or even 'end-customers' that may have their own workshops.

It was decided that an initial implementation would create a platform with dedicated services for dealers and end-customers. Volvo would provide these services through a secure Internet connection that would support the customers' and dealers' total business cycle. This 'business life cycle' ranges from getting information about services and products, to getting online services for vehicle fleet operations and follow-up, to ordering spare parts and accommodating resell (e.g., of an older truck). This paper focuses on the spare-parts services, called *Parts Online*. Figure 3 shows an internal project illustration of the online services that would gradually become available through Web portals as legacy integration proceeds. (A public section of the portal is available at www.volvotrucks.com/onlineservices.)

Original implementation

The scenario development provided the original implementation project with various possibilities. At that time, however, only one scenario had been cleared for implementation. The most feasible option seemed to be to strengthen the dealer–customer relationship by providing an additional channel for spare parts. Volvo would build upon the existing relation with its dealers. By improving the 'dealer offer', Volvo would gain in the competitive marketplace. Many dealers appreciated collaboration. A dealer principal at an IS/IT mature workshop offered a characteristic comment: 'There are, of course, large differences between dealers; still, we do not have the possibility to lead this development on our own'. The implementation reinforced an overall business

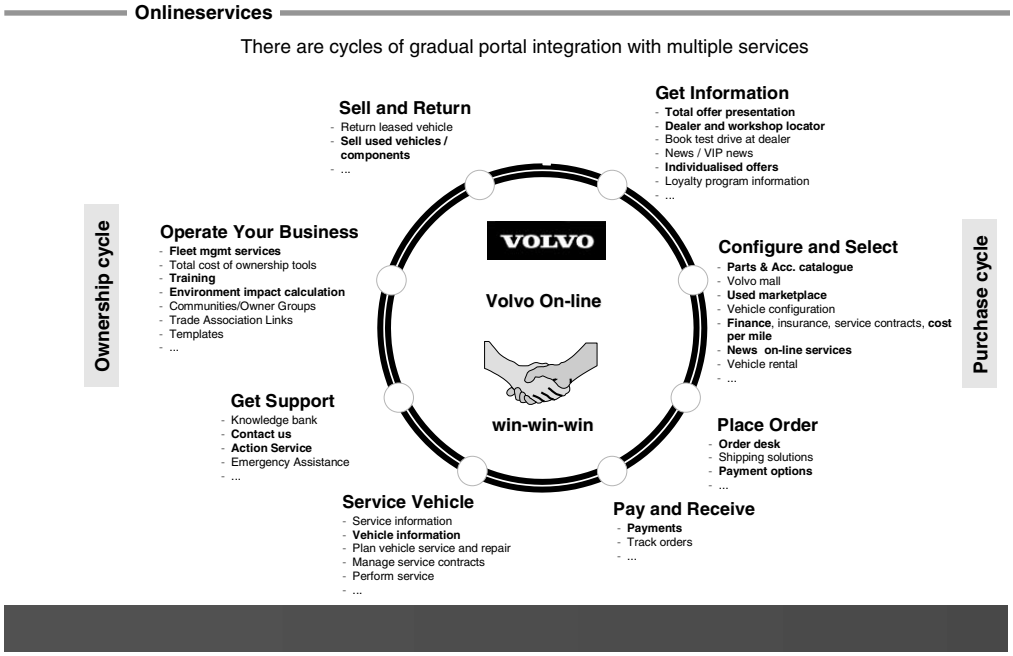

Figure 3 Internal Volvo slide regarding gradual development.

strategy that intended to attract end-customers from their own workshops to the dealer workshops. As Figure 4 shows, this approach essentially builds on Scenario 2.

For Parts Online, the original goal was to increase sales of accessories and consumable parts to any end-customer, as well as increasing sales of spare parts to end-customers who operate their own workshops within selected markets in Europe. Parts Online is a system where end-customers can search for and manage orders of spare parts 24 h a day, 7 days a week (24/7). Figure 5 shows an example screen from the Web portal. Originally, the functionality was organised into the following categories: *Find parts*, *Order parts*, and *Use parts*. Dealers could save time and resources on phone ordering, since end-customers would be able to do self-service on many activities. Volvo could gain experience and be involved in relationship build-up.

The original implementation project provided a means to reach customers, where the main impact was commercial relations, the technical platform, and extending the supply chain with delivery options and customer ordering systems. In Volvo's view, the largest challenges in deploying the technical platform were:

- single sign-on,
- multi-language and 24/7 capabilities,

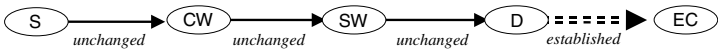

Figure 4 'Reaching end-customers' through the original implementation project.

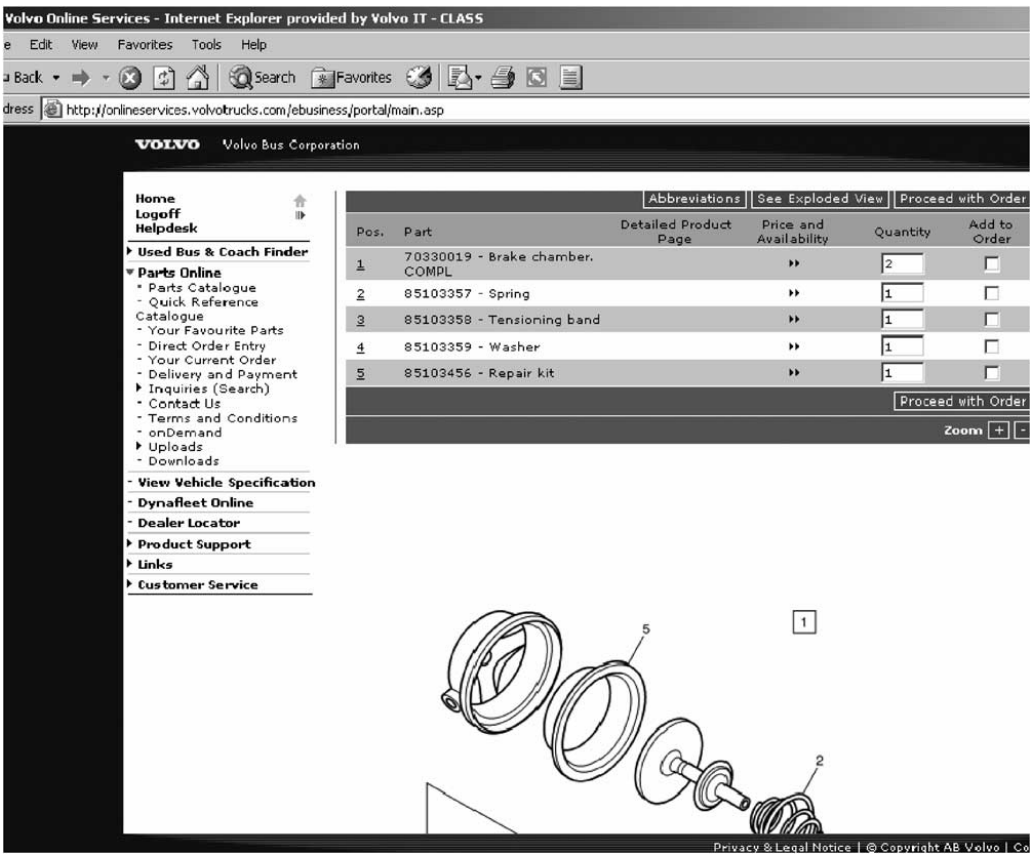

Figure 5 Example of Web portal screen from parts online.

- security,
- business process synchronisation, and
- legacy connectivity.

Single sign-on required tactical solutions to deliver access to different legacy systems without requiring users to log-on several times. The heterogeneity among end-customers raised new demands on multi-language and 24/7 capabilities, which development had previously down-prioritised as 'good-to-have'. Security aspects got several new dimensions due to considerable heterogeneity among the new supply chain actors. Difficulties with business process synchronisation and legacy connectivity will be discussed further below, but mainly relate to the implications of an unpredictable context. Nevertheless, the vast work did result in a platform that could actually be easily extended and respond in an agile way to increasing business demands. It also had functionalities that 'support the total business cycle'. (The next section addresses these developments.) This combined business and technology agility was a major benefit and, at the time, a large part of the innovation that would prove to deliver much more value than originally estimated. This would not have been possible without the first implementation. Furthermore, the implementation met considerable challenges in the central involvement of very local relationships. Market companies and dealers, as well as global functions, have yet to improve collaboration in cross-functional and cross-hierarchical ways. Consequently, this is still an emerging area.

Continuous implementation and innovation

Although there were large obstacles to overcome – both in terms of technology and relations – the established platform provided opportunities for 'follow-on' projects. Follow-on implementation projects refer to a directly succeeding project that can almost be regarded as a single flow of activities within the organisation. In this case, a project was launched based on a derived innovation. Not only would the Web portal features be usable directly by end-customers, they would also work for more established relations, such as those with importers. Importers mainly exist in small markets – sometimes referred to as the 'rest of the world' outside Europe and North America (e.g., Africa, Middle East, and Caribbean). Importers represent companies that import spare parts and sell to dealers.

Furthermore, in a few rare and minor cases, the aim was to extend business directly to end-customers. This would involve close proximity and human-to-human contacts from end-customers to dealers, but with the system and logistics connection going from a central warehouse directly to end-customers. The initial focus was on 'key customers' of large bus operators. To be considered a key customer, a person or organisation would have to meet certain criteria, such as having and maintaining a workshop with justifiable volumes and distribution points. A workshop manager at a large pilot site in Berlin summed up requirements on IS/IT as well as business: 'Even if we were interested in direct collaboration with Volvo, we had large demands on availability and productivity. It was good that their solution was not just a software installation'.

This first follow-on implementation, related to Scenario 3 and seen in Figure 6, generated a win-win-win situation between end-customers, dealers, and Volvo (and also gave importers a better offer). This derived 'win-win-win' situation emerged as a profound innovation and thereby a clear delivery of the introduced agility. The win-win-win situation, as well as the importer opportunities, had not been taken into account during scenario development. It has been a unique situation in which global functions, market establishments, and dealers collaborate both cross-functionally and between different levels. This has contributed much to learning and understanding the context. Furthermore, the return on investment has been very high in relation to the minor 'follow-on' investment that was required.

As the follow-on implementation was concluded, new possibilities emerged, not least because of the previous project's positive results. Volvo's focus was set on strengthening support to growing markets outside Western Europe (such as Asia) and extending the support warehouses' capabilities to deliver to end-customers. These warehouses were located in different countries to provide deliveries for Asia and Eastern Europe. Technically, the platform needed minor adaptations; the main objective was rather to extend logistical capabilities. That is, the goal was to use the additional capabilities to leverage agility and thereby provide business value.

Based on the experiences gained during the first two implementations, a second follow-on implementation (i.e., the third implementation project) was launched, correlating closely with Scenario 1 (see Figure 7).

Because there were several support warehouses, a main challenge of the implementation was to execute a more decentralised deployment. Although possible to manage, the deployment required close analysis and monitoring during roll-out. However, management attention was lower during this implementation project, resulting in

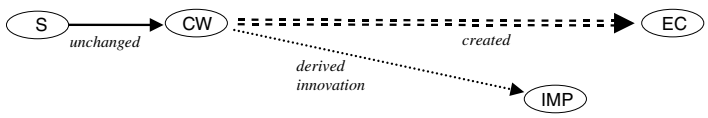

Figure 6 'Restructuring relations' through continuous implementation.

reduced focus. Technically, more advanced Web services (such as service instructions) could be developed. This was mainly because a critical mass of practical competence had been built-up, but also because platform stability had been established. Still, these Web services encountered difficulties, especially regarding alignment for business process synchronisation (Holmqvist & Pessi, 2004). As an example of the difficulty with business process synchronisation, even a 'simple' order entry can illuminate important implications. Once immersed in the details of the order entry process, each new party actually has differences, including cut-off times, order classes, transportation modes, and so on. These differences need to be assessed and managed. A quote from an end-customer in Singapore illustrates how she regards both the functionality and the new relationship: 'We would like to see enhancements to be made of the description of your services. At the same time, we are delighted for our established relationship and the way this can develop'.

Reflections on implementation projects

Before exploring the practical and theoretical considerations, we have a few brief reflections relating to the implementation projects. In the original implementation, the functionality was rudimentary, but evolved gradually. The context was very dynamic, and thus the project's scope was intentionally kept at a comprehendible size in order to secure deliveries. At the same time, this created a situation in which it would be possible to adapt rapidly to new issues during unpredictable conditions. The fundamental objective of reaching end-customers was, at least indirectly, initiated by strengthening the relation between dealers and end-customers.

The creation of a new platform was problematic. In order to establish relations with end-customers, it was essential to involve dealers. This triangle of relations was difficult to foresee as well as to manage. The main platform challenges were: single sign-on, process synchronisation, multi-language and 24/7 capabilities, security, and legacy connectivity. Some of these issues are classical in IT management discussions; others, such as single sign-on and business process synchronisation would benefit from more attention. Also, while advanced functionality develops through legacy integration and continuous implementations, the needs and implications of aligning processes become especially obvious. These might include (as noted by the user in Singapore) improving service descriptions in a technical way using WSDL, as well as assigning business contact people to nurture relations.

Although any summary of a complex context is doomed to have shortcomings, Table 1 is an attempt to highlight some of the characteristics that have been illuminated in this case (adopted from Holmqvist *et al.*, 2003).

The overall impression is that the initial implementation project's work offered payback in follow-on implementations. Both cost and lead-time were lowered considerably in later stages. The largest benefits of agility through implementation are that it enabled innovations in terms of functionality, IS/IT, and business coordination, and it offered the ability to manage

Figure 7 'Extending reach' through continuous implementation.

Table 1 Summarised view of implementation projects

	Original implementation (building on Scenario 2)	*First follow-on implementation (Scenario 3)*	*Second follow-on implementation (Scenario 1)*
Development cost (rel size)	1	1/5	<1/20
Lead time (rel)	1	1/2	1/4
Challenges			
Project process	Complex, because of the many functions involved, but with good focus	Easier, because of follow-on learning curve	Poor focus, because of less management attention
Technology	New, complex	Stabilising	Established
Commercial relations	Existing, but new collaboration	Emerging, but new	Experience from former set-ups
Logistics	Not focused	New	Existing
Results			
Cost/benefit	Emerging value	Great value	Value as expected
Innovation		Win-win-win relations	Extended reach and features

relations between stakeholders. The choice to keep projects at a comprehendible size contributed to these advantages. Still, the original implementation was generally perceived (especially during the first year) as too costly and delivering too little. The original implementation project was also perceived as taking longer than expected. However, in retrospect, choosing a relatively small implementation – even though the directional change was large – has come to be regarded as a successful approach. The learning enabled between business functions contributed to valuable experiences, particularly during stages of decreased management attention (as in the second follow-on implementation). In this case, the change process received different attention levels at different stages, and the agile characteristics possibly contributed to progress throughout.

The choice to strengthen the dealers rather than 'eliminate the intermediate' was seen as controversial, not least in the light of the initial 'ebusiness hype'. However, considering the products' complexity, the required service competence, and the supply chain structure, the choice has allowed the company to enable learning in several dimensions (Finnegan *et al.*, 2003). The business value objectives in terms of cost reduction potential were realised, but the number of expected online customers was overestimated. Dealers saved time by eliminating administrative work and decreasing time spent on the phone with customers. To maintain the relationship between Volvo and its dealers, it was important to reassure the dealers that the solution was built to support their businesses, not bypass them. By letting customers register with dealers and buy spare parts directly from them, financial and legal relations were maintained (while still allowing gradual changes). As experiences accumulated and relationships were built with mutual comfort and trust, innovations were generated. During the process, the concept of win-win-win arose, was formalised, and was used to communicate how a beneficial set-up for Volvo, the dealers, and the customers could be designed.

In order to 'support the total business cycle', Volvo chose a gradual approach to the integration of new services. The company was aware that establishing a new channel with new technology would be difficult, and could meet with resistance. Consequently, it aimed to include a valuable service in each part of the business cycle and expand gradually rather than to try to embrace everything at once (as Figure 3 exemplifies). The smaller scope and the goal of early interactions during implementations allowed essential learning in an uncertain and unpredictable context. This agile approach gave the organisation resilience while trying to conquer complexity in global aftermarket logistics.

Practical and theoretical considerations

Agility should be taken on with responsibility, expressed not just in words but in structure and culture (Dove, 2001). Because global aftermarket logistics has a high degree of uncertainty as a measurable dimension, it is possible to mitigate somewhat through good capabilities of sensing and responding. However, the context also contains ambiguity and unpredictability in non-measurable situations. Among the challenges are coordinating the development and implementation so that they lead to favourable business and IS/IT situations.

The case presented in this paper summarises and expands existing research, which include: aftermarket logistics and theoretical scenarios (Holmqvist *et al.*, 2001); the characteristics of ebusiness in logistics (Holmqvist & Enquist, 2001); actual ebusiness consequences for spare-part distribution (Holmqvist *et al.*, 2003); process integration and Web services (Holmqvist & Pessi, 2004); and initial findings related to agility and implementation (Holmqvist & Pessi, 2005). While several practical and theoretical considerations have already been presented in this paper, a brief overview may be valuable before we offer concluding comments.

The research presented in this case originates from a strategic revision made during a time of perceived turbulence ('the ebusiness boom'). The result was a decision to approach development and implementation incrementally, rather than manage change by launching a large project and change management initiative. The scenario development provided much initial awareness and remained a knowledge base, contributing to an architectural agility. Utmost, it leveraged implementation experiences by providing a relation to follow-on projects. The scenario development work was 'revisited' on several occasions: in formal workshops, as an introduction to new project members, and as refreshing inspiration to others. Using Web services proved feasible in this context. However, it also highlighted important implications: potential channel conflicts have been manageable (Görsch & Kühn Pedersen, 2000), strategic characteristics have been incremental rather than leapfrogging (Hackbarth & Kettinger, 2004), and differences in relations have changed gradually and been supported by electronic integration (Malone *et al.*, 1987; Rayport & Sviokla, 1995).

Before providing concluding comments, it is important to note that no general governance model for agility will be presented. At the most, scenario development can be seen as a guideline; given business dynamics, strategic developments are not amenable to strict control. Thus, many strategic planning and alignment approaches (e.g., Henderson & Venkatraman, 1993; Lederer & Salmela, 1996) might be inhibiting in practice, while simply allowing 'drift' (see Ciborra, 2000) may reduce the ability to drive progress. It is also important that developed scenarios (Schoemaker, 1993) not become prescriptive, but rather be used for strategic considerations and inspiration with an understanding that early, practical actions enable valuable learning.

This case illuminates important considerations regarding the discussions on extensive *vs* little strategic

planning. The main argument against little planning is that it can result in an insufficient understanding of the planning context (Newkirk *et al.*, 2003). This argument implies that more planning provides better readiness to achieve changes. However, in a context that is characterised by numerous international actors, sensitive business relations, and high uncertainty and ambiguity, there are demands on agile capabilities. In such a context, it is questionable whether more planning efforts would make an organisation more successful at implementing changes. As this case highlights, with a clear strategic direction – 'To reach end-customers, establish relations, and create a new channel' – it is possible to develop scenarios and be agile in direct actions during implementations. This contributes to continuous learning, which refines the development and provides results that would have been otherwise overlooked given the complex context.

Assuming that large global changes require large projects might provide a comforting feeling, but it can also lead to fixed project gates and milestone deliveries that grow into a mismatch with changing conditions. Thereby, the risk of project escalation increases (Keil & Mann, 2000). Volvo's project to develop an electronic parts catalogue for dealers is one illustration of this. Although de-escalation tactics (Montealegre & Keil, 2000) can be required if things grow out of control, it is better not to get into such a situation in the first place. Creating and sustaining agile capabilities is a way to mitigate such risks (Dove, 2001; Baskerville *et al.*, 2005). Learning and participation from actual implementations can influence scope, the number of affected users, supply chain actors, and geographical sites. The incremental and interactive approach between strategy and action, development, and implementation is favourable in the complex context of global aftermarket logistics. Consequently, agility is nurtured in two ways: by action through implementation, based on a strategic awareness; and by keeping projects small enough that it is possible to both comprehend and lead development.

Concluding comments

Volvo's structure for global aftermarket logistics relies on a platform that integrates legacy and new Web services, as well as on establishing new stakeholder relationships and altering existing ones. As the case shows, implementation projects emerging on a platform designed to address agile business demands bring innovations that enable a new business channel in a complex context. The study followed development and implementation, as well as innovations that emerged in the new business and IS/IT structure.

Creating a new platform is problematic, and establishing new relations is even more difficult. Among the key platform challenges were single sign-on, process synchronisation, multi-language and 24/7 capabilities, security, and legacy connectivity. The implications of single sign-on and business process synchronisation are particularly important areas for further research. With business relations, it is safer to introduce new technology within established domains, to build trust gradually, and to collaborate to gain contacts with new stakeholders. The financial and juridical relations required by any business-to-business relation create a comfort zone in which technical solutions and features can be introduced. As this case also illustrates, continuous implementation projects can deliver innovation in business concepts and in relations between stakeholders. Thereby, they can deliver an unprecedented agility in how IS/IT enables business value. The leverage for this is high, and it is easier to roll out the new channels after the first implementation.

In summary, agility is achieved by working continuously with scenario development and by keeping implementation projects to a comprehendible size in order to nurture learning. Both involve direct actions to manage technology and relations between supply chain actors.

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About the authors

Magnus Holmqvist (M.Sc.) is currently finalising his Industrial Ph.D. studies at the Göteborg University and the Viktoria Institute. He also works with Business Innovation at Volvo IT. He has extensive experience in global aftermarket logistics. His research interests include the integration of complex systems, process development and implementation, and project management.

Kalevi Pessi (Ph.D.) leads the Business Technology research group at the Viktoria Institute. He is head of the IT Management master programme at the IT-University in Göteborg. He has served as Managing Director and Knowledge Management Director in trade and industry. His current research interest relates to business value and architectural design.

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Paper 5

'SMART GOODS' AND MOBILE RFID A CASE WITH INNOVATION FROM VOLVO

by

Magnus Holmqvist
Volvo IT & Viktoria Institute, Sweden

and

Gunnar Stefansson
Chalmers University of Technology, Sweden

BACKGROUND

Today, the interest in RFID (Radio Frequency Identification) technology has resulted in various development and implementation activities at Volvo and other companies. Frequently the technology only substitutes for the traditional bar-code and is not used in an innovative solution to improve supply chain performance and collaboration.

RFID is emerging as a technology that is utilized for automatic identification of products and load units in different logistics contexts. The supply chain management context of today is increasingly complex, with global flows, just-in-time deliveries, customer demands for real-time track and trace capabilities, etc. Complexity and uncertainty are prevailing and a better understanding can be gained through research that provides contextualisations in areas such as aftermarket logistics. The large numbers of stakeholders in the supply chain and the desire to manage and control these complex supply chains demand better possibilities for data capture and increase of data capacity. The current developments are increasing the usage of advanced IS/IT solutions for logistics functions (Bowersox and Daugherty 1995, Stefansson 2004, Holmqvist & Pessi 2004). IS/IT development and implementation is considered as a critical issue. At the same time, logistics operations exist in a competitive environment and must secure fast and healthy return on each investment. Consequently, important considerations need to be made regarding how to manage this context.

The implementation of new technologies and switch over from already established solutions, for example bar-codes, does not come free of charge. Baskerville et al. are addressing the need of agility from both business and IT perspectives while implementing and using new technology (Baskerville et al 2005). Most RFID solutions involve fixed and costly infrastructure installations where reading antennas and related equipment, network and communication systems as well as integration towards legacy systems need to be established. Such RFID solutions are only financially justified in setups with high volumes and high value items. Consequently, most implementations are

based on closed-loop systems (Finkenzeller 2003; Fasth et al. 2005). Closed-loop systems refer to an intra company set-up where there is only one actor developing, implementing and utilizing the benefits of RFID, for example controlling assembly racks *within* a manufacturing plant without interaction between supply chain actors (actors are here used to describe both general participants in the supply chain as well as partners). An inhibiting factor for collaboration and more open systems is that the standardization of applying RFID is emerging but there are still implications since the standards are not (yet) widely used. An open system refers to a set-up in which several actors are collaborating and reaping the benefits of a RFID implementation, for example assurance of delivery *along* the supply chain.

The motivation behind the research presented in this paper is to explore how RFID can be utilized in more mobile and innovative ways and by that create new opportunities. In focus is a case including a setup of a mobile RFID solution using cellular networks (GSM/GPRS) together with web technology, and has been evaluated from the perspectives of operational reliability, usability and productivity. A mobile RFID solution that may leverage existing infrastructure, reduce integration needs and enable smooth collaboration can facilitate learning, usage and simplify implementations. By using the RFID tag as carrier of data, instead of other integration/data transfer it is possible to give the goods identification 'smart' features. 'Smart goods' are characterized by a higher level of sophistication than traditional goods identification. 'Smart goods' enhance supply chain performance through collaboration by enabling improved access, capture, usage, modification, dissemination and verification of information. The 'smart goods' capability is derived from utilization of RFID, cellular networks and web service technology.

This paper is part of several years of collaborative research between academia and industry, based on in-depth access to characteristics of Volvo and their aftermarket supply chain. The objective is to explore the business value in a new RFID setup. The results may assist practitioners concerned with RFID initiatives and nurture the academic discussion in logistics and IS/IT in general and evaluation of 'smart goods' and mobile RFID in particular.

This paper will now present the research method followed by a frame of reference. The focus is then made on the case study by describing the setup and characteristics. An analysis and evaluation of results is then made, with advantages and disadvantages, design constraints and business values, before concluding comments are presented.

RESEARCH APPROACH

The research method for this case follows an interpretive approach, with contribution of rich insight and drawing of specific implications (Walsham 1995). In-depth access to data collection has been facilitated through a management position that the first author holds at Volvo. The research in this paper is based on collaborative practice research (see Mathiassen 2002), which rigorous process has the purpose to provide contributions to both organizational development and scientific knowledge. Researchers and practitioners agreed to work in collaboration during this study and weekly

status meetings have been a formal occasion on which objectives and results have been discussed. Bartunek and Louis (1996) discuss 'insider and outsider' roles and the need to respect that there are different perspectives present.

In order to assess the feasibility of 'smart goods' and a mobile RFID solution, the setup that was initiated involved both a qualitative and a quantitative data gathering. The scope of the study is a supply chain flow from a Scandinavian supplier base, through a cross-docking terminal in Göteborg towards customers in Brazil. The qualitative case study method is primarily based on gathering information from personal and semi-structured interviews, observations, analysis of documentation and focused workshops (Walsham 1995; Yin 1984). The study was performed to describe Volvo´s operations in a supply chain setup and the applied mobile RFID solution. The semi-structured interviews addressed open-ended questions based on a written guideline to one or more respondents in strategic as well as operational positions. Workshops were held (especially to penetrate usability aspects) with several stakeholder roles, such as decision makers, designers/developers and users. The interviews were followed up by on-site observations and a comparison with existing documentation.

To enforce the qualitative approach, a quantitative study was carried out in order to generate data that could be used to evaluate the 'smart goods' and mobile RFID solution (especially to penetrate lead-time productivity). More than 3.000 measurements of various attributes were carried out in a unique context of mobility at the cross-docking terminal set-up. This quantitative data enabled enhanced possibilities to evaluate productivity gains, automation potential and implications for legacy system integration.

In order to explore how RFID can be utilized in more mobile and innovative ways three factors have been studied:

- Operational reliability, since new technology must be robust in an aftermarket logistics context;
- Usability, since mobile devices are required in many situations and involve lots of user interaction; and
- Productivity, since lead-time impacts the business case and is a determinant for return on investment.

The criteria for analyzing and interpreting the case is to evaluate performance of 'smart goods' capability, how it is derived and how convergence of the applied technologies can be utilized for logistics setup applications. Based on the analysis of the empirical data, advantages and disadvantages of the solution were summarized into a business case.

Different measures have been taken in regard to the quality of the case study. For the construct validity, multiple sources of evidence were used. Reflection-in-action and reflection-on-action among researchers as well as participating practitioners have been used to enforce quality (Schön 1983; Yin 1984; Applegate 1999). Case study explanations were made and sent to the respondents prior to the interviews. The case study reliability is enhanced by documented interviews, workshop notes, measurement results and research diary. Respondents as well as results of measurements

have strengthened the conclusions and contribute to expanding existing research. Relevant literature on logistics, RFID technology, cellular networks and IT-management has been reviewed to facilitate evaluation of primary data.

FRAME OF REFERENCE

The frame of reference contains relevant topics to establish a common language for the paper and explain terms and issues that relate to the case context.

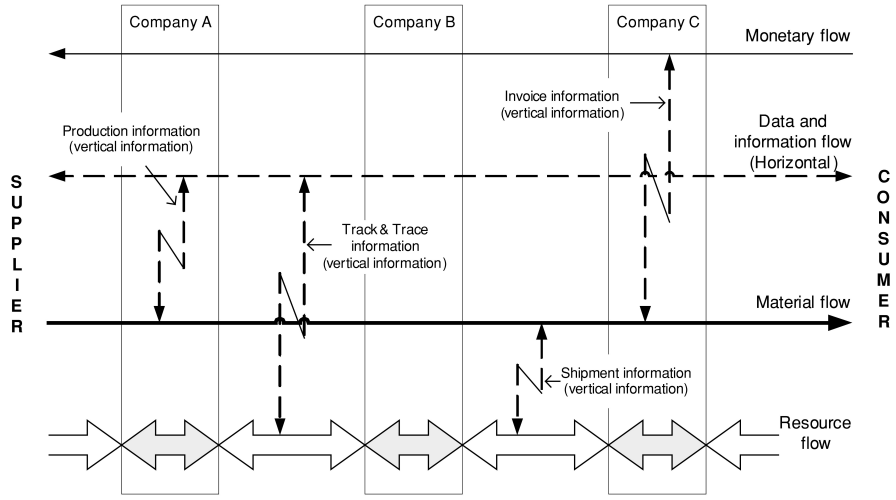
Supply Chain Management

There are several flows to manage in a supply chain (Stefansson 2004). These are the resource flows, including internal resources as forklifts, pallets or other load units and external resources as vehicles, containers, etc. In addition, flow of material exists between the parties, usually downstream and single directed.

The information flow is bi-directional between parties and finally the monetary flow is directed upstream in the supply chain. The flows are shown in Figure 1.

FIGURE 1

THE FOUR FLOWS IN LOGISTICS



Source: Stefansson 2004

The information flow is divided into two distinct flows (horizontal and vertical). The horizontal flow is the flow of data and information that goes mainly between organizations and between units within the same organization. The vertical data or information flow, on the other hand, is mainly kept within an organization and is often considered to be monitoring or control information. This information is desirable to distribute and make accessible to other actors at many occasions (Ciborra & Hanseth 1998; Christopher & Towill 2000). The vertical data or information flow connects the material flow to other flows, e.g. material flow to resource flow for tracking and tracing purposes, and material flow to financial flow for payment purposes. For that purpose, the identification of material and resources is very important and data collection activities become central to support fast and reliable decision making.

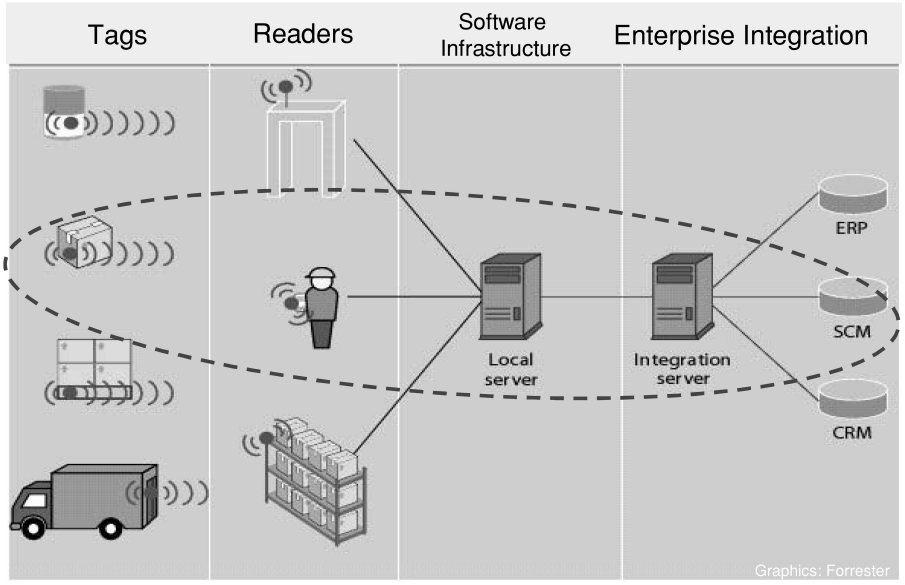
Radio Frequency Identification (RFID)

RFID is not a new technology of automatic identification – it has been around since the 1940s. The technology has been used by the military and other organizations with special needs as an advanced identification system. The RFID has only recently been used commercially and it was not until the late 1980s that it was introduced in industrial applications (Ollivier 1995). The diffusion of RFID has gone slowly, because of tough implementations, high operational costs, lack of standards and difficulties in collaboration between parties (Rogers 2003; Alvares et al. 2005; Quaadgras 2005). Usage of international standards is emerging (e.g. ISO 18000 and EPC), which has led to increased attention to open system implementations instead of justification on a closed loop basis only.

RFID systems are basically made by some main components, tags and readers and apart from these components, an application that handles the collected data towards the integration needs of the enterprise shown in Figure 2.

FIGURE 2

THE RFID SYSTEM ARENA



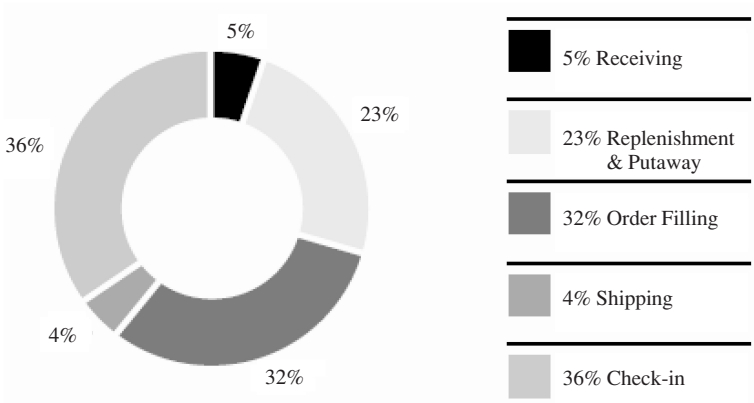
The dotted line is made to highlight the focus for the case presented in this paper. The Finkenzeller (2003) RFID technology can be described as a substitute to bar-codes and the main difference is that the RFID technology offers extended data capacity (e.g. individual item identification instead of just article number) and extended data capture possibilities (data collection without line-of-sight). RFID implementations are often associated with high start-up costs due to the required infrastructure of readers, network communications, integration installation, control system, setup tuning, software and integration, training, maintenance, organization and workflow (Chappell et al. 2002).

The Auto-ID Center has identified two key drivers that affect the degree of benefits derived from RFID solutions; the number of product touches and the current degree of process automation (Chappell et al. 2002). Increased number of product touches usually involve manual activities, thus increasing labor costs. Other benefit areas that can be identified are: order fill rate can be increased, lead time reduction as well as quality control can be improved, visibility as transparence through various transitions and storage can be made easier, etc.

Currently, many large scale RFID initiatives intend to deliver labor cost savings. Chappell et al. (2002) have identified the labor cost savings in various areas of the supply chain as shown in Figure 3.

FIGURE 3

LABOR COST SAVINGS



Source: Chappell et al. 2002

The figure above shows that the check-in and order filling are the areas of highest savings followed by replenishment and putaway.

Cellular Network (GSM / GPRS)

The telecom industry is continuously developing infrastructure for communication. The main objective of this study is to evaluate the feasibility of utilizing the existing cellular infrastructure in combination with RFID and therefore issues of the infrastructure have been investigated. The GSM standard (Global System for Mobile Communications) was introduced in the mid 1980s. Today, GSM is the most popular standard for mobile use in the world used in some 135 countries (Dubendorf 2003).

GPRS (General Packet Radio System) is a development of the GSM network which uses packet-switched technology and provides mobile device users with 40 Kbps for data transmissions (Ghribi & Logrippio 2000). GPRS is based on a standard issued by the ETSI (European Telecommunications Standards Institute) and is one of the main data services available for mobile cellular networks. The technology offers data access using packet switching over the regular GSM network (Elena et al. 2002).

An important aspect that affects the quality of the GPRS connection is the number of active users. More active users imply fewer available timeslots, which decrease the throughput per user and as a result, the latency increases. Latency can be defined as the time the data signal is transported through cables or network devices (Ruohonen et al. 2004).

This brief frame of reference can support a sensible theoretical basis to inform of topics and relevance to the field. The paper will now focus on the case context before evaluation and discussion of results. IT-management discussions that are concerned with challenges within complex contexts benefit from being enriched by results from in-depth case studies as addressed by Davenport and Markus (1999). This may be independent of if one has a tendency to favor strategic planning and alignment theories (Lederer & Sethi 1988; Henderson & Venkatraman 1993) or preferring Ciborra's perspectives of less control and more drift (2000). Thus, the case can enrich many areas.

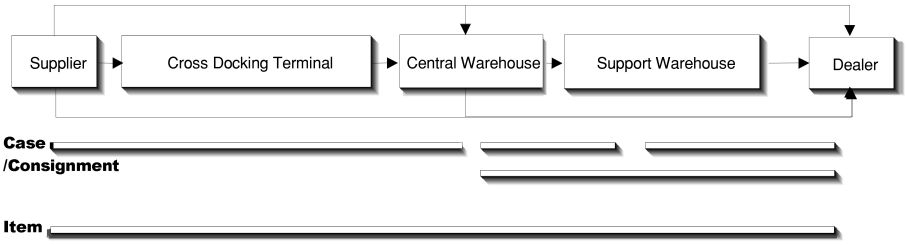
CASE CONTEXT, SET-UP AND EXECUTION

With global presence and sales exceeding 200 billion SEK more than 80.000 employees at Volvo focus on business-to-business operations in the areas of Trucks, Buses, Construction Equipment, Marine Engines and Aerospace. Volvo is a world-class provider of transport solutions, services and products.

Aftermarket logistics is a complex operation characterized by intensive information exchange between several supply chain actors, in the case of Volvo 1,000s of suppliers and 10,000s of distribution points at dealers. Every day ('365&24/7') around 70,000 order lines are handled towards more than 185 markets. Volvo manages inbound flows from suppliers via cross-docking terminals into central warehouses and support warehouses as well as outbound flows towards dealers (see Figure 4). The inbound flow normally contains an unbroken consignment of cases, which during the outbound flow are broken into different distribution units according to demand. In these flows, items (mainly spare parts) are distributed in various forms of cases and consignments depending on allocation and demand.

FIGURE 4

THE SUPPLY CHAIN ACTORS AND FLOWS



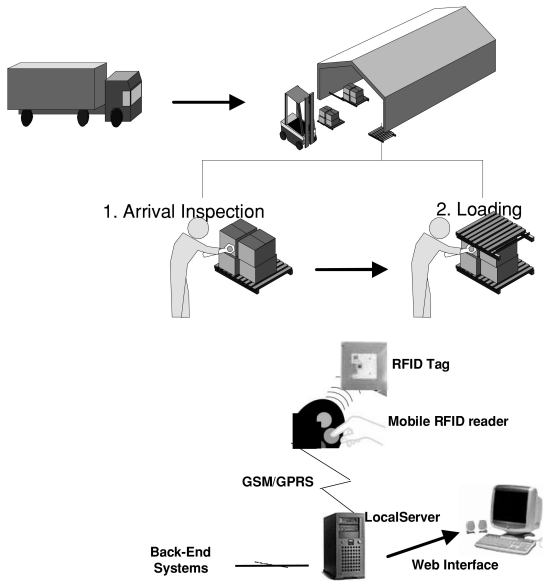
The industrial product families, for example a truck, contain 100,000s of parts, which demand both a long-term service responsibility and management of complicated supersession chains. The "parts" also increase in complexity, as they are no longer just physical but also digital as well as part of service arrangements and wider business solutions.

Case Set-up

In order to assess feasibility of 'smart goods' and mobile RFID as an emerging technology with potentials to leverage existing infrastructure and get innovative usage a practical setup was initiated. After a scenario development a detailed process mapping was done through workshops in order to ensure proper qualitative foundation for measurement. Experiences existed on closed-loop systems, within manufacturing, but the aim now was to go further with collaboration and open systems to address increased business value between stakeholders. The detailed process map out-lined interfaces and addressed potentials and resulted in an original implementation upon a suitable flow. This flow was seen as having a manageable degree of complexity, forecast of substantial growth and involved global characteristics as going from a supplier base in northern Scandinavia towards customers in the Brazilian market place. The mobile RFID solution was designed to manage two tasks: Arrival inspection and Loading (see Figure 5).

FIGURE 5

OVERVIEW OF THE CASE SETUP



The practical setup addressed and involved collaboration with the main actors along the selected supply chain flow. Other actors could participate, such as transport forwarders, customs agents, etc. The integration possibilities for such actors could be stimulated to various degrees by a web interface (through website access and web service request). Consequently, quick and differentiated adoption is facilitated with a shift from roll-out (ie push) to 'roll-in' and 'Get pull' effects (ie., that organizations and users pull access of offered functionalities). The analysis of integration needs was made to large extent involving the back-end systems at the cross-docking terminal. The quantitative data were collected in the hands-on operations at that site.

'Smart goods' and Mobile RFID Solution

To be able to read passive RFID tags, the mobile device must be a cellular phone that is equipped with an RFID reader that has a built-in antenna using the frequency of 13.56 MHz. The cellular network connection enables real-time data transfer between the mobile device and the back-end system. When the tag is within range of the reader the device application "wakes up" and confirms itself by

its unique ID number. This unique ID number is connected to attributes stored on a local server and used to facilitate an enhanced workflow of the legacy system. The end-user also adds data, depending on the application mode, via user input from the mobile device. The data transfer between the reader and the local server uses GPRS with the security of the SSL v.3.0 protocol. This protocol ensures authentication and data encryption of the connection. The RFID tag contains a unique serial number, but can also store information related to a specific device or task. When the reader has identified the tag, the mobile device performs the predetermined operations (in this case Arrival inspection or Loading). A local server was managing the event log and acting as a repository and intermediate towards integration with back-end systems and/or 'glocal' web connectivity.

To explain the 'Smart goods' thinking examples are presented from the Arrival inspection and the Loading activity. In terms of the Arrival inspection the RFID tag contains a 'Dispatch number', thereby the cross-docking terminal did not have to get such data integrated from the supplier base. Furthermore, the matching between actual arrived cases and invoiced cases is easily brought down to case level instead of dispatch level. This is enabled by that the mobile RFID reader collects each case-id handled and is then matched to the dispatch number. In the loading activity a container-id added through the mobile RFID reader could enable customer tracking of the goods.

Procedure for Execution

The results presented in this paper were collected during the winter 2004/2005, with a quantitative measurement period lasting six weeks. During this period the execution was made in normal operations and more that 3,000 readings were gathered for evaluation of the setup. Four persons were dedicated end-users at the cross-docking terminal. The purpose of the arrival application is to record the cases and consignments as they arrive, in order to increase productivity in data gathering activities and status reporting. The loading application supports the loading operations, where the cases and consignments should be assigned to specific cargo carriers (for example which container number). At the practical setup site the purpose of the loading application was to record in which specific container the cases were loaded, something that was previously done manually with pen and paper. This information is also crucial to provide towards the Brazilian customs clearance authorities.

EVALUATION AND ANALYSIS

As mentioned, the assessment of feasibility for the 'Smart goods' and mobile RFID solution has the evaluation criteria of operational reliability, usability and productivity. Fundamentally, the solution must be reliable in order to be applicable in a complex supply chain context. The mobility aspect addresses a certain attention towards usability, which is crucial for implementation and smooth roll-out. Any solution must be proven to deliver increased productivity in the supply chain context, due to competitive conditions as well as sensitive relationships between actors. Thus the

solution must at least be on-par with existing solutions in terms of productivity and then deliver other qualities or enable valuable services.

Operational reliability

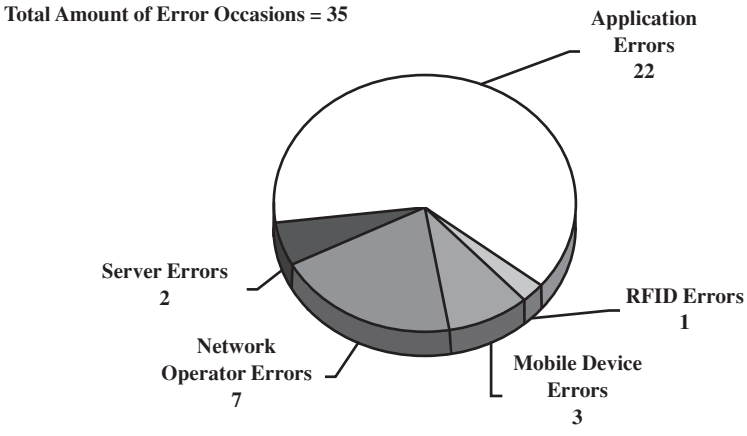
The operational reliability is based on evaluating experienced errors during the setup in connection to the mobile RFID solution. In order to provide overview of the reliability the errors have been divided into five categories:

- *Application errors;* Failures occurred in the application. At several occasions, mainly due to the same application interaction, the end-users encountered a software error that resulted in a blank display. When the end-users faced the blank display, the application had to be shut down and restarted in order to continue the tag readings.
- *Network operator errors;* These implied that the data captured from the tag readings were not transferred to the server, thus the application was no longer working properly.
- *Mobile device errors;* At one point of the setup one mobile RFID reader was detached from the rest of the device. Twice, while running the arrival application, the mobile device indicated "No RFID reader attached". This was analyzed and evaluated as an error connected to the device.
- *Server errors;* The solution experienced an outage in the delivery of mobile messaging services during a period of total two days. The outage was caused by a hardware failure in the provider's infrastructure. During the outage, certain services connected to text messages could not be sent.
- *RFID tag error;* One pure RFID failure was encountered during the setup, as one tag was not readable. Otherwise, the tested tags worked properly, also weather conditions like rain, snow and dirt did not prevent the tags to be read.

Out of the more than 3,000 reading events a total amount of 35 errors were experienced. The pie chart in Figure 6 illustrates the five errors categories and the error rate. The largest error category is application errors which represent 22 error occasions. The second largest category is network operator errors, which represents 7 error occasions followed by the mobile device, the server and the RFID categories.

FIGURE 6

THE EXPERIENCED ERRORS



Only one error was identified and categorized as an RFID error, thus RFID can be considered as having a high operational reliability of 99.96 % in relation to 3,000 readings. The fact that only one error occurred and the tags were re-used, indicates a high durability as well as strengthens the high operational reliability. Compared to other studies this is a rather high reliability (Finkenzeller 2003; Chappell et al. 2002), this would be the result even if one would compound all error categories. Still, crucial for evaluating the operational reliability of the mobile RFID solution is to regard each component, the mobile device and adherent applications as well as server and back-end integration. The 'Smart goods' and mobile RFID solution is dependent on these different parts, why it is relevant to measure the operational reliability for these parts as well. The distinguishing category is the application errors. The operational reliability for this category is 99.26 %, which is the lowest measure of the different categories. It could be argued if this figure is low, however, the application should have a high operational reliability as it is a critical component of the 'Smart goods' and mobile RFID solution. The application should be well functioning in order to carry out the intended task, otherwise it will affect the daily work. Possibly, the most frequent error could also be eliminated by enhancing the application. Overall, the operational reliability is considered to be high in this case.

Usability

In a context where there is clear and direct interaction between end-users and an IS/IT solution the evaluation of usability becomes critical. If that is overlooked large problems may occur during

wider implementations, affecting productivity as well as quality. According to the end-users at the cross-docking terminal, the mobile RFID device was easy and flexible to use in their work. This work implies a fairly rough environment, which requires durable tools. The mobile device had a plastic cover, which should protect the device against environments that contain moisture, dust, etc. However, the keypad of the mobile device is small and on occasions it could be difficult to press the right key. Since a lot of the work is performed outdoors, the end-users may use gloves (especially during cold months). It would therefore be an advantage if the mobile RFID solution had larger keys than conventional mobile devices, especially if the usage requires the keypad for frequent user inputs. Each case may have to seek different balances, for example, on the one hand it is preferable to have a small device and an easy-to-carry RFID reader and on the other hand it is desired to have a large keypad and display while performing some activities.

The end-users felt that the applications were easy to learn and simple to use in their specific environment. The applications designed for this setup included different user inputs which, according to the end-users, were unnecessary actions and time consuming. Scenarios from the end-user perspective, in this case, should be focused at enabling 'Reading of all tags in one sequence without any user input'. However, this 'extra input' may be an essential trade-off since one large gain can be to eliminate back-office or control work from other functions and bring them closer to the actual operations enabled by 'Smart goods' RFID and back-end integration.

Table 1 gives an overview of usability parameters and judgments from the end-users by highlighting positive and negative aspects.

TABLE 1

USABILITY JUDGMENTS

Usability Parameters	Judgment
Stand-by Time	+
Sound Feedback	+
Vibration	+
User Menues	+
Size	–
Keypad	–
User Input	–
Applications (Frozen screen)	–
Reading Distance	–
Display	+/–
Durability	+/–

Of course these aspects are highly context specific. At the cross-docking terminal the stand-by time (several days) and the sound feedback was most appreciated, while the reading distance and user input was perceived as most negative (due to the small device).

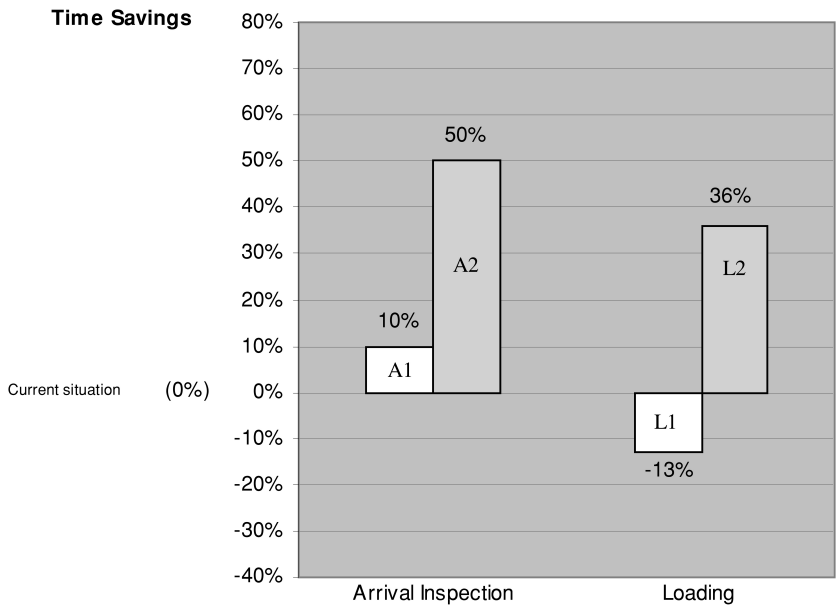
Other supply chain actors express that their usage of 'smart goods' and mobile RFID would make similar usability considerations. Overall, simplicity in devices and usage facilitates implementation and learning.

Lead-time productivity

Possible productivity improvements have been evaluated through measuring lead-times and making comparisons between a 'smart goods' and mobile RFID solution and the situation that exists without the solution. Time measurement has been performed regarding both the arrival inspection and loading activities with different results. As mentioned initially, the data from the more than 3,000 time measurements have not been used to get a statistical foundation, from which generalized conclusions can be drawn. Figure 7 provides a representative illustration of the results.

FIGURE 7

OVERVIEW OF LEAD-TIME PRODUCTIVITY



In the arrival inspection the results indicate a possible time saving ranging from around 10% (A1) up to as much as 50% (A2) compared to the current routines. The use of the Loading application indicate situations of more than 30% in lead-time reduction (L2). However, interesting and noteworthy, is that there are situations when the 'smart goods' and mobile RFID solution contributes to productivity decreases. It seems related to situations with a small number of cases and/or consignments per container, and the enforced data input may actually slow down the operations as much as more than 10% (L1). Specific brake-points for such a correlation have not been found at the point of presenting these results. The results which are presented can give an indication upon the size of lead-time impact and may be set in relation to other studies. However, to really draw conclusions the specific case characteristics will be determining actual outcome. This has been confirmed during workshop discussions involving the concerned supply chain actors additional to the cross-docking terminal, which also confirmed with different estimates that benefits in their own activities would be gained. An earlier section presented Figure 3 (Chappell et al. 2002), with an outline of RFID savings in relation to distribution of activities. The arrival inspection supported by mobile RFID may be interpreted as part of Check-in and Receiving activities and the loading application to be used during Order filling and Shipping activities.

The arrival inspection and loading routines differ from each other especially in respect of case and consignment quantities. At arrival inspection the number of cases checked is considerably higher than at the loading operation (due to the relationship between number of inbound suppliers and the much higher number of outbound distribution points). This circumstance might be a further reason to why the measured time savings are lower for the loading application than for the arrival inspection application.

DISCUSSION ON 'SMART GOODS' AND MOBILE RFID

In order to begin a summary of this paper, before concluding comments are suggested, a couple of recommendations may be valuable to share. 'Smart goods' and mobile RFID solutions can gain a basic value proposition by combining existing cellular technology with the emergence of RFID technology. A complex supply chain can benefit from leveraging existing infrastructure and thereby eliminate or lower the need for a new and fixed RFID infrastructure. These lower barriers of entry are based on two main components, on the one hand by utilizing existing infrastructure of the cellular network instead of building a new one, on the other hand by using mobile devices with a high degree of usability that are easy and fast to introduce.

The context specifics shall never be underestimated for actual implementations. Implications for supply chain management require business rules and integration efforts to handle an increased amount of data. Still, the results from this study may provide some insights to develop directions for 'smart goods' and mobile RFID solutions. Design constraints for applications can consider the amount of readings to be performed per minute and the number of data input per reading (recommendations in this case are set to <10 readings/minute, and no more than three data inputs/reading). Furthermore, there is a crucial aspect of the fact that GPRS/data package is a 'non-prioritized'

communication (Speech has priority and depending on the cellular network load, GPRS communication may be slower at certain occasions). Consequently, data retrieval should be limited in terms of size as well as designed for not becoming 'showstoppers' for operations. Interview respondents as well as on-site measurements confirm this direction.

The running costs of RFID tags are impacting the business case just as much as with fixed RFID installations, hence there is a preference to high-value items and/or case/consignment identification for open systems (McFarlane & Sheffi 2003; Smith & Offodile 2002). Existing operations are often optimized with usage of the standardized Odette label (within general automotive and aftermarket logistics). Odette uses bar-code systems for identification and information exchange between supply chain actors. In order to have a smooth transition from this setup, which can involve as much as seven bar-code readings per label, it is still suggested to incorporate a RFID tag into the Odette label. Different processes and actors may then transform and gain benefits gradually. Before a combined alternative is introduced it is likely that a separate RFID printer is being used. This will mean that there will be attachment of both RFID tag and Odette label for identification. Thereby, potential errors must be mitigated during a dual process. Just considering the 'smart goods' and mobile RFID solution in relation to existing back-end system integration the integration efforts can, in this case, be reported as requiring a third of the assigned resources. Gradual integration with focus on both business relationships between actors and usage of IS/IT is a critical factor to balance in order to find a successful match (Bowersox & Daugherty 1995; Holmqvist & Pessi 2004). Overall, the costs of a mobile RFID solution may be estimated as equal to a fixed installation regarding RFID tags and integration needs. However, with relation to local software, RFID readers and web service connectivity there are large cost savings to be utilized by levering the existing cellular network. Especially 'smart goods' thinking can facilitate collaboration and reduce such integration needs. Again, each business case needs individual assessment, but in the site setup presented in this case the cost savings have been estimated to be larger than 20%.

Learning from this case can indicate some context characteristics where 'smart goods' mobile RFID solutions may be favorable (to be considered in relation to the design constraints mentioned earlier): specific item dealer inventory control, vehicle/rental equipment return, break-down service assistance vans, yard management and cross-docking terminals (the latter as long as they do not handle too large volumes). General context are: high demands on durability (rough and dirty conditions), need for extended details (for example identification on item level, which bar-codes are unable to manage), need for mobility (with RFID for short range, GPRS/data packet for long range, web for 'glocal' info access/connectivity), and finally the low barriers of entry (utilizing existing infrastructure and advantages of easy setup, roll-out and usability). The value of being able to reconfigure a setup, depending on changes in the supply chain, adds capabilities of agility (Baskerville et al. 2005; Christopher & Towill 2000). Learning also high-lights a need to balance considerations on strategic alignment, planning and drift together with further aspects of researching the intertwined relationship of development and implementation (Lai & Mahapatra 1997). Consequently, managing by balancing can contribute to learning and innovation in the field of logistics as well as IS/IT.

Benefits for each supply chain actor may vary as well as their impact on relationships. By highlighting some for the supplier base, Volvo and the Brazilian market context this evaluation will be concluded. Suppliers which have manual routines and few implemented supporting information systems will gain more benefits of a 'smart goods' and mobile RFID implementation than a supplier which already has a high level of automation and sophisticated information systems. This is also dependent on which flow is concerned and can relate to Figure 1 (Stefansson 2004). Considering the challenges of introducing new technology in areas with low familiarity of using technology, the low barriers of entry of the 'smart goods' and mobile RFID solution may be an advantage. Furthermore, an increase in the degree of automation normally increases productivity and decreases errors (Chappell et al. 2002). At Volvo many end-users are equipped with mobile phones which are used for status reporting and communication with the planning coordinator for arrival and loading activities. The use of mobile phones increases the user mobility and availability, which allows reception of work orders on the move, making the work more efficient. With further advantages from the 'smart goods' and mobile RFID solution new business values can be gained.

Benefits for customers vary to an even larger extent due to their large quantity and heterogeneity. In the Brazilian market, which was directly involved in this study, many manual routines carried out at the receiving site involve registering, inspecting and allocating the arriving cargo. The improvements, at the reception area, are expected to be as large (or larger) than at the reference site. This is due to the fact that the manual activities are very time consuming. There is a problem with quality control points and the volumes would not justify fixed RFID installations. A 'smart goods' and mobile RFID solution can still provide benefits.

CONCLUSION

This paper has explored how 'smart goods' and mobile RFID can be utilized in order to create new opportunities in a complex context for supply chain management. An innovative mobile RFID solution using cellular networks with data package communication (GSM/GPRS) together with web technology, has been evaluated with the perspectives of operational reliability, usability and productivity. The evaluation is based on qualitative input from stakeholders in the Volvo supply chain together with more than 3,000 readings from a setup in an operational environment. The results show that operational reliability is important not only with regard to RFID tags failures but utmost with consideration to the whole flow of information. The relationship between supply chain actors relies much on the access and accuracy of data. Availability drives collaboration and by continuously managing both development and implementation learning as well as innovation is nurtured. The usability evaluation has revealed that a 'smart goods' and mobile RFID solution can be easy to use and quick to learn thus facilitating wide adoption among supply chain actors with a 'get pull' effect. The lead-time productivity improvements range from 10% up to as much as 50%, but also contain examples of productivity decreases of above 10% in certain use-case scenarios.

Present RFID implementations are associated with high costs, implying fixed infrastructure installations at each site. However, a 'smart goods' and mobile RFID solution can leverage existing

infrastructure and thereby utilize previous infrastructure investments and enable smooth implementations. Each business case needs individual assessment, but in the site setup presented in this case the cost savings have been estimated to be larger than 20%. Design constraints outline some guidelines on suitable volume and use-case characteristics for a 'smart goods' and mobile RFID solution. The case context implies suitability for flows of less than 10 readings/minute and no more than three data inputs/reading. Nevertheless, 'smart goods' and mobile RFID can enable open systems instead of closed-loop applications. Thereby, supply chain management and collaboration between actors can be nurtured and new value webs can emerge. Furthermore, this is supported by growing awareness and development of global standards. However, system integration should not be underestimated but addressed into each business case.

The results of research in this field may assist practitioners concerned with RFID initiatives and nurture the academic discussion of logistics and IS/IT in general and evaluation of 'smart goods' and mobile RFID in particular. Suggestions for future research directions can involve further statistical validation of practical results from RFID implementations, within similar or other business contexts. Research is also needed upon details from empirical settings, for example upon correlation between application tasks and volume/frequency of cases and consignments.

Currently, there are few studies in the area of mobile RFID solutions, but possibilities exist that this area will grow faster than other RFID areas and involve larger IS/IT challenges.

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ABOUT THE AUTHORS

Magnus Holmqvist (M.Sc.) is an Industrial Ph.D. Candidate at the Göteborg University and currently works with Business Innovation at Volvo Information Technology. He has extensive experience from global supply chain management with after market business as a speciality. Mr Holmqvist research interests concern IT-Management of IS/IT development and implementation, integration of complex systems and his research has been published in *Scandinavian Journal of Information Systems, European Journal of Information Systems* as well as at international conferences.

Gunnar Stefansson (Ph.D., Chalmars University of Technology) is an Associate Professor of information systems in logistics in the School of Management of Technology, Chalmers University of Technology and a Program Director at the IT University of Göteborg where he runs a Masters program within logistics. He earned his Ph.D. working on collaborative logistics management and the use of information technology to support logistics activities. Dr. Stefansson has published results from his research in many well known journals such as *Int. Journal of Technology Management, Int. Journal of Production Economics, European Journal of Operation Research, International Journal of Physical Distribution* and *Logistics Management,* and more.

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