LAPPEENRANTA
UNIVERSITY OF TECHNOLOGY

Petri Niemi

IMPROVING THE EFFECTIVENESS OF SUPPLY CHAIN DEVELOPMENT WORK – AN EXPERT ROLE PERSPECTIVE

Thesis for degree of Doctor of Science (Technology) to be presented with due permission for public examination and criticism in the Auditorium of the Student Union House at Lappeenranta University of Technology, Lappeenranta on the January 23rd, 2009, at noon.

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Abstract

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This study focuses to the intersection of three sets of activities in a company: expert work, development work and supply chain management, SCM. Experts and expert work represent a set of individuals whose efficiency and impact this study is intended to improve, while development work defines the set of organizational activities to focus on. SCM as an expertise area acts as the platform on which this study is built. The study has two aims. Firstly, it aims to derive a model helping an SCM expert to increase the effectiveness of expert work in development tasks by understanding the encountered organizational situations and processes better, reflecting his/her past and future actions to organizational processes and selecting and adjusting the processes and contents of his/her work accordingly. Secondly, it aims to develop applicable approaches and methods to understand, evaluate and manage the organizational processes and situations in development work.

The integrative model on approaches and methods to improve the effectiveness of development processes is split to two aggregate dimensions: technical performance of the developed solution and consumption of resources of the development process. Six potential approaches and methods aiming at helping in the management of organizational dimensions are presented in enclosed publications. The approaches focus on three subtasks of development work: decision making, implementation and change, and knowledge accumulation. The approaches and methods have been tested in case studies representing typical development processes in the area of supply chain management. As a result, four suggestions are presented. Firstly, SCM experts are advised to consider the SCM development work to be consisting of development processes. Secondly, inside these processes they should identify and evaluate the risk of difficult decision-making related to organizational factors. Thirdly, they are prompted for an active role in implementation and change, supporting the implementation through whole process. Finally, the development should be seen in a holistic view, taking into account the stage of knowledge and organizational issues related to it, and adopt a knowledge development strategy.

Keywords: Supply chain management, organizational development, expertise, decision-making, implementation, knowledge development, implementation, change

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Absolutely necessary people for this research process have been the co-authors of the studies. Janne Huiskonen has brought his wide knowledge and unfailing logic to the processes. Petra Pekkanen and Hannu Kärkkäinen have been in key roles by introducing the theories and frameworks applied in this work. I would like to express my gratitude to all three co-authors for their analysis effort, valuable questioning of my reasoning, their contribution to the writing of the publications and, finally saying that "This is ready for publishing." Otherwise the writing of this dissertation could have proved to be a never-ending task.

It is clear that without my former work history this project would not have started at all. I would like to thank all those people who have provided material to this project by participating in the development projects that are a source of questions and wonder and material of the study. Special thanks belong to my former colleagues, with whom the questions have been discussed, leading in the end to the research questions of this study.

To carry out a research and writing project requires physical facilities, time and financial support. All of these have been provided by my employer, the Department of Industrial Management at Lappeenranta University of Technology: it has provided me excellent working facilities, allocated time for the research work and, paid also a salary not only for teaching but also for doing research. People who have been directly or indirectly contributing to this work have been so numerous that it is not possible to mention them all, so thanks to all the people in the Department of Industrial Management, and special thanks to all the people of the Supply Chain and Operations Management Laboratory. I also thank Liikesivistysrahasto and Suomen Logistiikkayhdistys for motivating financial support.

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Lappeenranta, November 25th, 2008

Petri Niemi

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This thesis consists of an introductory part and the following six research publications:

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2. Niemi P. & Huiskonen J. (2006). ***Quantitative analyses in strategic supply chain decision-making – a tool for decision or a weapon for struggle?*** 14th International Working Seminar on Production Economics, February 20-24, 2006, Pre-prints volume 3, pp. 247-257.

3. Niemi P., Pekkanen P. & Huiskonen J. (2007). ***Improving the quantitative analysis impact on supply chain policy-making***, International Journal of Production Economics, 108 (2007), pp. 165-175

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6. Niemi, P., Huiskonen, J. & Kärkkäinen, H. (2008b). ***Supply chain development as knowledge development task***. Accepted for publication in International Journal of Networking and Virtual Organisations.

The contribution of Petri Niemi to the publications has been in all the papers to be responsible for identifying the research questions and planning of the collection of research data and writing the major parts of the paper. The data has been collected by Petri Niemi, except papers 5 and 6 where the data has been collected together with Janne Huiskonen. The analysis of the data has been carried out together with co-authors. Co-authors took part in collecting the literature in studied area, and had an agreed role to question and check the data, observations and reasoning.

Part 1
Overview of the dissertation

1 Introduction

Today's business is dominated by expertise and experts. This is an obvious consequence of the increasing complexity of the world around us: phenomena like globalization and rapid development of information and communication technology have made the practices of business and manufacturing more and more complex. The only way organizations can manage the complexity is specialization: business and industrial organizations have become collections of valuable *experts* rather than groups of interchangeable workers. An increasing number of employees work as "knowledge craftsmen", combining their expertise with other experts. Also more and more experts are not directly involved in the product development and production technology, but they work as specialists, consultants, staff advisors, coordinators, or project or development managers on expertise areas like marketing, purchasing, legislation and *supply chain management*, the expertise area concerned in this study. Typically they conduct and lead *development work* in their expertise area using their expertise to analyze activities, pinpoint problems, make plans, give advice and recommendations, coordinate development, harmonize practices and implement new systems and techniques. For a firm to survive in competition today, this kind of expertise and development work is becoming more and more valuable.

One of the most unquestioned concepts of modern management is that development work consists of cycles of analyzing, planning, decision making and implementation also referred to as the problem solving cycle (Schön, 1983; van Strien, 1997). Analyzing and planning have self-evidently been experts' playground, while decision making and implementation have traditionally been seen as a management and leadership issue: experts provide a solution and managers decide whether to implement it, and after that they take control of the implementation. However, the picture has changed and will presumably continue changing. Experts exercise significant power in many decision situations requiring special knowledge, where the general management simply can not do anything else than rely on the expertise. An expert can define for instance what to point out for analysis and what suggestions to announce for decision making (Langley, 1995). The more complex the business environments and technologies become, the more dependent the companies are on expert knowledge, and the more important the managerial task is to ensure that the specialized experts work towards common goals. As a managerial problem, this is often seen as a problem of communicating the values, objectives and strategies. However, an obvious question, but seldom asked, is whether this phenomenon should also be seen as a problem related to the expert role and work. Obviously, most of the research on decision making and implementation from the management perspective is valid even though the viewpoint is changed to one of an expert, but it is also obvious that there are some differences in the means and actions of an indirectly responsible expert compared to ones of a responsible manager in decision making and implementation.

The expertise to move goods from supply sources to the consumer has played a significant role in the development from the management of limited resources of the early days of industrialization to today's abundance of goods and services. The expertise area, nowadays known as *supply chain management* (SCM) has taken under

its umbrella various techniques and approaches and evolved to a distinct profession with distinct education to it. Lambert et al. (1998) define supply chain management as "the integration of key business processes from end user through original suppliers that provides products, services, and information that add value to customers and other stakeholders". From the definition of supply chain management it follows that as a development area SCM spans organizational boundaries, extending from a company's internal development between units and departments to development work considering different companies as members of the same supply chain, which may be the most dominant characteristic of SCM development work. Accordingly, decision making and implementation are spread to more or less independent units and companies. This characteristic has led many SCM scholars state like J. F. Shapiro, (2001, p. 25) that "barriers to implement new techniques and practices (integrated supply chain management) are organizational, not technical". Likewise, the main message of the survey and literature review of Fawcett et al. (2008) is that the success (and failure) of SCM is founded on people. In the daily work of SCM experts this characteristic means that they have to live with a multitude of organizational aspects related to their development issue in addition to the technical complexity of their "own" development area. The SCM experts are expected to lead the supply chain development work between different cultures and organizational environments, to find solutions and head for a decision between conflicting aims and objectives, not to mention developing and implementing new techniques and operating models for and with people with a large variety of knowledge and skill levels. This study aims to fill the gap in the understanding of SCM development work, especially from the viewpoint of an SCM expert, and above all find approaches helping to improve the effectiveness of SCM expert work and impact for practical situations.

1.1 Research domain and objectives of the study

The research domain of this study can be described as an intersection of three sets of activities in a company: expert work, development work and supply chain management, SCM. Experts and expert work represent a set of individuals whose efficiency and impact this study is intended to improve, while development work defines the set of organizational activities to focus on. SCM as an expertise area acts as the platform on which this study is built. This set-up means that the results of the study can be expected to contribute primarily to the expertise area of SCM and to other similar expert work and development areas. The definition of the domain is illustrated in figure 1.

The fundamental aim of this study is to find ways to increase the speed and efficiency of the adoption of SCM techniques in business organizations. From the standpoint of an SCM expert, the problem of slow adoption can be seen for example as an inability to decide on actions despite sound reasoning, slipping from agreed policies, resistance to change practices, and in general slow adoption of new techniques. The reasons behind these perceived problems can be technical and related to the core skills of an expert, but they are often caused by lack of understanding of organizational and managerial aspects of the solution in hand. This study focuses on this elusive category of reasons, looking at them from the standpoint of an expert in an advisory role. It aims to find ways of an SCM expert can help the organization more effectively to

achieve higher performance in the SCM area by fitting the suggested solutions and the development activity to the organizational situation.

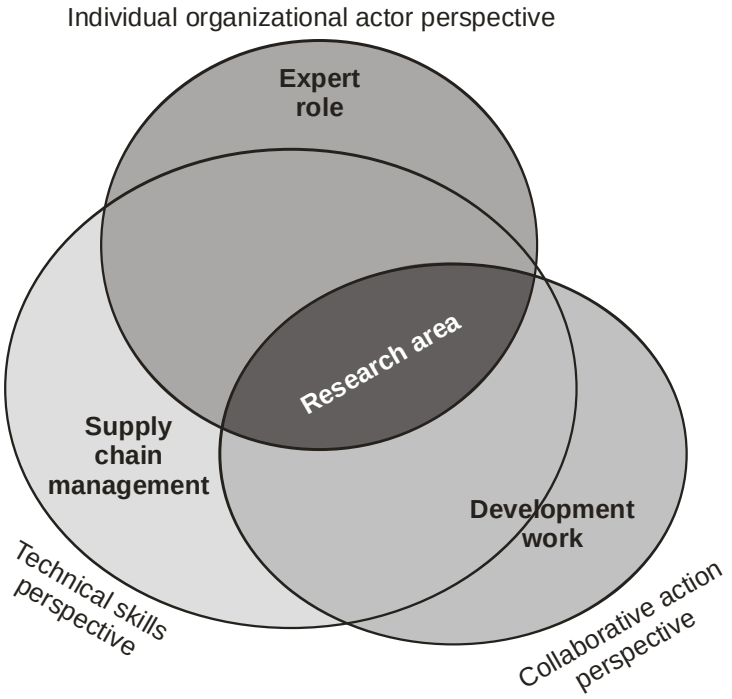

Figure 1 - Research domain of the study

The general approach of the study can be seen as a quest to find solutions for a class of problems, in the spirit of the *design science paradigm* (van Aken, 2004, 2005). The ultimate aim is to construct approaches for an SCM expert to assess better the organizational and managerial situations faced in practical development work, trying to find ways of how the expert can improve his/her work by understanding the organizations and organizational situations better. This general aim has been refined as two objectives for this research:

Objective 1	To derive *a model* helping an SCM expert to increase the impact and effectiveness of expert work in development tasks by: - better understanding of the encountered organizational situations and processes - reflecting his/her past and future actions to the organizational processes and - selecting and adjusting the processes and contents of his/her work accordingly.
Objective 2	To develop applicable *approaches and methods* to understand, evaluate and manage the organizational processes and situations in development work.

To clarify the terminology, *an approach* describes an overall perspective on a phenomenon and how to bring it about. *A method* is subordinate to approach, and it gives operational guidance to actors (Werr et al., 1997). The objectives mean that theory is used as an instrument for crafting a model, approaches and methods aiming to help the practitioners in their work. The goal is to derive from theory a model helping in understanding the organizational situations and processes SCM experts face in development work. Understanding itself is not the objective in this study, but constructing a model and approaches helping to understand the situations.

1.2 Outline of the thesis

The thesis consists of a summarizing report and six enclosed research publications. The first chapter of this summarizing report introduces the research subject and defines the objectives of the study. In the second chapter the research area is defined and the research is tied to background theories and research literature. The third chapter presents the research strategy and the methodological choices made in the study. The fourth chapter introduces an integrating model aiming to help an SCM expert in understanding, adapting and affecting the organizational dimensions in development work. The chapter ties together the six approaches for SCM experts to understand, adapt and affect the organizational dimensions, presented in the six enclosed research publication. Chapter five concludes the study and discusses the scientific and managerial limitations and implications of the study.

The enclosed research publications are:

1. Niemi P., Pekkanen P. & Huiskonen J. (2004). ***Understanding the strategic supply chain decision-making – when solving a model is not enough***, EUROMA 2004 –conference, Fontainebleu, France, June 27-30, 2004, proceedings vol. I, pp. 435-444.

2. Niemi P. & Huiskonen J. (2006). ***Quantitative analyses in strategic supply chain decision-making – a tool for decision or a weapon for struggle?*** 14th International Working Seminar on Production Economics, February 20-24, 2006, Pre-prints volume 3, pp. 247-257.

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2 Expert role, development work and supply chain management

As usual in social sciences, and especially in the quite young discipline of management research, the concepts and terms are ambiguous, and need to be defined in every study. The research domain of this study has been defined as an intersection between three sets of activities in a company: expert work, development work and supply chain management (SCM). SCM as an expertise area acts as the platform on which this study is built. Firstly, the concept SCM is introduced focusing on especially the characteristics of it as an expertise and development area. In the broader sense, experts are those individuals whose working practices this study is intended to improve. The second section gives an insight into how the concept expertise has been seen in the literature and what are the general remedies and potential approaches the literature gives to expert work. The third concept, development work, defines the set of organizational activities this study is focuses on. In the last section of the chapter, these three concepts are tied together and the research gap is defined.

2.1 Supply chain management

The term supply chain management came into common knowledge in the late 1980's as an extension of logistics, though some scholars see the terms interchangeable. Logistics, as well as many other terms commonly used in business, originate from military terminology. In business language it generally refers to the management of the flow of goods, information and other resources, between the point of origin and the point of consumption in order to meet the requirements of consumers. In this study it is not necessary to take up the cudgels for or against any definition, by confining to the widely cited definition of the Supply Chain Management Council:

> *Definition 1* **Supply chain management (SCM)** means integration of key business processes from end user through original suppliers that provides products, services, and information that add value to customers and other stakeholders" (Lambert et al., 1998).

The key business processes of SCM, constituting the field of integration, are (Cooper et al., 1997; Croxton et al., 2001)

1. Customer relationship management
2. Customer service management
3. Demand management
4. Order fulfillment
5. Manufacturing flow management
6. Procurement
7. Product development and commercialization
8. Returns management

As a branch of science, SCM has its origin in the discipline of operations research and operations management (OR/OM). OR/OM is an interdisciplinary branch of applied mathematics which uses methods like mathematical modeling, statistics, and algorithms to arrive at optimal or good decisions in complex problems. The history of OR can be traced back to the 16th century, but naturally its integration to common industrial practice follows the industrialization and especially the emergence of Scientific Management introduced by F. W. Taylor in 1911. Since then its significance has risen together with the astonishing development of computing capabilities. Studying the content of almost any academic SCM training program reveals that the core of SCM skills consists of operations research methods: applied mathematics and statistics, wide variety of different models and algorithms to be applied in different situations. It is obvious that the educational background guides the SCM practitioners to an analytical, fact-based, systematical problem-solving approach (Sprague, 2007).

The development of data systems and data processing capabilities in the last decades has enabled more sophisticated modeling and numerical analyses. However, presumably most SCM practitioners have experienced that even the most thoroughly calculated analyses and recommendations do not ensure quick decision making and smooth implementation. One possible reason for this can be the SCM practitioners' viewpoint on decision making: in SCM practitioners' world decisions are made based on analyzed facts, and the decision process itself is a rational, linear process producing an objective choice between alternatives, while the reality of decision making is a complex, recursive, irrational, even political mixture of processes. (Sprague, 2007)

It is important to note that SCM experts potentially use significant power in the development work even without a formal decision making status by deciding what to point out as a problem or development area and what to suggest for possible solutions to the problem (Langley, 1995). Secondly, the implementation of a complex operating models and techniques in complex environment requires usually highly specialized expertise involvement in the implementation process. The expertise and presence of experts is naturally necessary to teach and train people new ways to operate, but also because the implementation includes changing, fitting and developing details and also developing the models and tools further. It is obvious that an SCM expert needs, besides the core substance of SCM, knowledge and skills to manage the organizational issues related to the development work, especially in circumstances typical to SCM development: crossing organizational borders and strong involvement in decision making and implementation processes (van Hoek et al., 2002).

An excerpt from the definition of SCM, "integration of key business processes from end user through original suppliers" (Lambert et al., 1998) highlights the most dominant characteristics of SCM as an expertise and development area: it spreads its influence over organizational boundaries, not only between units and departments inside a company, but also between independent companies of a supply chain. One manifestation of the increasing importance of the organizational dimension of SCM is that most contemporary textbooks on SCM or OR/OM devote a significant number of pages to organizational aspects. As an example, a book headlined "Modeling of the Supply Chain" (Shapiro, 2001) addresses one chapter out of twelve to "Organizational Adaptation to Optimization Modeling Systems". To mention some findings focusing

on the relationship between SCM and organization, Johannessen and Solem (2002) present how SCM (or logistics) ideologies are evolving from machine ideology to network ideology, in which shared control and trust, coordinated cooperation, learning and information sharing are key issues. Stonebraker and Afifi (2004) approach SCM to find contingencies between supply chain technology and differentiation and integration. In their study, supply chain technology refers to evolutionary phases of SCM technology.

Studies taking the perspective of an individual SCM manager or expert have not been numerous recently, after the early days of logistics and definitions of logistics managers' responsibilities. However, in the rapidly changing world the question of what an SCM expert needs to know and master, is a question of high relevance, especially for educators. To mention some latest studies from this perspective, Giunipero and Pearcy (2000) have gathered importance ratings on thirty skills from purchasing professionals. Gammelgaard and Larson (2001) have studied the perceived importance of 45 context-independent logistics skill areas of logistics practitioners and students. The conclusion that top ten skills are occupied with human and organization-related skills like interpersonal communication, decision making, and teamwork can be drawn from both of these studies. The similar results of Mangan and Christopher (2005) add change management to the list. It should be noted that these studies have considered the work of an SCM manager, not expert work. However, managers of an expertise area like SCM shift constantly between manager and expert roles because of the coordinating nature of the expertise area. Carrying out and conducting supply chain development work, SCM managers have seldom direct authority over the issues seen necessary to change, and in that sense the findings of these studies give some insight into the required skills of an SCM expert. The abovementioned studies reinforce the presumption that the organizational situations and processes where are too narrowly understood by SCM experts. Consequently, it seems to be worth the effort to focus on how an SCM expert can approach these organizational situations and processes more easily and efficiently.

In their study on the benefits, barriers, and bridges to effective supply chain management, Fawcett et al. (2008) present quite thorough literature review on studies dealing with barriers to strategic supply chain management. They have found totally 34 studies considering the issue, published between the years 1994-2004. A summary of barriers to effective supply chain management is presented in table 1, and a summary of bridges to effective supply chain management in table 2.

It is interesting to note that very few remedies are suggested in the literature to managing the managerial complexity of the SCM task, although it is seen as a relevant problem. It is easy to see that the focus SCM research is on technical solutions to collaboration. The factor of attention to human factor in table 2 refers mainly to human factors of internal and external collaboration (Akkermans et al, 2004; Barratt, 2004; Handfield and Nichols, 2004; Mentzer et al., 2000).). There has been an over-reliance on technology in trying to implement it (McCarthy and Golocic, 2002), and the SCM interface to the organization and organizational culture has been paid very little attention to.

Table 1 - Barriers to effective supply chain management (Fawcett et al., 2008)

Barriers to effective supply chain management		Occurrences in the literature
Interfirm rivalry		
1.	Internal and external turf wars	16
2.	Poor SCM planning	10
3.	Lack of vision of SCM	9
4.	Lack of channel trust	8
5.	Executive commitment	7
6.	Poor SCM understanding	7
Managerial complexity		
7.	IS/IT deficiencies	10
8.	Organizational structure / culture	9
9.	Lack of SC measurement	8
10.	Lack of alliance guidelines	7

Table 2 - Bridges to effective supply chain management (Fawcett et al., 2008)

Bridges to effective supply chain management		Occurrences in the literature
1.	Information transparency	16
2.	CFT/CF collaboration	16
3.	Collaborative planning	15
4.	IT architecture/internet	11
5.	Formal performance tracking	11
6.	Adoption of strategic SCM vision	11
7.	Attention to human factors	11
8.	Supplier certification/reduction	9
9.	Target segmented customers	8
10.	Shared investment/benefits	4

To summarize SCM as an expertise and development area, there is a major dilemma: by nature SCM crosses the organizational boundaries, but as an academic discipline it is strongly based on applied mathematics. The crossing of organizational boundaries emphasizes the understanding of the organizational processes and understanding the social context of the organization, while the education of the SCM experts based on applied mathematics leads to a rational, mechanistic conception of an organization. The aim of this study is bridge this gap.

2.2 Expert role and expertise

Webster's dictionary (1994, p. 502) defines an expert as "a person who has special skill in or knowledge in some particular field; a specialist; an authority". From the definition it follows that expert and expertise are psychological and sociological concepts. Since the 1940's, expertise has been a research subject of cognitive psychology, dealing with fundamental questions like the development to an expert, processes mediating the expertise, the role of gathered knowledge and skills vs.

individual talent. (e.g. Tynjälä, 1999; Ericsson, 2006). In the sociological context, organization theory has produced many concepts related to expertise and expert work. One of the earliest observations, specialization pays, from the levels of nation to an individual, was noted already by Plato 2.000 years ago and for example by Adam Smith in 18th century. Max Weber claimed that in an organization there must be a hierarchy of authority and the organizational roles should be staffed on the basis of technical competence rather that kinship. In the 20th century F. W. Taylor and Henri Fayol started the evolution of management thinking. Although there are hints on the use of staff advise dating back to 2000 BC Egypt, it was in the mid-nineteens James D. Mooney and Alan Reiley introduced the staff function and suggested that staff activities should be clearly distinguished from line activities. The notion "line commands, staff advises" lays the ground to what expert and expert work means in this study (Khandwalla, 1977).

As the name implies, the focus of organization and management research has been managers, their work, perceptions, thinking, roles, and the way how they form, change and interact in the organization. The traditional thinking on expertise has seen it as a resource which the management utilizes. Expertise hiding in the heads of experts is a managerial expedient and its utilization is the manager's responsibility. In the last decades the roles of an expert and manager have gone through a vast change. However, in many situations it is difficult to distinguish the expert and the manager, and necessity to do it can be questioned. It can be said that despite the role a person has, the business environment calls for a more proactive and responsibility-taking role from every participant, among others those individuals who approach the reality from the angle of an expert (e.g. Senge, 1992).

Basically, the experts in focus in this study can be divided to two main categories: members of staff and consultants. However, more and more people working in business organizations "drift" between the roles of the manager, expert, and even worker: a logistics manager is the head of logistics department, but has as a secondary duty to make a plan for a companywide supply chain improvement program. This is the reason why it has not seen necessary to delimit the research area of this study to a specific organizational entity, but to the work domain, expert work, despite who is carrying it out. For the purposes of this study, expert role can is defined as follows:

Definition 2 **Expert role** is advisory role utilizing distinct expertise, where the individuals are neither directly responsible for executing and implementing the results of it, nor directly responsible for making other people to execute the results.

Following from the definition, the contribution of expert work to the organization discussed in this study is *advice*: a solution to a problem, a plan or a suggestion for action.

The problems of the model based on extracting the expert knowledge have led to different approaches to help practitioners in solving problems in organizations. An expert can help the people in organizations to find the solutions themselves: a consultant, researcher, as well as any individual interferes the organization by being in interaction with individuals in the organization (Argyris, 1970, 1993; Korhonen,

2008). This kind of deliberate, external intervention is called by Edgar H. Schein process consulting (Schein, 1987, 1988, 1999), and his work gives excellent guidelines for interventions in face-to-face situations. As the basic idea of process consulting is to "help others to help themselves", these skills are certainly useful for an expert consultant or any expert. Though Schein (1999) argues that it is not useful to develop typologies of intervention, this study argues that from an expert point of view there is room for more generic approach to organizational situations than seeing every situation as a special situation. The argument is supported by two practical observations: firstly, psychology-derived "facilitative intervention" (Schein, 1999, p. 245) skills require totally different orientation to organization than for example a technically educated and oriented expert has. It is difficult to step from an involved expert to an intervening facilitator. Secondly, (good) facilitator skills can be obtained only during a long period of practice (Schein, 1999).

The aim of this study is to improve the effectiveness of expert work. Measuring the effectiveness of advice is difficult because the organization gets the benefit of advice only after it has implemented the advice. Seeing the effectiveness in the context of the expertise area, the measuring turns to evaluation of the advice itself, and the solution is compared to the theoretical and professional state-of-art solutions of the expertise area. For example the suggested supply chain model is compared to the technical performance of the best available models. In the organizational context this may be misleading. The effectiveness of the advice should also be seen as the effectiveness of the process of formulating and implementing the suggestion: the less a solution requires the organization's effort or resources, the more effective it is.

2.3 Organizational development work and development process

In the business language, the word *development* has two meanings. It can mean active and deliberate work to gain something or it can mean a "natural" flow of changes in the environment to which the organizations try to adapt. In this study the phrase *organizational development work* is used to stress the deliberate, and systematic and target-oriented nature of the work carried out by individuals in organizations, which covers a wide variety of activities. Secondly this study focuses on a certain type of development work: development of supply chain management. SCM as a development area is described below in details, but in general the development work in question has effects on the organization itself: its processes, practices, and how it is organized. For the purposes of this study development work can be defined as follows:

Definition 3 **Organizational development work** is deliberate, systematic work carried out to bring out the capabilities or possibilities of the current resources of the organization and/or to bring the organization, a part of it, or a set of organizations to a more advanced or effective state.

In the organizational context, development work is related to the role of staff in classical organization theory and to planning and planning function of an organization (Mintzberg, 1979). A specialized planning function emerges when the management task gets too complex to handle with direct and middle line supervision. In the triangle planner-manager-worker the planners, or developers, carry a part of the line manager's planning and control task by standardizing the processes, outputs and skills of the organization. In that context, development work means all the work needed to formulate those standards, carried out by planning specialists, experts in their own areas. In practice, most development work can not be isolated as expert work from doing and managing, it involves all organizational actors: managers (decision-makers) decide what to develop, with what resources, select what standards are implemented and take at least some responsibility on the implementation of the new standards. Workers get involved in the implementation process but are also often involved in the planning process.

Active, systematic development work carried out in organizations can be divided to two broad categories according to the initiative: continuous improvement and strategy-driven development. Strategy-driven development has its origin in strategic planning paradigm dating back to 1960's, work of H. Igor Ansoff (1965) and his contemporaries and management paradigms like management by objectives. The logic is to hierarchically divide the strategic aims to development objectives, then to plans to achieve the objectives, followed by implementation of the plans and, finally, follow-up the success of the action. Continuous improvement has its origins in the quality management paradigm, where W.E. Deming introduced a recursive development process known as Deming's cycle, where the follow-up of the improvement actions triggers a new process of improvement action. In practice these approaches are difficult, and not necessary to distinguish when discussing the development work itself. However, seen as deliberate work, systematic development follows more or less the phases of analyzing, planning, decision making, implementation and follow-up cycle.

Maybe the most easily observable manifestation of contemporary systematic development work is *project management* (Kertzner, 1992, Johansson et al, 2007), which has risen to a focused research area in the last two decades, has broken out from the anatomy of a project to management of projects and linking the projects to strategy. Research and development on the project management area has produced applicable tools and practices. However, seeing the development work as project management supplemented with project selection and prioritization gives too simplistic view to the development work, because a significant part of development work is carried out outside defined projects. Reasons for this are various. Research on project management has pointed out that a significant problem of the project organization is the relationship between the project and the permanent organization (Johansson et al., 2007). In the practical life the problem can simply be that project management skills can be inadequate, or, the project organization is too heavy for some development activities. Some development issues can be implemented for example as a new policy by simply enforcing and informing the organization. Despite the apparent simplicity, the new policy can be a result of an intensive and exhausting analysis and development work carried out by experts in the area. Also an essential part of development work is analysis work not included in any specific project, neither aiming at one. This includes for example analysis of the applicability of new

techniques, feasibility studies, current performance analysis and solving emerged problems.

Though an interesting question, this study does not concern the necessity to organize development activities as projects. It aims to find approaches and methods, helping to understand and manage the problems related to decision making and implementation inside and outside projects. However, to manage and study development work it is necessary to split it to smaller building blocks, hereafter called *development processes*.

Definition 4 **Development process** is an organizational process aiming at bringing the organization, a part of it, or a set of organizations from the current, unsatisfying state to a more advanced or effective state.

The definition comprises both processes aiming at solving a perceived current problem and goal-driven development processes. Looking at the development work and processes from the viewpoint of an expert, some typical roles of an expert related to organizational practices and processes can be identified. Some of these roles are presented in table 3.

Table 3 - Typical expert roles in SCM development processes

Task	*Expert role / task*
Analyzing	- Analyzing current practices and processes. - Comparing current practices to best available practices or best applied practices. - Defining and describing problems in current practices.
Planning	- Planning better performing practices and processes. - Developing alternative solutions to problems. - Coordinating development on one's responsibility area
Decision making	- Pinpointing problems needing to be solved. - Making suggestion the allocation of resources to own responsibility area. - Suggesting prioritization of actions.
Implementation	- Giving advice and recommendations. - Translating plans to practice. - Solving practical problems in implementation.

2.4 Framing the effectiveness of the SCM development work

As stated in the topic of the study, the model to be presented below is intended to improve the *effectiveness* of development work. Development work can be categorized as knowledge work. Gregerman (1981) defines that the output of knowledge work is usually difficult to quantify, and the effectiveness of the work depends mainly on the approach selected by the knowledge worker. Because the

development work, especially in the area of SCM, is collaborative by nature, its effectiveness is an elusive concept. There is also some literature on the effectiveness and performance measurement of white-collar work in general, where the performance measurement can have three purposes (Takala et al., 2006):

- *Administrative purposes*: recruitment, promotion and motivation
- *Improvement purposes*: analysis on problems and target setting
- *Strategic purposes*: seeking desired outputs contributing to the overall goals of the organization.

In this context the effectiveness is seen as the performance measurement for strategic purposes. An expert carrying out development work can be considered effective when he/she promotes those development issues which give the highest value added for the effort of the whole organization. This composition is derived from the presumption that the utilization of expert knowledge increases both the quality of the implemented solution and the effectiveness of the development work. In other words, the presumption can be put so that we believe that the more the decision making and implementation are based on experts' knowledge, the better they are. Obviously this kind of positivistic conception is quite far from professional reality, as the connection between the quality of input data and the quality of the decision is not at all straightforward and clear. However, it is arguable to take this presumption as a starting point for research purposes, simply because the dominant way of thinking of SCM experts stems from the positivistic conception of reality.

Development work is defined above as deliberate, systematic work carried out to bring out the capabilities or possibilities of the current resources of the organization and/or to bring the organization, a part of it, or a set of organizations to a more advanced or effective state. It can be thought to consist of a set of development processes, carried out by an expert usually together with the rest of the organization. Through development processes the expert knowledge is diffused to the organization for example as new ways of working. Seeing the development work in the context of surrounding environment of the expertise, the effectiveness of development work can be reduced to the effectiveness of the solutions or plans. Looking at the problem from the viewpoint of a problem, dimensions of the effectiveness of development processes can be expressed as:

1. ***Technical performance*** of the developed suggestion
2. ***Consumption of resources*** of the development process

Being an SCM issue in this study, technical performance includes both the technical and economical performance of the solution. Consumption of resources includes expenditure of money, work, time, starting from analysis to the last steps of implementation both from the expert and the implementing organization. Both these dimensions aggregate a multitude of variables, not necessarily easy to distinguish or measure. As a simple example of the model, figure 2 shows two suggestions for development processes. In the figure suggestion A is technically and economically superior compared to suggestion B. However, the technically and economically superior suggestion requires more resources. The reasons for this can be numerous:

the planning phase requires more skills and work, the decision making phase is time-consuming because of its wider implications to the organization, and the implementation stage may be difficult because of deeper changes to current working practices and skills requirements.

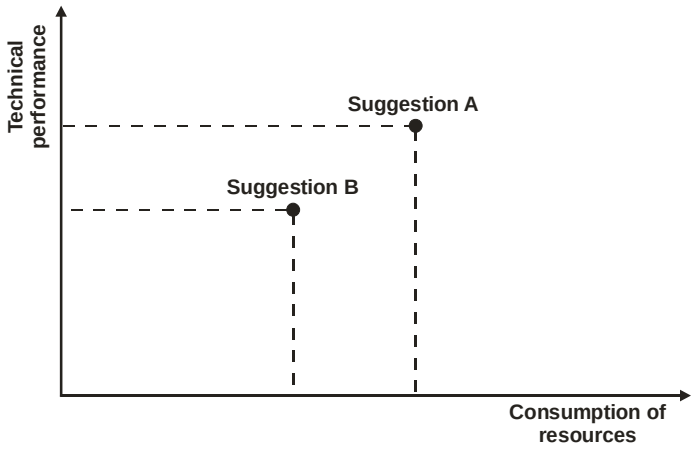

Figure 2 - An illustration of the dimensions of the effectiveness of the development process

It is obvious that aggregate measures make it difficult to position actual suggestions or potential development processes in the frame. Reflecting the perception that decision making is in many cases seeking for satisfying rather than optimal solutions (March, 1994), the illustration gives an adequate principle how the development initiatives are actually evaluated. It should also be noted that an essential managerial decision is to allocate the development resources between development processes. The allocation can be more or less transparent, ranging from joint agreement of a development project portfolio to heuristic evaluation processes of single suggestions inside individual managers' heads.

From the viewpoint of an expert, the field can be seen as a battlefield of competing development suggestions. SCM development suggestions compete with each other and against other suggestions potentially utilizing the same resources. Basically, a sound, well communicated strategy should inhibit this kind of thinking, but it seems that in big companies this viewpoint can very concretely guide the expert work. In practice it is seldom possible to derive all the development issues from the strategy, for at least two reasons. Firstly, the origin of the development issues lies in operative problems and analyses of operative work and processes. Secondly, the development issues can stretch beyond the strategy period or they are potential building blocks of a new or revised strategy. In that sense there is plenty of room for an SCM expert to guide the development by suggestions.

2.5 The research task

The prevailing moving spirit of this study can be expressed by citing J. F. Shapiro (2001, p. 25) "barriers to implement new techniques and practices (integrated supply chain management) are organizational, not technical". Consequently, the major presumption of this study is that increasing the skills to handle organizational barriers increase the SCM expert work effectiveness. Basically, the increase can stem from two sources:

1. Improving the management skills to understand the SCM concepts better. After that it is easier for the management to relate the expert's suggestions to organizational context.
2. Improving the SCM expert skills to understand, evaluate and manage the organizational processes and situations in development work better.

This study focuses on the latter one, improving the expert skills. It is obvious that the role of an SCM expert is different in different situations, but in this study the focus is on individual SCM experts who see their role themselves primarily as that of technical advisor, or situations where an SCM expert is seen by the surrounding organization primarily as a technical advisor. However, it is obvious that the approaches developed in the study could contribute to managerial work as well.

The technical expertise area in question is broadly defined as supply chain management. The aim of the research work can be put as an intention to build bridges out of the sandbox of an SCM expert, starting inside the box by laying the foundation on built-in rational, analytical models of thinking and extending those bridges to the surrounding, fuzzy and irrational environment called the organization.

The question of whether an SCM expert, carrying out a development task and being responsible for a development process, should see his/her role as an external, facilitating consultant or as an involved technical advisor was raised above. From this standpoint, a fundamental presumption on when the framework presented below is applied can be made: an SCM expert has to make a trade-off between improving his/her core, technical skills and consulting skills. One can, and in many cases it is even fruitful to learn a process consultant role and improve one's intervention skills in face-to-face situations. However, there are several reasons why a technical (SCM) expert should mainly stick to his/her core skills. Firstly, the more the expert spends his/her resources in the facilitator role, the more the organization loses his/her technical resources. Secondly, it may be difficult to shift between the expert and the facilitator role in practice (Schein, 1998). However, the salient argument of this study is that if an expert understands the organizational aspects of his/her work, the organization can achieve higher performance.

The general aim of the study is to find ways to relate the development process and the content of the expert's suggested solutions to organizational issues faced during the process starting from analysis and ending up in the implementation and follow-up of the solution. As a scientific research task, the principal aim is to piece together a view to the problem area. On the other hand, this study starts from the fundamental

presumption that there is existing research to be applied to the research field. The research task is twofold. Firstly, the task is to formulate from existing literature an intermediate level model to describe and understand the key organizational aspects of SCM expert work in development processes. Secondly, the task is to develop approaches and methods based on existing research and demonstrate their usefulness in conceptualizing practical problems and suggesting general solutions to problem situations. The task can be expressed as research questions as follows:

1. How to describe the development process in the context of organizational situation and from the viewpoint of expert work?
2. What kind of approaches can be utilized to improve the effectiveness of the development work?

These research questions focus the work outside the mainstream of SCM research, which means that the relevant literature is not very large. To summarize the assessment of this study in relation to previous research, the main characteristics of this study have been described in chapter 2.1, where it is also shown that there are two streams of studies related to this research agenda. Firstly, there are some studies taking the perspective of individual SCM managers and their skills (Giunipero and Pearcy, 2000; van Hoek et al., 2002; Gammelgaard and Larson, 2001; Mangan and Christopher, 2005). The aim of this study is to contribute to that stream by focusing on the expert role typically included in these job descriptions. Secondly, there is a stream of research focusing on the implementation of supply chain management practices (Fawcett et al., 2008; Akkermans et al, 2004; Barratt, 2004; Handfield and Nichols, 2004; McCarthy and Golocic, 2002; Mentzer et al., 2000). To this research stream, this contributes by presenting practices to carry out the implementation task. As an additional connection to previous research, the work of Korhonen (2008) can be mentioned, which approaches the same problem by aiming to find ways of how to help people to find solutions by themselves as a cross-functional process development effort, while this study approaches the problem in the context of bringing in expertise and expert knowledge to similar processes.

3 Research strategy and methodology

In this study, the driving force has been the author's perceptions of the research issue during more than a decade as a practitioner, precisely as a consultant in the expertise area of SCM. During numerous projects the perception that many assignments had been more successful if the author and his colleagues would have understood better the organizational situation to which the assignment was related, has became more and more evident. It is also obvious that there are plenty of potentially applicable theories, not directly applicable to expert and development work in the SCM environment, but possible to operationalize to such an environment with reasonable effort. This chapter outlines first the general approach or paradigmatic orientation of this study, how this study deals with the reality and nature of knowing. After that the methodological choices to carry out the research are presented and justified. Finally, the research data and its collection are presented and discussed.

3.1 On paradigmatic orientation

All science is based on paradigmatic thinking involving distinct assumptions on the nature of reality (ontology), how we can come to know that reality (epistemology), and how we can systematically access what can be known about that reality (methodology) (Guba and Lincoln, 1994). There are numerous ways to classify research paradigms, and one of the most commonly cited in social sciences is the one of Burrell and Morgan (1979), which divides the paradigms to four categories according to whether they emphasize regulation and stability vs. radical change and whether they represent subjective, individualistic theories vs. objective, structural theories. For this study, as for the mainstream of organization theory, the discussion about radical structuralism vs. regulation is irrelevant, but the subjective-objective discussion comes closer to the research area. Staying on the regulative side, the objective side is called *functionalism*, while the subjective side is called *interpretivism* (Burrell and Morgan,1979).

For the last century, the mainstream of academics doing research on economics, business and organizations, have adapted the positivistic, functionalistic conception of science (Emory, 1985; Burrell and Morgan, 1979). The epistemological heritage of positivism is to search regularities and causal relationships among basic components. Together with the ontological assumption of objectivity, the conception that the reality exists independent of those observing it, the goal of functionalistic research is replication in the service of theory testing and refinement. In practice this means that the data should be collected and analyzed in such way that another researcher collecting and analyzing similar data under similar conditions will get similar results. On the opposite side interpretivism, a subjectivistic conception of reality is that the reality, or the reality perceived as objective, exists only in the observer's mind and is therefore subjective. Consequently, it denies the search of regularities and causalities, instead it is based on the belief that a deeper understanding of a phenomenon is only

possible through understanding the interpretations of that phenomenon from those experiencing it (Goles and Hirscheim, 2000; Shah and Corley, 2006).

Because interpretive research and functionalist research have different aims, but both are needed to develop theory, it is important to note that each has its strengths and weaknesses, depending on the research question being investigated (Shah and Corley, 2006). It is obvious that the dominance of a single paradigm does not fully reflect the diversity of the social, organizational and phenomenological reality (Goles and Hirscheim, 2000). In that sense, though the original set-up for this study was the author's perception as an expert consultant that the real business world does not follow the logic of the positivistic philosophy of life, the positivistic and functionalistic perception of nature has not been thrown aside. Quite the contrary, the aims of this study rely strongly on the findings and conceptions of positivistic, functionalistic research: the axiom that processes are reducible to physiological, physical or chemical events has not been questioned, but the limitations of the paradigm have been realized. New viewpoints have not been looked from extreme subjectivistic and interpretivistic paradigm, but rather extending from the ground of the positivistic paradigm towards the other extreme.

In social sciences, among others in the research areas of organizations and management, poor diffusion of research results to practice is a widely recognized problem. Frequently suggested reasons for this is are related to poor communication and the factors making the communication between management scholars and practitioners (Whitley, 1988). Sometimes this is seen as a dilemma, namely a rigour-relevance dilemma, meaning that the knowledge is either scientifically proven, but too reductionistic, broad or trivial to be of practical relevance, or relevant to practice, but then lacking sufficient scientific justification (Schön, 1983; Argyris and Schön, 1991). Pettigrew (1997) sees the dilemma as double hurdles, the research should meet criteria of scholarly quality *and* managerial relevance. As one answer to this dilemma, a philosophical school known as *pragmatism*, argues that the methodological choices are subordinated to pragmatic value of the research (Tashakkori and Teddlie, 1998). For a pragmatist there is an objective, positivistic reality, existing independently from an individual, but in can be only imperfectly understood (Goles and Hirscheim, 2000). In this study pragmatism means that it is still believed that operations and SCM research produce results that can be applied to practice to gain better results, but in practice it should be accepted that the application of these results, in the organizational and social context, is too multifaceted to an approach based on assumptions of fully rational behavior, like operations research (Huiskonen, 2004).

One consequence of the rigour-relevance problem is that a professional practitioner faces the reality where the academic knowledge is not applicable, but a different type of knowledge, theory-in-use, develops to fill the gap (Argyris and Schön, 1974). Looking at the theory-in-use of an SCM expert as a research subject from the positivistic viewpoint may be quite confusing. Evidently, the dominant paradigm of an academically educated SCM expert is dominantly positivistic, therefore the positivistic conception of reality gives a natural ground to build on. This is why this study gets off from the ground of positivistic paradigm. The reverse side of the coin is that the reality is far too complex to handle with positivistic theoretical models, the problem field is far too complex. That is why we have to build bridges towards more interpretative conceptions on reality for practitioners' helping them to deal with the

reality open to various interpretations, Argyris and Schön (1978, p. 5) argue that "the theories created to understand and predict may be quite different than theories created to help people make events come out".

3.1.1 Design science paradigm

Inspired by Simon's (1969) seminal book "The Sciences of the Artificial" van Aken (2004) suggests that the field of organizational and management research should be seen as a field of *design science*, as in engineering and medical science, aiming to *applicable knowledge*. Compared to the research paradigm of explanatory (positivistic) science, the mission of design science is not to describe, explain and possibly predict, but to develop knowledge for the design and realization of artefacts, to solve construction problems, or to be used in the improvement of the performance of existing entities. Van Aken (2004, p. 220) states: "Understanding a problem is only a halfway to solving it. The second step is to develop and test alternative solutions…In management one needs next to description-driven research programmes also prescription-driven research ones in order to develop research products which can be used in designing solutions for management problems." This does not mean that the actual application of scientific knowledge is a managerial problem, but the development of scientific knowledge to solve a class of managerial problems. The research following the design science paradigm is not concerned with action itself, but with knowledge to be used in designing solutions (van Aken, 2004).

The main difference between description-driven and prescription-driven research lies in the research object. In description-driven research the object is a phenomenon that has taken place and it is seen necessary to be explained. Prescription-driven research sees that the researcher and the research object interplay, the researcher tests alternative solutions for problems representing the research object, a class of problems. The product of prescription-driven research is a justified *technological rule*, defined by van Aken (2004, p. 228) as *"a piece of general knowledge, linking an intervention or artefact with a desired outcome or performance in a certain field of application"*. The research product can be a causal model, but often it has a heuristic nature: if you want to achieve Y in situation Z, then something like action X will help. Design science does not limit itself to understanding, but also develops knowledge on the advantages and disadvantages of alternative solutions. That way the research towards technological rules, new ones or better ones, is achieved by saturation of evidence rather than proofing the causal models (van Aken, 2004, 2005). The differences between description-driven and prescription-driven research programmes are summarized in table 4.

Table 4 - The main differences between description-driven and prescription-driven research programmes (van Aken, 2004)

Characteristic	*Description-driven research programmes*	*Prescription-driven research programmes*
Dominant paradigm	Explanatory sciences	Design sciences
Focus	Problem-focused	Solution-focused
Perspective	Observer	Player
Logic	Hindsight	Intervention-outcome
Typical research question	Explanation	Alternative solutions for a class of problems
Typical research product	Causal model, quantitative law	Tested and grounded technological rule
Nature of research product	Algorithm	Heuristic
Justification	Proof	Saturated evidence
Type of resulting theory	Conceptual	Instrumental

In management literature *constructive research* presented by Kasanen et al. (1993) has many similarities with the design science approach. The research task is seen as solving relevant managerial problems by creating constructions; models, frameworks and methods and testing their functionality empirically. It can be argued that its scope is a bit narrower, a research project carried out with constructive approach represents a single research attempt in a series of attempts guiding gradually towards enough saturated evidence to be considered as a technological rule, which is not clearly recognized.

The present research has been carried out following the design science paradigm which principally raises three viewpoints for the research. Firstly, the objective of this study is to find *alternative solutions* for SCM practitioners to be used in solving *a class of problems*, the problem of carrying out SCM development in an organization. Secondly, the study approaches the problem with agenda recognizing the role of the researcher as an active player making the interventions and analyzing outcomes. Thirdly, the result of the study is a suggestion on a model aiming to help actual SCM development processes and to further tested and refined through grounding and testing it in practical situations.

3.1.2 Theorizing and empirical research

There are basically two ways to get a grip on the chosen research question, induction and deduction. Inductive inquiry proceeds from observation to development of general hypotheses, while deductive research uses general statements derived from a

priori logic to explain particular instances (Harrison, 2002). Hyde (2000) argues that the adoption of formal deductive procedures can represent an important step for assuring conviction in qualitative research findings. Wallace ((1971) cited in Harrison, 2002) argues that both these strategies, theory generation through deductive strategies and theory testing processes are necessary and related in the activities of doing empirical research and theorizing, and sees them as stages in a cycle, where a researcher can enter at any point of the cycle, as presented in figure 3.

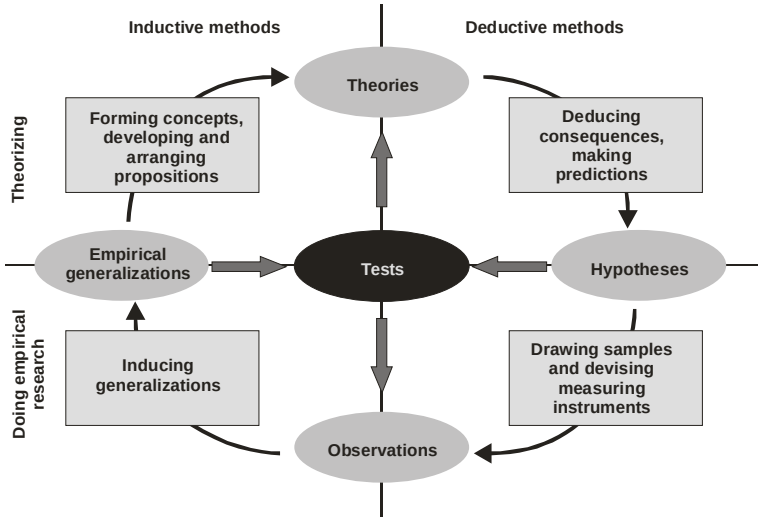

Figure 3 - Combining inductive and deductive strategies (after Wallace (1971) in Harrison, 2002)

Meredith (1993) introduces a process of analytic induction, presenting research work as a continuous, iterative cycle of exploration, description, explanation and testing. His conception of science is that "Throughout this iterative process, descriptive models are expanded into explanatory frameworks which are tested against reality until they are eventually developed into theories" (Meredith, 1993). He argues that every step is necessary in science, for example ignoring the explanation causes that we have no understanding on the phenomena. If testing is ignored, each new explanation takes the field into a new direction. Ignoring description leads to prescriptions disconnected from the reality.

For a study like the present one, seeing research as an iterative cycle points out the need for dialogue between ideas and evidence, giving a special opportunity to case-oriented research (Harrison, 2002). In general this can be interpreted so that there is room for different kinds of research. This study has its origins in the author's perception that there is room for deductive, theory-driven concept development, and especially for research integrating the fragmented pieces of previous research into a more comprehensive conception of the problem area.

3.2 Methodological choices and research data

In methodological literature, a common argument is that in sound research the methodology should be selected after the formulation of the research questions. However, almost every researcher faces two problems when starting a new research project turning the ideal, linear process as an iterative or even an inverse process. The first one is the fact that there are very few researchers who master the whole range of methodologies ranging from quantitative, statistical and experimental methodologies to qualitative methodologies digging the hidden connotations in text and speech, even though the whole range is "approved" in the research community. Secondly, to achieve results, every researcher faces the challenge of access, is it possible to obtain data to answer the stated research question (Gummesson, 2000).

The starting point of this research was the author's experience in tens of SCM development processes as an expert consultant. The experience had pointed out the need for new, applicable knowledge in the field. The surprisingly small number of relevant literature on the SCM development processes and expertise utilization indicated also that there is room for research on them. It was also possible to gain access to research data, a base of development process assignments. The major strength of the data is its deep, experiential and to some extent longitudinal nature achieved in long-term involvement in the development processes. A potential problem of the data is that it was not originally collected in the form of research data. Because the author has been deeply involved in the processes, there was an obvious risk is that the research data gets distorted by the perceptions of the author. The question, how this kind of data can be used as research data, what kind of research strategy and analysis methodology would produce scientifically qualified results needed to be answered first. The following sections focus on describing how the problem was tackled in the empirical part of the study.

3.2.1 Selecting the research strategy

A typical research question representing the design science paradigm aims at alternative solutions for a class of problems. It can be said that case studies are somewhat built-in strategies for design science approaches. The evidence is expected to be saturated through a series of multiple case studies towards grounded and field-tested technological rules (van Aken, 2004, 2005). However, the choice to apply design science approach does not commit to any methodological choices; both quantitative and qualitative approaches are applicable. Consequently, it does not give any relaxations on general criteria for judging the quality of research.

As stated above, there are two main aspects to be taken into account when selecting the research strategy and methodology: the objectives or the research questions of the research program and the availability of research data. In that sense the desire to produce applicable results and the available qualitative, experiental data tipped the balance to favor research strategy which is commonly called case study research. Case study is maybe one of the most misunderstood concepts in academic research. During the 1980's and 90's, academics like Robert Yin (1981, 1994) and Kathleen Eisenhardt (1989), put lots of effort to justifying and clarifying the role and content of it. It seems that case studies have found their place in different fields of research, though it can be

said that in practice calling an academic research a case study tells in the first place only that *n* is one or small. The variety of approaches called case studies is quite wide and should be discussed more thoroughly.

To define a case study, it *"is a research strategy which focuses on understanding the dynamics present within single setting"* (Eisenhardt, 1989, p. 534). Yin (1981, p. 59) states that case study as a research strategy *"attempts to examine a contemporary phenomena in its real-world context, especially when boundaries between phenomenon and context are not clearly evident"*. Especially Yin's definition reflects the debate on the role and content of case studies of 1980's, describing the field as a kind of negation of the field of quantitative approaches requiring an ability to distinguish the boundaries between the phenomenon and the context. The point in these definitions is in two phrases: *contemporary phenomenon* and *understanding*. A case study in management and business research is expected to dig deep into an interesting, complex phenomenon in order to describe, analyze and interpret it for understanding the relationships in it better.

The general aim of scientific research is to contribute to theory building. Case study as a research strategy uses one or more cases to create theoretical constructs and propositions from case-based evidence (Eisenhardt, 1989). Theory building through case studies follows the replication logic, like laboratory experiments. But while laboratory experiments isolate the phenomena from the context, case studies emphasize the rich real-world context, replicating, contrasting and extending the emerging theory. (Eisenhardt and Graebner, 2007). That way case studies are tied to the exploration, description and explanation stages of the research cycle presented above. The archetypes of research usually labelled as case study can be placed to one of the research stages (Yin, 1981).

However, taking in the design science paradigm and the research questions presented above, the author has found it difficult to place the present study as a "pure" form of case study for three reasons. Firstly, the objective aims to an artifact, expected to be deducted from previous research. Secondly, also as a consequence of the selected approach and the research questions, the aim is to put together existing pieces of relevant theories as an applicable model. Thirdly, the empirical data is utilized as a test ground rather than as a source of explanations of phenomena. The dualistic aim to form a conceptual model on expert work in the SCM development process and find applicable approaches and methods to different problems guided the research program to be split into six independent studies on potential approaches for different problem areas, as presented in figure 4.

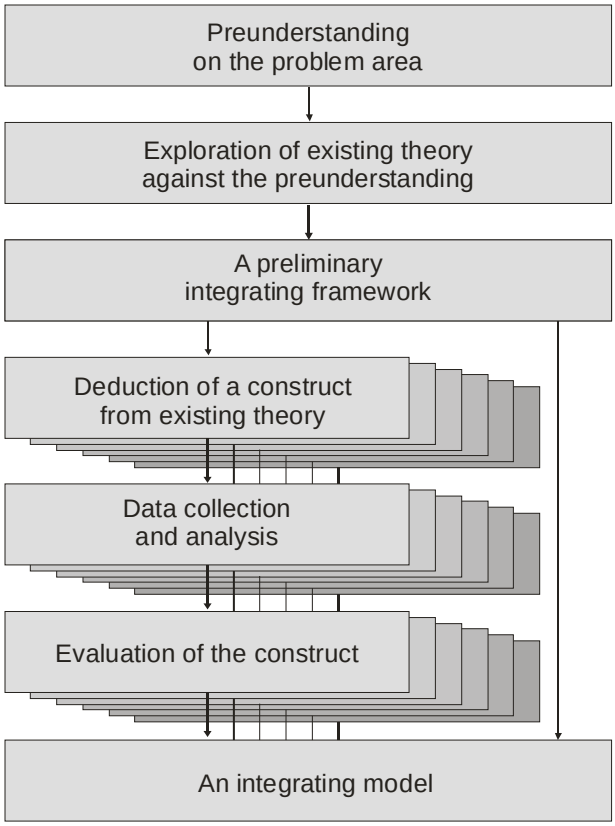

Figure 4 - The research program

Entering the research area requires a pre-understanding of the problem field (Gummesson, 2000). In the case of this research program, pre-understanding is the author's experience in the research field, which has led to first tentative definitions of the problem area. In the second step, a tentative framework was formulated as a synthesis of the literature and the pre-understanding. As a result of this phase, the problem area was divided into three separate research topics, which in principle formulated the preliminary framework.

The six separate studies representing each three research topics are discussed in the next section. Principally the logic of how the studies are related to the overall study follows the logic presented in figure 4. An artifact, more precisely a model, was designed on the basis of existing research on the problem area, which was then tested by using the collected data. The ultimate criterion was whether the designed model can help an expert piece together the situation. From the point of view of this program, the possible recommendations for action can be considered as additional results. Finally, a tentative framework was refined to an integrating model of the research topic.

3.2.2 Data collection and analysis

Qualitative methods are "an umbrella term covering a wide range of interpretative techniques which seek to describe, decode, translate, and otherwise to come to terms with the meaning, not the frequency, of certain more or less naturally occurring phenomena in the social world" (van Maanen, 1979, p. 520). Collecting qualitative research data in the real world is not a linear process. To a great extent, it is intertwined with analysis and interpretation (Denzin and Lincoln, 2000): inferring from the data raises new questions and needs to check, ensure and expand on new aspects of the data. As described above, the pre-understanding of the problem area was obtained through the author's experience, and becoming acquainted with the literature produced a preliminary framework, a selection of theories and existing research potentially applicable to the problem area. After the formulation of the framework, the work within the research sectors was started.

The quality of research stems from two sources. Firstly, there is the quality of the reasoning, including both the deduction of theoretical frameworks from existing research and the reasoning leading from empirical observations to new conclusions. In a scientific report like this, the reasoning should be observable in the text itself. Secondly, there is the quality of data collection and analysis. This quality is often, for practical reasons, difficult to make visible in the text, but there are common practices that ensure the quality of the empirical analysis.

Triangulation refers to seeing the studied phenomenon from different angles to increase the validity and reliability of the research (Denzin, 1988). It can mean that the data is collected from different sources, and analyzed by different researchers, or the research question is approached with different methods or in the light of different theories (Eskola and Suoranta, 1998). In this study, besides attempts towards triangulation in the data collection, carrying out the research analyses mainly in three member research teams can be seen as an attempt towards triangulation. As a major source of the research data have been the observations of the author, it has been essential that other researchers familiar with the research methodology have systematically participated in the analysis process by drawing their own conclusions, questioning the author's interpretations of the data, requiring reasons and pointing out issues necessary to check from other sources.

The main source of empirical data for this study has its origin in the author's career as an expert consultant conducting SCM analysis and development projects in the years 1995-2001. The research data consisted of three types of material: literal, the author's participative observations and interviews. Since year 2003, the first two types of data have been translated through narratives of the processes to tabulations of the observations. The literal material consisted of consultant reports of development projects, minutes of project meetings and some other literal sources like articles about the companies. Evidently, the role of the literal material was to act as a platform where the author's participative observations were placed. The collected participative observations could be divided to three categories. Firstly, there were observations on how the companies had adapted the suggestions and environment where the suggestions were introduced. Secondly, there were observations on the success of corrective actions based on the experiences of the previous cases. Thirdly, there were incidents causing success or drawback during the development processes. The third

type of data collection, interviews, was mainly used to verify the participative observations. The interviewed people were a colleague who had worked in the same projects and persons involved in some of the processes. The main methodological features of the enclosed publications are summarized in table 5.

Table 5 – A methodological summary of the publications

Publication	1.	2.	3.	4.	5.	6.
Research strategy	A multiple case study	A multiple case study	A multiple case study	A case study	A case study	A case study
Unit of analysis	5 development processes	8 development processes	8 development processes	Single development process	2 development histories	2 development histories
Primary data collection	Participative observations and archival data.	Participative observations and archival data	Participative observations and archival data	Numerical, actual test data of five units of a company, participative observations	Participative observations, interviews and archival data	Participative observations, interviews and archival data
Research database	Narratives of the processes	Narratives of the processes	Narratives of the processes	Quantitative data for a model	Narratives of historical development	Narratives of historical development
Analysis methods used	Tabulations, cognitive maps	Tabulations, cognitive maps	Tabulations, cognitive maps	Mathematical modelling	Tabulations, cognitive maps	Tabulations, cognitive maps
Output of the empirical analysis	Evidence on the validity of the model	Evidence on the validity of the model	Evidence on the validity of the model	An illustration of utilization of the model	Evidence on the validity of the model	Evidence on the validity of the model

According to Silverman (1993), observation is the fundamental method to collect data in qualitative research methodology. Observations are traditionally presented as a continuum from complete observation to complete participant (Burgess, 1984). This data has been collected from processes where the researcher has been a complete participant, simultaneously as a research object and an observer. Methodologically, an interesting feature of this research is that the processes have taken place before the research program was launched. In fact the observations were gathered as they would be gathered from an interviewee who happens to be the interviewer simultaneously. Naturally this has to be taken into account in the data collection and analysis. Therefore, four strategies have been applied in the data collection and analysis. The first and second strategies have already been mentioned. Firstly, the nature of the obtainable data has been taken into account already when formulating the final research questions. Secondly, the analyses have been carried out in research teams where the co-researchers have had an agreed role to question the data and reasoning. Thirdly, the data has been checked with people able to do it, unfortunately very few people had a comprehensive view to the case situations. Here checking means that the persons have checked and given their opinion on the conclusions from the cases. As a fourth strategy, the narratives have been tied as far as possible to archival data. After these actions the quality of the data can be considered adequate for the purposes of this study. It should be kept in mind that the empirical data is here expected primarily to confirm and extent the existing theory, not to act as an independent source of analytic, inductive reasoning.

4 Effectiveness of development work

This chapter ties together the concepts expert work and the development process as a proposition of an integrating model, which is then used to tie together the approaches and methods aiming to increase the effectiveness of SCM development work. After that the roles of the approaches and methods presented in the enclosed six studies are summarized.

4.1 The model of development process effectiveness

To understand the interaction between expert work and the organization, the expert work can be seen as a series of interventions an expert makes to organizational processes (Argyris, 1970). Every intercourse is an intervention to the organization changing more or less the course of the organizational processes. The problem with the concept intervention in practice is that they are so numerous that conscious utilization of the concept in expert work could be quite exhausting, because even presence of an external expert or a harmless inquiry can start or stop processes in the organization. For the purposes of this study, a more rough and general approach is needed. Above we have defined the generic stages of a development process, and looking these activities from the expert perspective, this study proposes a four-staged process of a solution development presented in table 6.

Table 6 - The stages of solution development process

Phase	*Description*
Analyzing	Development of a technically optimal solution.
Planning	Bringing the solution to decision making taking into account the observed and/or predicted organizational limitations.
Decision making	Processing the solution in the decision making process by taking into account the organizational limitations seen by the decision-makers.
Implementation	Operationalizing and adjusting the solution in the implementation process.

The first phase analysis is here seen as a manifestation of the skills of the expert, how good a solution he/she can design without constraints. This does not mean that the expert should start by aiming to formulate a theoretically optimal solution, and after that to continue to the next stages. The technically optimal solution serves here only as a reference point to technical performance of the suggestions presented for decision making, the solution decided to implement and the solution implemented. The organizational constraints can be seen as factors affecting the consumption of organization's resources, and on the other hand make the technical performance of the implemented solution lower than the optimal, theoretical solution. In that way there

are four turning points in the development process. They are hereafter denoted as follows:

- S_t - A technically optimal solution without organizational constraints
- S_s - A suggestion brought to decision making, organizational constraints taken into account by an expert.
- S_d - A solution decided to be implemented
- S_i - A solution implemented

The effectiveness of development suggestion has been defined above to be consisting of two aggregate dimensions: technical performance of the developed suggestion and consumption of resources of the development process. In that framework expert interventions are successful when the intervention utilizes the expert knowledge and improves the solution at its stage as much as possible, taking into account the organizational limitations. Accordingly, the development process can be depicted as subsequent stages, where an expert guiding the process can, to a limited extent, affect to the amount of resources consumed and the technical performance of the solution. The process is illustrated in figure 5.

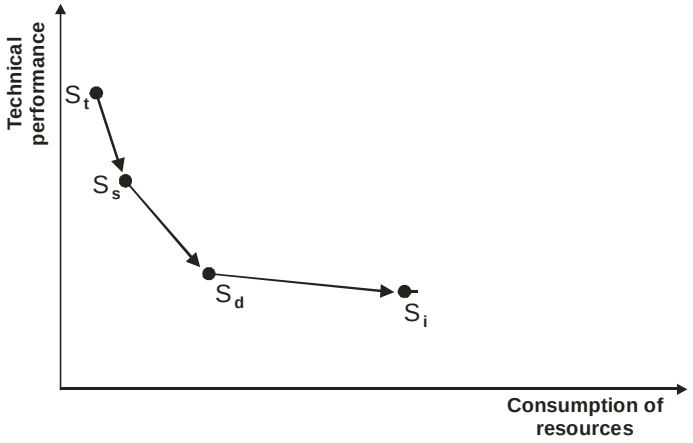

Figure 5 - The basic model of the effectiveness of the development process

It is obvious that in many cases there is a trade-off between technical performance and resource consumption: with a more sophisticated solution it is possible to achieve higher performance, but it can be expected also to consume more money, require more training, and more time to implement. It should be noted here that the model is composed of a set of undefined variables and the relationship is defined here only at aggregate level. Therefore it aims to give only suggestive, aggregate indications, not precise, quantitative measures. In the following the model is used to illustrate the effects of the approaches presented to improve the effectiveness of supply chain development work. The approaches represent three types of views to the improvement of the development process effectiveness are presented. The categories depicted with terms of the model of development process effectiveness are presented in table 7.

Table 7 - Approaches to improve development process effectiveness

Category of approaches	*Explanation with terms of the model of development process effectiveness*	*Publications addressing the issue*
Management of decision making situations	Selection of the level of technical performance and consumption of resources of S_s to obtain as high technical performance of S_d as possible, taking into account the constraints of the decision making situation.	1, 2
Management of change and implementation	Minimizing the consumption of resources and performance loss to obtain high S_i by fitting S_s and affecting the process from S_d to S_i	3, 4
Management of knowledge accumulation	Selection of S_s to obtain fast development cycles by fitting S_s to the organizational situation evaluated and managed with knowledge management techniques	5, 6

4.2 Management of decision making situations

4.2.1 Decision making

During the modern era of business and management, decision making has been the subject of research from many viewpoints. Maybe the most pivotal proposition was introduced by Herbert Simon (1960) with the model of a three-phase managerial decision making process following the "intelligence-design-choice" sequence. Simon and his contemporaries opened up the concept of rationality, discrediting economic rationality, the notion that the decision process with complete information is simply seeking the one choice that maximizes the utility. They saw decision making as a boundedly rational cognitive process converging sequentially from the stage of problem definition to the final stage of choice (Langley et al., 1995).

The academic research on decision making is roughly divided into two main streams. The first is today called management science or operations research, stems from natural science and the work of Frederick Winslow Taylor and his descendants, being mainly interested in the content of the decision. The aim is to develop procedures to find optimal solutions to decision problems. The other stream stemming from behavioral and sociological sciences is interested mainly in the process how an individual or a group of individuals is makes decisions. From the practitioner's point of view the fundamental difference between these paradigms can be put in one word: rationality. Compared to the operation researchers' view that decision making seeks for the best option, an optimum based on perfect knowledge, the behavioral school has introduced the concept of limited (or bounded) rationality in decision making

(Simon, 1960). The idea of limited rationality has been widely accepted, not only as a fundament of a school developing behaviorally based concepts of decision making, but also as an extension to rational models of decision making (March, 1994).

Presumably a majority of the SCM experts have a technical and/or economical education, which gives them a rational insight into decision making. They are likely to expect the environment to follow a rational procedure of choice, which makes the choice conditional on the answers to four questions (Simon, 1976; March, 1994; see also literature on practical rational decision making approaches, e.g. Kepner and Tregoe, 1982):

1. What are the alternatives?
2. What are the consequences following from each alternative?
3. How valuable are the consequences associated with each of the alternatives?
4. How should the choice be made between the alternatives?

In the course of time the models based on rational choice have been developed to deal with especially risk and uncertainty. But, as March states (1994, p. 5) "pure rationality strains credulity as a description of how decisions actually happen". Studies of decision making in the real world have shown that not all the alternatives are known, not all consequences are considered. Instead of *expected value* and *risk* the decision-makers often consider the *best possible* and *good enough* actions. Although the individual decision-makers, educated in theories of rational choice, try to be rational, they are constrained by limited cognitive capabilities and incomplete information. (March, 1994)

It can be said that even if the complete information to make a decision is available, it will always remain incomplete in the mind of the decision-maker. There are more or less obvious information constraints limiting the ability to utilize the complete information. The list below has been adapted from March (1994):

1. *Attention is limited.* Time and capabilities to attend all the available information are limited, there are too many relevant aspects, and too many decision matters compete of the time resources.
2. *Memory is limited*. The capabilities of both individuals and organizations to store and retrieve information are limited.
3. *Comprehension is limited.* Decision-makers can have difficulties to use the information to form inferences on causal connections of events. They can have the relevant information but fail to see its relevance.
4. *Communication is limited.* There are limited capacities for sharing complex and specialized information.

To cope with these limitations, decision-makers have developed their own procedures to accommodate these constraints. These procedures and the psychology behind them introduced e.g. in March (1994), form the core of theories of limited rationality, and

would require more space than available here. However, the information constraints presented above reveal the first focal problem of this part of the study: an SCM expert launching a development process as a suggestion to decision-makers is tackles with information constraints, not only with constraints related to the decision-makers, but also with his/her own when deciding what suggestion to introduce and what information to gather for the decision-makers to support making of that decision. That way an SCM expert, as a technical advisor, should select from the set of possible interventions the one which:

1. Gives the biggest increase to the performance with the lowest resources ***or***
2. Is a logical step towards a solution giving the biggest increase in the performance with lowest resources

4.2.2 Approaches for management of decision making situations

The effect zone of the approaches tackling the problems faced in decision making through the model of development process effectiveness is depicted in figure 6. From the expert's point of view, the main variable to influence the process before the decision is the content of suggestion (S_s). The figure demonstrates simplistically the seemingly common trade-off between the decision-maker's perception on the needed organizational effort to implement suggestion S_s compared to suggestion S'_s with lower technical performance. The trade-off can be seen as a consequence of the decision-makers' tendency to seek satisfying, not best possible solutions (March, 1994). Accordingly, an expert can select between lowest satisfying solution and the theoretically best-performing suggestion. Assuming that both the suggestions S_s and S'_s presented in figure 6 fulfill the satisfying requirements, it can be expected that the more resource consuming the suggestion S_s is compared to S'_s, the more probable it is to extent the time and resources consumed before the decision is made (comparing S_d to S'_d). If the resource consumption means effort to overcome organizational resistance between organizational units, it can also be expected that the final solution to be implemented will achieve lower technical performance.

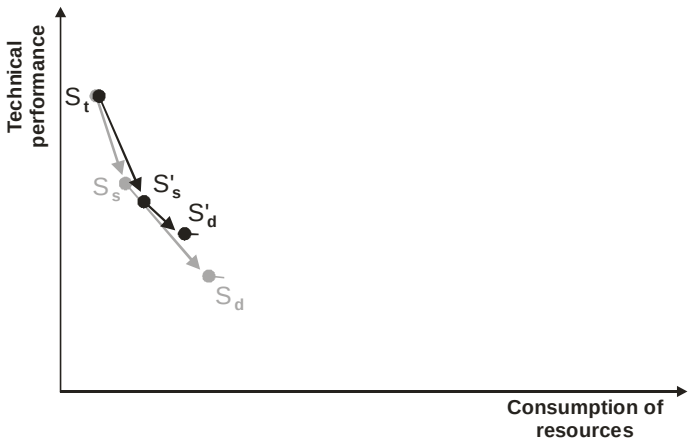

Figure 6 - The effect of adaptation to the decision making situation

Publication 1, *Understanding the strategic supply chain decision making – when solving a model is not enough* and 2, *Quantitative analyses in strategic supply chain decision making – a tool for decision or a weapon for struggle?* by Niemi, Pekkanen and Huiskonen present two potential methods to be utilized to assess the decision making situation in a development process. The contents and contributions of the publications are described in the following sections.

4.2.2.1 Content and contribution of publication 1

This paper presents and discusses how the analysis process is tied to the strategic supply chain decision making process and what different roles analysis can have in it. Also some guidelines are presented on how to recognize the situations when the role of analysis changes, and how to react to this. The study is based on the framework on strategic decision making presented originally by J. D. Thompson (1967) and utilized in the research on strategic decision-making for example by P. Nutt (1998a, 1998b, 2002). It suggests different approaches to particular decision making situations categorized on the basis of how clear the means of producing results and the objectives of the decision are resulting in four basic decision making strategies:

1. **Analysis** is recommended when both the objectives and means are clear. In this situation the decision makers can evaluate the alternatives with available comprehensive data and choose the alternative that has the best characters to attain the objectives.
2. **Judgment** approach is recommended when the objectives are clear but the means and steps to achieve them are unclear or ambiguous. This is usually the most popular way to make strategic decisions, because it is fast and the decision maker does not have to justify the decision, as it is based mostly on experience and "wise opinions" of the situation.
3. **Bargaining** is recommended when the means are clear but the objectives are conflicted or unclear. This is usual in a situation with multiple decisions-makers from many organizational entities with conflicting goals. The decision is usually a compromise.
4. When both the means and objectives are unclear, there is no rational base for making the decision, the decision-making method is called **intuition.** This situation is beyond the scope of this study.

The study argues that an expert can improve the quality of the decision making by taking care of the applied decision-making strategy. In practice, as the expert has the best knowledge of what can be analyzed, this means hindering unwanted shifts from analysis to bargaining and judging. This results as two basic approaches towards unwanted shifts:

- Shift towards bargaining caused by diverging objectives - involve the decision-makers in the analysis and try to agree on joint objectives.

- Shift towards judging caused by lack of confidence on the analysis - involve the decision-makers in the analysis and apply qualitative practices in the analysis process

4.2.2.2 Content and contribution of publication 2

According to Langley (1995), some organizations tend to exhaust themselves with analyses while some organizations tend to decide on intuition without adequate facts and analyses. Langley has identified five factors causing these risks. The study in publication 2 considers these tendencies from the point of view to a single analysis assignment. It can be assumed that a risk to exhaust with analyses is realized as a process that does not end in a decision or the decision is substantially postponed. Accordingly, a risk to make arbitrary decisions is realized as a process where the results of the analysis are neglected in the decision making.

The study utilizes a three-dimensional classification of a supply chain decision-situation, which proved to be quite a difficult task. The reason for this is the qualitative and aggregate nature of the factors. However, a main guideline found in the study is that an analyst should keep two aspects in mind related to decision making. The first issue is the motive for the analysis assignment. Especially in a decision-oriented environment the primary or at least important motivation for an analysis assignment can be persuasion by another party. The second issue is to understand and keep in mind the motivation and opinion divergence and the fact that opinions can change as a consequence of the results of the analysis. The findings of the study can be summarized as the following six suggestions for supply chain analysts. The motivation of these suggestions is to keep the analyst on track in organizational dynamics related to the analysis assignment. The suggestions are:

1. Identify all the key players, the decision-makers in the expected suggestions and also those who are supposed to be in charge of the implementation of the suggestions.
2. Identify the potential underlying sources of divergent motivation and opinions, such as conflicting objectives, imbalance between the required efforts and the gains to be achieved by the decision-maker.
3. Get in one-to-one discussion with all the key players. Actively dig out the motivation and opinions of all the decision-makers and implementers.
4. Prepare the analysis especially for those participants whose motivation and opinions are furthest from the potential outcomes of the analysis.
5. Identify the dominant decision making style in discussions and first meetings. Prepare yourself to speed up the fact and consensus-oriented groups and slow down the decision making oriented groups.
6. Proceed stepwise in as many steps as possible, producing intermediate results and re-directing the analysis as often as possible in joint meetings with the key players.

4.3 Management of implementation and change

4.3.1 Change management and implementation

Basically, putting new methods and tools into action in an organization can be seen from two perspectives. One is to see the process as more passively as adaptation to environmental pressures. The other, a more traditional and popular one in management literature, is to see it as active implementation of new methods and tools. Implementation itself has been seen as a major challenge during the era of rapidly developing ICT technology, and therefore it has also attracted a vast number of researchers from various disciplines. There are studies on the implementation of ICT tools, and related closely to SCM, there are studies on ERP implementation, for example that of Tchokogue et al. (2005) who point out strategic, tactical and operational prerequisites in an ERP implementation, and Sarker and Lee (2003) who have studied organizational enablers for ERP implementation. Managing organizational change has risen to a focal managerial issue in the rapidly changing environment.

Evidently, supply chain policy-making is a far less complex procedure than the revolutionary strategic and cultural change processes described in the change management literature, but some of the change management findings can be adapted to all policy-making situations. In the literature, the models and efforts for managing change in organizations are usually step-wise approaches, viewing change as a dynamic and ongoing process with multiple activities and stages. A multistage process makes the change more effective because each stage can be associated with one of the common obstacles in organizational change, like politics, low level of trust, or lack of teamwork. Also the controlling and managing of organizational transformation is easier with a systematic framework (e.g. Dawson, 1994; Kotter, 1996; Riis et al., 2001).

4.3.2 Approaches to managing change and implementation

Utilizing change management techniques in expert work can be expressed in the model on development process effectiveness as an aim to decrease the consumption of resources and/or to achieve higher performance of the implemented solution (S_i, S'_i) with the same consumption of resources. Naturally this requires a sound decision making process, and it should be noted that the decision phase can not be disconnected from the implementation phase. The influence of the utilization of change management is illustrated in figure 7.

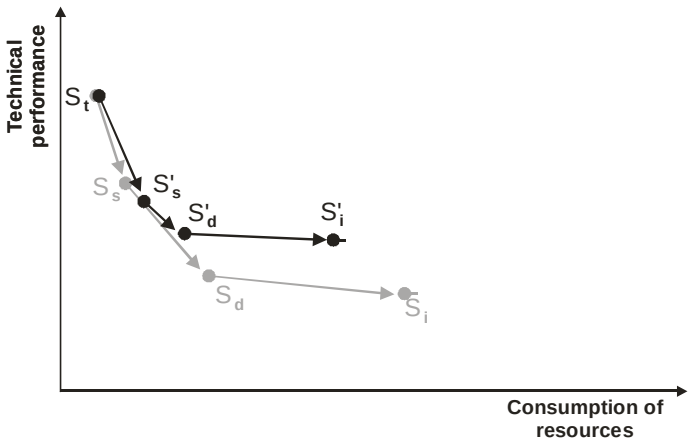

Figure 7 - The effect of utilization of the change management approach

The approaches improving the efficiency of development process based on change management research are presented in publications 3, *Improving the quantitative analysis impact on supply chain policy-making* by Niemi, Pekkanen and Huiskonen and 4, *An approach to improve logistical performance with cross-unit benchmarking* by Niemi and Huiskonen. The contents and contributions of the publications are described in the following sections.

4.3.2.1 Content and contribution of publication 3

This paper examines the phenomenon of formulating and bringing in a set of new ways of working, a supply chain policy, into the supply chain environment and applies the discipline of change management in the process. It derives the success factors of the phases from generic change management practices and points out the expert support roles in the phases. The study raises a big question of analyst's (expert's) role. Is their task only to bring in the "facts and just the facts" to the process or should they participate in the decision making and stand for a solution they prefer? Obviously the role depends on the situation, assignment and the person in question. The study gives a basic frame to the analysts to see their work as an essential part of the change process, and also some guidelines to adapt to the situations encountered.

4.3.2.2 Content and contribution of publication 4

This publication gives an example of an approach balancing the effort and the aimed level of precision of the expert work. The benchmarking approach is proposed to satisfy the managerial need for simple but effective tools to find the improvement objects in the field of inventory management. The main difference of the benchmarking approach to e.g. optimizing approaches is that only the relative differences need to be analyzed instead of determining the absolute optimums of the selected variables. This choice considerably decreases the needed effort, and is also more in line with the level of reliability of the data that can be achieved in practice.

4.4 Management of knowledge accumulation

4.4.1 Knowledge accumulation

In their research on the implementation of management practices Vastag and Whybark (2003) found that firms learn through their business and trade contacts rather than through management literature, consultants or academics. This claim poses a serious challenge for academic researchers to provide new means of transferring research-based management knowledge into practice: how could we improve and speed up the adoption of new knowledge? If we look at the present situation concerning supply chain management, the problem is not lack of data and tools, but rather lack of knowledge of how to use them. We have technological solutions, i.e. various analytical tools, but what we need are new organizational solutions, i.e. redesigning of processes and revising of measurement and incentive schemes to promote the utilization of new technologies. This new situation also creates a need to reconsider the roles and skills of the people in the new processes. As a matter of fact, it seems that the failure to see these organizational and managerial aspects has been one of the main reasons for the slow adoption of supply chain and inventory management techniques in many companies. This proposition has been used in this study as a starting point for searching for new ways to facilitate and speed up the adoption of new techniques, especially in the area of inventory management.

There are various models describing the organizational adoption of innovations, which can be used to study the adoption of for instance various tools and techniques (and roughly speaking, also new related knowledge), such as the well-known adoption model of Rogers (1995). As the Rogers model describes the various factors that affect the organizational adoption of new innovations, such as organizational practices and tools, they are commonly used in the prediction and comparison of the organizational adoption of various practices. In the case of the development of organizational processes, the organizational adoption of new knowledge takes place gradually.

According to various studies concerning knowledge accumulation in companies and their business processes (e.g. Housel, 2001; Bohn, 1994; Moore, 1999), knowledge development and accumulation can be categorized and described in distinct phases or stages. These models are usually called “maturity models”. Maturity models can be described as roadmaps for implementing practices in an organization. The purpose of the models is to help in continuous improvement of the capabilities of an organization in certain application or management areas, such as software development (Niazi et al., 2005), R&D (Berg et al., 2004), process development (Moore, 1999) or knowledge management (Paulzen and Perc, 2002). The basic idea is that because an organization cannot implement all the best practices in one phase, maturity models are used to help to introduce them in stages. Maturity models also offer systematic guidelines and norms for continuous learning and improvement in organizations. Presumably, the adoption of supply chain management techniques and the related knowledge takes also place gradually, following the logic of the knowledge maturity models.

Taking a more active approach to knowledge accumulation, literature presents different organizational approaches or strategies to knowledge creation and accumulation. According to Nonaka (1988) and Nonaka and Takeuchi (1995), the concepts of "top-down" and "bottom-up" management focus on information flow and information processing. While the top-down management approach (centralized knowledge management systems; see e.g. Civi, 2000) emphasizes the process of implementing and refining decisions made by the top management as they are transmitted to the lower levels of the organization, bottom-up management (decentralized knowledge management systems; Civi, 2000) emphasizes the influence of information coming up to the top from lower levels for management decision making.

The approaches of individual firms are usually seen to be located somewhere in the continuum between the above two types (Nonaka, 1988). The new proposed management concept that Nonaka and Takeuchi (1995) call the “middle-up-down” approach is a process that aims to resolve the contradiction between the visionary but abstract concepts of top management and the experience-grounded concepts originating on the shop floor, by assigning a more central role to middle managers. Middle managers are positioned at the intersection of the vertical and horizontal flows of information in the company, which makes them the key persons for organizational knowledge development. The knowledge is accumulated in an organizational knowledge base, which involves both tacit and explicit dimensions of knowledge. Concerning the organizational knowledge base, at the general level, tacit knowledge is primarily accumulated in the corporate vision and the organizational culture, while explicit knowledge is primarily accumulated in the developed technologies, products and concepts. According to Nonaka and Takeuchi (1995), this process is particularly well suited for the age of fierce market competition and rapid technological change. It is the most fitting model for bringing about organizational knowledge creation (Civi, 2000).

4.4.2 Approaches utilizing knowledge accumulation models

Utilizing the knowledge accumulation models, in this study the knowledge maturity models and knowledge development strategies, in steering of the SCM development work can be seen as an integrative approach between the consecutive development processes (S_{i1}, S_{i2}, S_{i3},. in figure 8). The logic of the consecutive development processes follows the logic of the knowledge maturity model, but the development stages in figure 8 should be seen rather as individual processes or subtasks focused to the problem area needed develop to climb stages in the knowledge maturity framework.

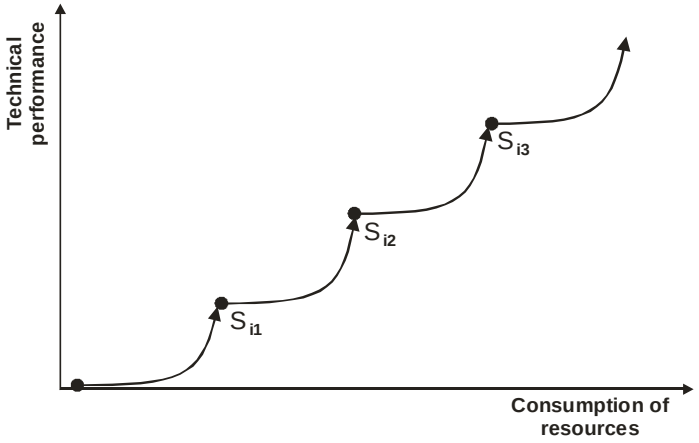

Figure 8 - Consecutive development processes

Basically, the knowledge maturity model points out the priorities in the development work, while the knowledge development strategies give a generic approach to knowledge accumulation in organization. How the higher steps with less resources consumption are actually achieved, is primarily due to that suggestions and the development strategy fit to the organizational situation. The effect of this is more effective development processes. as illustrated in figure 9.

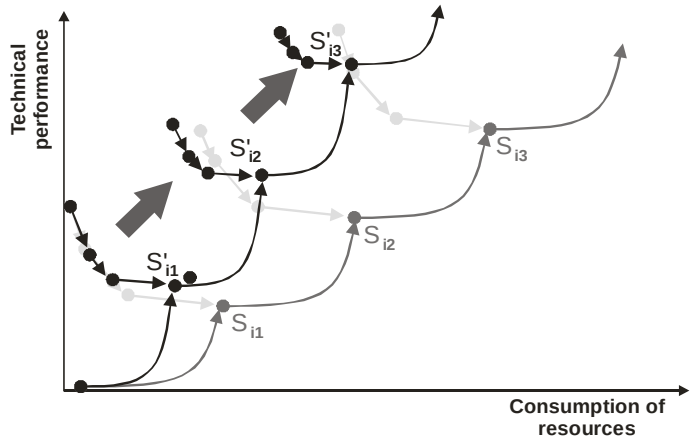

Figure 9 - Effect of applications of knowledge accumulation models

The identification of maturity stage related development needs and application of deliberate and appropriate knowledge management strategy results higher and/or less resource consuming steps towards higher technical performance, as illustrated in figure 9.

The approach applying knowledge models is presented in publication 5. *Understanding the knowledge accumulation process – implications for the adoption of inventory management techniques* and the approach applying knowledge

development strategies in publication 6. *Supply chain development as knowledge development task*, both written by Niemi, Huiskonen and Kärkkäinen. The contents and contributions of the publications are described in the following sections.

4.4.2.1 Content and contribution of publication 5

In publication 5 the knowledge maturity models are applied to identify the stages of the evolution process and assess the management attributes when improving the inventory management practices and adopting more sophisticated inventory management techniques. The management attributes are 1) technical tools, 2) skills, 3) roles and responsibilities, and 4) performance measurement and incentives systems. The management attributes that are related to each other are identified for development stages. Two case companies are analyzed with the model. The model is found useful in assessing the current situation in inventory management practices, identifying the development focus areas and prioritizing the development effort.

The case study presents a path for how companies can gradually adopt sophisticated inventory management techniques. The path includes quite strong organizational changes which seem to be important for adopting new techniques as quickly as possible. However, the question still remains, whether it is possible to bypass the expertise centralization stage and adapt the optimization practices as a 'black box', implement and use tools without changes in the organization and management practices. In this study we did not find a path for such an approach, but on the other hand, the research on organizational learning has focused on seeking an environment where this kind of adopting is possible. However, these changes in the corporate values, climate etc. are fundamental and difficult processes for a company.

A major presumption in the study is that the process development stage can be described with management attributes and, to achieve sustainable results, the development related to these management attributes should proceed more or less parallel from stage to stage. In the case studies the framework worked as expected. It helped to assess the development and the current situation, and pointed out the development focus areas.The maturity model and management attributes help to see the development problem in a wider scope. As a practical tool the maturity model helps to prioritize the development actions, when to train people, when to invest on IT tools, when to reorganize, and when to improve performance measurement and incentive systems. The tool can be useful when deciding on the goals for development of inventory management.

4.4.2.2 Content and contribution of publication 6

Publication 6 shows how a development strategy is more or less consciously selected, what are the main factors affecting the selection, and how it guides the development effort in supply chain development and adoption of inventory management, representing generally applicable supply chain techniques. Inventory management is defined as the task of handling the uncertainty of the demand and/or the product and service offering in the supply chain. The findings and suggestions are based on empirical observations on the implementation processes of inventory management tools in two case companies.

The study utilizes mainly two research streams of knowledge management to understand and support the adoption of complex practices in supply chain management. The first of them, the knowledge maturity models describe the knowledge accumulation as stages of how the organization develops itself to utilize the particular knowledge, and for instance the adoption of new tools, systems and practices such as inventory management tools. The second stream gives us guidelines on strategies of how to accelerate the knowledge creation in an organization, in our case particularly related to inventory management. Adapted from Nonaka and Takeuchi (1995), this study presents three generic strategies: the top-down strategy, where the management works as the motor of change, the bottom-up strategy, which relies on training the shop-floor level people, and the middle up-down strategy, which is based on making the mid-level of the organization responsible for the development target.

The findings of the case studies suggest that the selection between different strategies is related to the cultural and organizational environment, the complexity caused by the issue itself and by climbing the knowledge maturity stages, and the relative importance of the issue to be developed. It seems that a company has a preferred development strategy, depending on its culture and organizational environment. For a company with a strong entrepreneurial culture and structure utilizing it, the bottom-up strategy seems to be quite an obvious solution to start the development process. It can be expected that the entrepreneurial culture encourages trial-and-error behaviour and motivates the operators to improve their skills and practices. A hierarchical structure and risk-avoiding culture naturally applies the top-down strategy. It tries to solve a problem by giving instructions and developing at a higher organizational level, and implementing the results after that. However, it should be kept in mind that the approaches of individual firms are usually seen to be located somewhere on the continuum between these two types (Nonaka, 1988).

5 Discussion and conclusions

The research domain of this study was described as an intersection of three sets of activities in a company: expert work, development work and supply chain management, SCM. In the study, experts and expert work represent a set of individuals whose effectiveness this study is intended to improve, while development work defines the set of organizational activities to focus on. SCM as an expertise area acts as the platform on which the study has been built. The fundamental aim of this study was to find ways of how an organization can achieve higher performance by utilizing internal and external SCM expertise better. The objectives of the study were twofold: to derive a model and approaches helping an SCM expert to increase the impact and effectiveness of expert work in development tasks by:

- Understanding the encountered organizational situations and processes better
- Reflecting his/her past and future actions to organizational processes and
- Selecting and adjusting the processes and contents of his/her work accordingly.

As an expertise and development area, SCM has a major dilemma: by nature SCM crosses the organizational boundaries, but as an academic discipline it is strongly based on applied mathematics and a positivistic conception of reality. The crossing of organizational boundaries emphasizes understanding the organizational processes and the social context of the organization, while the education of the SCM experts leads to a rational, mechanistic conception of an organization. As a result of this research program this report has presented a model to conceptualize SCM expert work in organizational development and suggested six approaches for an SCM expert to piece together and manage the phases of development work.

5.1 Scientific contribution and value of the study

The general aim of scientific research can be said to be cumulating organized knowledge in an authenticated manner. The research following the design science paradigm aims towards technological rule through field-tested and grounded technological rules (van Aken, 2004). In the spirit of the design science paradigm, this study has built a model and six approaches to provide alternative solutions to an improvement problem, and evaluated them empirically. To tie the approaches together, an integrating, conceptual model on SCM expert work in development processes has been presented. First of all, it should be noted that though the model has two dimensions, aggregate variables defining the success of action, it has not been used to measure how much the suggested approaches can help. The aggregate model is meant to act as a model for thinking, helping a practitioner to assess and adapt his/her actions to the organizational environment and situation. From the viewpoint of this study, it acts as platform tying together the set of approaches, and, potentially

providing a platform to be utilized in future research on such methods and approaches. What the study primarily suggests is that there are ways to improve SCM expert work in organizational development processes. These approaches have been evaluated in the empirical studies. In the spirit of the decision science paradigm, the results of the study can be presented as suggestions, as presented in table 8.

Table 8 - The findings of the study as suggestions for practitioners and researchers

Suggestion	*Publications*
1. Consider the SCM development work to be consisting of development processes.	Introduction
2. Identify and evaluate the risk of difficult decision making related to organizational factors.	Publications 1 and 2
3. Consider the process as a change process and adopt a change supporting role and actions during the whole process.	Publications 3 and 4
4. Consider the development initiatives, taking into account the knowledge maturity stage and adopt an appropriate strategy for knowledge accumulation.	Publications 5 and 6

These findings raise the question of how far this study has reached in the quest towards field-tested and grounded technological rules. Considering field-testing, van Aken (2004) borrows the concepts from software development: the testing follows two stages. The first one, α-testing, is carried out by the originator of the rule, while β-testing is carried out by third parties (this concept is almost equivalent to the concepts weak and strong market tests presented by Kasanen et al (1993)). It is obvious that the studies are in the α-testing stage, as the tests are carried out only by the originator. To build the suggestion to the stage of a technological rule, a third party testing is required, which is made possible by publishing this study.

Considering the grounding, the managerial technological rules will usually not be grounded in terms of general laws, but rather in terms of generative mechanisms (van Aken, 2004). A generative mechanism means in the case of this study that the rules are justified with saturated evidence through reflective cycles, presumably with several case studies providing enough evidence. It can be seen that the suggestions for practitioners are at quite a general level, and it can be expected that through further research these suggestions could be expressed in more rigid terms.

When evaluating the quality of qualitative research and research following the design science paradigm, it should be kept in mind that the research is much more application-oriented than causal models of description-driven research. Therefore, the quality criteria are also slightly different. Thomas and Tymon (1982; see also van Aken, 2004) have presented five requirements for relevant research:

- Descriptive relevance
- Goal relevance
- Operational validity
- Non-obviousness
- Timeliness

Descriptive relevance refers to external validity established usually by multiple case studies. This study utilizes to a large extent the multiple case study approach, which does not mean that the external validity is high. Besides the fact that the research has reached only the α-testing stage, there are many limitations related to the case situations analyzed in this study. Firstly, the research data has included only situations where the expert role could be clearly defined and there has been no managerial role involved. Secondly, the intra-company assignments have been carried out against a fee, which could also affect especially the decision-making situations compared to an expert role in the staff. Thirdly, this study does not give answers to the questions of whether the approaches focus on the most problematic areas, and whether these approaches are the most effective ones. It is obvious that the practical situations are so multifaceted that it can be expected that different approaches are useful in different situations.

Goal relevance refers to the extent to which the research results refer to matters the practitioner wishes to influence. From the viewpoint of an expert, the goal relevance of this study is obvious: the results help an expert in his/her work. There are also indications that the results can be utilized without regarding the expert role, for example the applications of knowledge maturity models and knowledge accumulation strategies could be applied to managerial work as well.

Operational validity refers to the extent to which the practitioner is able to control the independent variables in the model. This study considers a variable and multifaceted set of situations. However, operational validity has been a primary underlying target of the study: to provide applicable results or practice.

In the aim towards a reductionistic format of technological rules, there is a risk of overly obvious research results. However, it can be argued that already the finding of this study that the organizational aspects related to SCM should not be seen as managerial issues only, but also related to the active role of an SCM expert, is a non-obvious result.

Timeliness is always a problem of the research on business. However, as this study appears to be one of the first attempts in the research area, it depends on the viewpoint whether this study is hopelessly late or ahead of its time.

The nature of scientific research is that it is expected to contribute to the theory. In practice this means that it builds new research results above the previous research. In chapter 2 it has been noted that the research questions place this study outside the mainstream of SCM research, but that there two related research streams to the study in hand. For the research stream taking the perspective of an individual SCM manager and his/her skills, this study suggests that the manager and expert roles could and should be approached as separate issues in order to dig deeper into the work in the area of SCM. This study has shown that there are ways to improve the development work from the perspective of an expert, which justifies the distinction. The second research stream considered above was focusing on the implementation of supply chain management practices. For this research stream this study gives an alternative viewpoint to the implementation task. It shows that it is possible and worth trying to dig deeper in the development processes, not only in the ends of the processes.

5.2 Practical implications

The objectives of this study were to contribute to practical expert work. Because the model and approaches have not yet been applied to practical expert work, the practical value of the study will be shown in the future. The tests carried out in the empirical part show only that the models can work in practice. However, some ideas can be presented on practical implications of the applicability and usefulness of the presented approaches.

In the beginning of this study the question of whether an expert should take or change his/her role in decision making and implementation was risen as one of the main questions behind the study. The study did not provide an answer to this question, as it was not studied. However, it can be said that if an expert applies the presented model and approaches, the role would inevitably change from the traditional narrow professional role to a more proactive, responsibility-taking role. It must be admitted that a proactive role, especially considering decision making and change management might cause confusion between the managerial and expert roles. The expert takes actions that have traditionally been reserved to responsible manager or, by understanding the potential outcomes better, lead the manager according to his/her personal wants. But does this not happen already today with experienced experts (see Langley, 1995)? Through understanding the organizational aspects, the expert guidance can be expected to lead towards best solutions available for different situations.

This study has presented an aggregate view to the effectiveness of expert and development work worth further development. A challenging problem faced in this study was how to evaluate and measure the expert work. Because the issues related to the effectiveness of expert and development work are so multifaceted, the idea to refrain at aggregate level makes it possible to utilize the model as a conceptual way-of-thinking.

Another viewpoint this study has opened is the one of education. Putting this study in the frame of the development of theory-in-action (Argyris, 1993) this kind of model for a practitioner does not make the development of professional tacit knowledge or theory-in-action useless. The aim was to build practice-oriented approaches focusing on the most important organizational issues. That way the model could work as a starting ground for a junior professional.

5.3 Endnote: Further research?

It is customary to end a research report and especially a doctoral dissertation to thoughts about future research and questions found important to study in the future as well as questions interesting to the author. Taking this study as an opening for discussion, the issue the author wishes to highlight is the original composition of the study: a technical expert in a coordinating role in an organization. It is hard to believe that this kind of a role would be vanishing. This issue is addressed especially towards SCM/OM research community. Studies even discussing the organizational aspects

related to new techniques in SCM are rare, not to mention digging deep into the actual work of the individuals responsible for putting the new research results of the SCM/OM research community into practice in organizations.

On personal level, interesting research topics rising from this study are numerous. Naturally the selected approach left a lot of perceptions to be studied empirically, but there is also a lot of conceptual work to be done. If the potential research topics are evaluated through the glasses of applicability and usefulness to professional work, it is quite easy to raise the stream of applying the knowledge management concepts to the SCM development environment as a frontline subject of research. Knowledge management is an even younger branch of science than SCM, which means that the progress in that area is relatively fast and may give new insights to the SCM area as well. A concrete research topic in the area of knowledge management would be a more thorough validation of the knowledge maturity model presented in this study.

The research program has also raised interesting, but more abstract and more difficult issues. In general the topic of expertise in a traditional industrial organization seems to require research attention, simply because the research on professionals has for the last decades concentrated on professional organizations, not professionals in organizations. It does not seem that the setting manager-expert-worker is going vanish in the near future.

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Part 2
Publications

Publication 1

Petri Niemi, Petra Pekkanen and Janne Huiskonen (2004)

Understanding the strategic supply chain decision-making – when solving a model is not enough

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UNDERSTANDING THE STRATEGIC SUPPLY CHAIN DECISION MAKING – WHEN SOLVING A MODEL IS NOT ENOUGH

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ABSTRACT

A strategic supply chain decision changes not only the present supply chain structure but also the management practices, performance measurement systems and/or organizational structure. These kinds of decisions involve many decision makers from several organizational entities. Practice shows that a modeling approach has several limitations in these situations. This paper points out how strategic supply chain decision making can be improved by understanding strategic decision making. It shows how the analysis process can be tied better to the decision making process and how other decision making approaches can be used with the analysis. A case study of five decision situations and companies is presented.

Keywords: Supply chain management, decision making

INTRODUCTION

Supply chain management (SCM) can be defined as "the integration of key business processes from end user through original suppliers that provides products, services, and information that add value to customers and other stakeholders" (Lambert, 1998). From the definition it follows that proper SCM requires management of the activities, resources and actors over the functional and organizational boundaries, as well as through different levels of the organization. This horizontally and vertically wide scope poses big challenges to the decision making processes. The decision maker has to be able to deal with a huge amount of different types of information, satisfy different external customers' requirements, and also deal with the possible conflicting objectives of the different actors in the process.

Simultaneous development of data systems and data processing possibilities has enabled more sophisticated modeling and numerical analyses. However, presumably most of the OM practitioners involved in this kind of decision making have experienced that even the most thoroughly calculated analyses and recommendations do not ensure quick decision making and smooth implementation.

BACKGROUND OF THE STUDY

As a response to the decision making requirements in SCM several types of approaches are used. SCM, and logistics and operations management in general, as a research discipline has a strong historical connection to operations research, which emphasizes quantitative modeling of strictly defined problems. Therefore, the dominant approach in operations management has been modeling. For example, the concept of hierarchical planning, where the planning advances from top level, long-term planning tasks toward short-term operational tasks, has benefited of different types of models (e.g. Stadler, 2000). The contemporary ERP and supply chain planning systems have been built on this basis there. These systems have been especially strong in operational and tactical level planning tasks, i.e. in producing and implementing mid-term and short-term production plans. So far, these systems have not been as effective with strategic level decisions (e.g. Chopra & Meindl, 2001).

Although supply chain decision making involves strategic, tactical and operational levels and the respective time-frames, the competitive performance of the supply chain is mainly decided through strategic level decisions: service strategies, network design, changes in policies and operating models, and organizational choices. It seems that approaches supporting this kind of decision making effectively are needed. To develop these approaches, the features of the decision making process have to be understood. In this paper we begin to tackle this question by finding out the possible shortages of the analytical model solving, the dominant approach suggested as decision making tool in academic literature.

Structured approaches to SCM decision making have generally evolved along three lines: optimization, simulation, and heuristics (Ballou, 1989). Optimization is potentially the ideal way to solve a decision problem. However, problem descriptions can rarely be as extensive and in as much detail as would be required for the model to be sufficiently close to the reality to be convincing. With simulation models the problem description can be more easily made in sufficient detail, but these models leave the burden to the user to decide which decision alternatives to test and also to decide on their order of superiority. Heuristics, i.e. various rules-of-thumb, has been decision-makers' pragmatic approach to avoid the burden of extensive modeling and still achieve satisfactory solutions to several decision problems. The obvious deficiency of heuristic rules is that it is not guaranteed that they work well in various decision making situations. Instead, the convenience of their use may encourage decision-makers to apply them to situations they were not originally meant to, without any attempt to test their appropriateness. However, heuristic rules are very popular in practical decision making, also with strategic level decisions, because the strategic problems are not easily formulated into straightforward optimization problems. Heuristic rules are typically manifested as various decision making principles and concepts, which are used to reduce the complexity of strategic planning.

Problems with modeling approaches

Almost any analyst who has tried to use modeling to support decision making in the real-world environment has encountered problems. The problems are related either to the modeling itself or to the implementation of the results. E.g. Powers (1989) has recognized the following disadvantages of optimization modeling:

- The size and structure of the problem is too complicated for a model to guarantee a globally optimal solution.

- "The black box syndrome": the decision maker does not understand how the model works and what its assumptions are, and therefore feels uneasy with its results.
- The aggregation level used in the model limits the level the model can give operating rules for to implement the results. It is possible that a model of manageable size is at too an aggregated level to be practically relevant.
- Random behavior and great amount of detail are in some decision problems the necessary characteristics of the data to be used, and optimization models are not best suited for these kinds of problems.

In two decades from Powers' observations, remarkable progress has been made with computer technology, which relaxes many of the abovementioned limitations of modeling. Only the black box syndrome may probably have become worse.
One way forward with these problems is to develop better approximations for various parameters used in models (Shapiro, 2001). However, strategic level decisions typically involve different types of information and knowledge to be used to get a comprehensive view about the situation. It is also possible that the many strategic level decision making situations are so unstructured that it is doubtful whether they can ever be convincingly dealt with one approach only, such as solving an analytical model.
The contemporary development seems to go into two different directions: it seems that improving the software and hardware improves the validity and hence the relevance of the modeling approach in solving many types of decision problems (e.g. Shapiro, 1999). But at the same time, there is a strong perception based on practical experiences that the implementation success of the results achieved by the more sophisticated methods is not essentially better than the one achieved with very simple approaches, i.e. heuristic type of rules.
These perceptions bring up a big why-question. Merely solving a model may not be a sufficient approach for strategic level decision making. The question why the results of the modeling analysis get implemented poorly is an important one from both the decision-maker's and the analyst's point of view. In this paper we focus on analyzing the reasons why the modeling approach has failed or has been successful in some strategic supply chain decision making situations.

THE RESEARCH OBJECTIVES AND DESIGN

The aim of this study is to deepen the understanding of strategic supply chain decision making in order to support the decision process with quantitative modeling and analyses. The underlying question is why the analysis results sometimes lead to a decision and implementation, sometimes not.
The objectives of this paper are to:
- Present the role of modeling and quantitative analysis in the decision making context.
- Point out how the analysis process can be improved by taking into account the characteristics of the decision situation.
- Present some practical guidelines to support the strategic supply chain decision making with modeling and quantitative analysis.

A vital part of the study is to tie the theory of strategic decision making to the strategic supply chain decision making context. We have carried out a field study consisting of five decision situations in five case companies. A member of our research team has been

involved in the situations as an external analysis provider. The material used in the study includes literal reports of studies, meeting minutes and interviews of the participating analyst.

THE BASIC DEFINITIONS AND CONCEPTS

The analysis and analysis process

In the previous section we discussed the problems of the modeling approach and described the approaches widely used in supply chain decision making. In this paper analysis can mean a wide range of techniques from a simple cost model to the most sophisticated modeling approaches. The common factor is the usage: to support decision making in a strategic supply chain decision. In the decision making context, the concept analysis means that the decision maker evaluates the alternatives with comprehensive data and chooses the alternative that has the best characteristics to attain the objectives.

Our fundamental aim is to find ways how to make more successful analyses for decision making. In this study to be considered successful an analysis should meet two criteria. First the analysis should produce theoretically justified, "correct" answers. This has been in the scope of OM researchers for years. Secondly, the analysis should facilitate the decision making and the implementation as much as possible. This is what we focus on this study.

Table 1. The components of successful analysis

Internal success of the analysis process	External success of the analysis process
- The analyses give theoretically justified answers to the questions. - The questions are relevant with respect the availability and reliability of the data. - The analyses are correct with respect to the assumptions made and data used.	- The analyses enable and convince the decision makers to make the decision - The analyses make the participants commit to implement the decision

In the next sections the analysis process refers to a process where usually a series of quantitative analyses are brought to the decision making process. In this sense the analysis process includes also the means to ensure the external success.

The framework of strategic decision making

In the literature, strategic decision making is defined as a non-linear process in which decision-makers gather information, set directions, uncover and evaluate alternatives and implement the favored alternative (Nutt, 1998b). Strategic decisions are also usually unstructured and poorly defined and both technically and politically complex (Nutt, 1998b, Mintzberg et al. 1976). Obviously this characterizes also strategic the decision making process of supply chain.

Research into how decision-makers evaluate alternatives and make the final choice has defined four evaluation-choice approaches: inspiration, judgment, bargaining and analysis, as described for example by P. Nutt (1998a, 1998b, 2002). These evaluation practices can be linked to J.D. Thompson´s framework (1967). The model suggests different approaches to the particular decision making situations categorized on the basis of how clear are the means of producing results and the objectives of the decision.

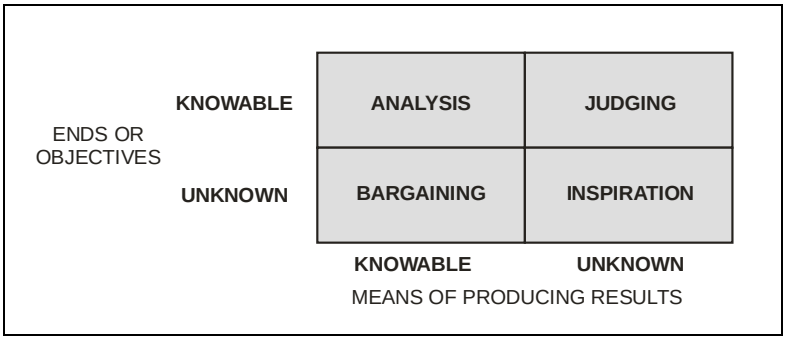

Figure 1. The match between decision making approach and the situation at hand

Analysis is recommended when both the objectives and means are clear. In this situation the decision-makers can evaluate the alternatives with comprehensive data and choose the alternative that has the best characteristics to attain the objectives. The analysis approach demands that the alternatives are clearly defined, and the variables, consequences and dimensions of the decision are well known. In strategic decision making a pure analysis approach is very unusual (Mintzberg et al. 1976).
The judgment approach is recommended when the objectives are clear but the means and steps to achieve them are unclear or ambiguous. These kinds of situations usually call for an expert who determines which alternative answers best to the defined objectives. This is usually the most popular way to make strategic decisions, because it is fast and the decision maker does not have to justify the decision, as it is based mostly on experience and "wise opinions" about the situation.
Bargaining is recommended when the means are clear but the objectives are conflicted or unclear. This is usual in a situation with multiple decisions-makers from many organizational entities with conflicting goals. The decision is usually a compromise.
When both the means and objectives are unclear, and there is no rational basis to make the decision, the decision making method is called intuition. These kinds of situations are beyond the scope of this study.

Strategic supply chain decision
A strategic supply chain decision refers to a decision aiming at a change in the present supply chain structure, or an operational model requiring also changes in the management practices, performance measurement systems and/or organizational structure. Consequently, it is characteristic for a strategic supply chain decision that it involves many decision makers from several organizational entities. Traditionally these kinds of situations have led to bargaining: the organizational entities in the supply chain have negotiated an appropriate solution. Even though the analysis is present in the decision making, the nature of the decision making is to some extent bargaining, even between units of the same organization.
Another significant feature of a strategic supply chain decision is that the tradition of making decisions by judgment is strongly present. The practice is run with rules of thumb, and the decision making relies strongly on experts' skills and knowledge. A strategic supply chain decision is actually a set of parallel and consecutive decisions. This means

that there are features of making decisions by analysis, bargaining, judging and even intuition.

SUPPLY CHAIN ANALYSIS IN THE DECISION MAKING CONTEXT

According to findings in strategic decision making (e.g. Mintzberg et al 1976), one cannot expect to find many strategic supply chain decision situations where pure quantitative analysis is applicable as the sole approach to the whole decision making process. The decision process includes situations where judging and bargaining are more applicable and the analysis has different roles in the decision making context. However, if we understand the analysis as a process tied to the decision process and the decision process consisting of a set of parallel and consequent decisions, it is inevitable that the decision process includes single decisions where the analysis approach is not applicable. We argue that external success of the analysis can be improved if the analyst can assess the decision situation and match the analysis process to the decision situation.

Basically, from the analysis point of view the first question is to understand the situation at hand in the decision making context: to what extent the objectives are known and common and to what extent the means to produce results are known. How then to identify the situation? Basically the question is whether there are situational factors present, driving the decision process towards bargaining or towards judging. Our suggestion is that the analyst consciously reacts to the situation. He or she accepts the situation and calls for a more suitable decision making process or certain sub-parts of the process.

As described above, a bargaining situation arises when the objectives are unknown, or the decision making parties have different objectives. In this case, a single analysis can have the role of

- selling one party's objectives and convincing the other decision making parties, and
- unifying the objectives of the different parties.

The factors driving towards bargaining are different objectives of organizations and individual people. In this situation, the analysis can stay in the role of convincing the other party or it can aim to unify the objectives of the different parties. Both roles may prove to be difficult, like Langley (1995) has described in her study.

When the objectives are known and the means unknown, the theory suggests a judgmental approach. This means in practice that the decision making is done by expertise and experience. In these cases the role of the analysis is to

- support, verify, test and complement the expertise, and
- concretize and communicate the created models for decision making and implementation.

The strive towards judgment means that to achieve the best possible situation it is necessary to bring in expertise and qualitative analysis. A sign for the need of bringing in quantitative analysis might be for example that

- The decision makers do not accept the results because they do not understand the process of producing the results.
- The models give results that are intuitively contradictory, and managers do not want to act against their intuition.
- The decision makers question the assumptions and data used in modeling.

Case findings

The cases are summarized in table 2. Besides the basic information we have included some subjective evaluations in the table. First we have identified the key implementers of the suggested decisions and evaluated how big changes, if any, they expected the analysis to show. This is then reflected to the perception of the project launchers and the analysts' perceptions of the changes suggested in the analysis.

Table 2 - Summary of the case situations

	Case A	Case B	Case C	Case D	Case E
Industry	Construction materials industry	Construction materials industry	Wholesale	Packaging industry	Forest industry
Employees total	3 500	3 500	1 200	500	2 000
Proportion of the sales in question	8%	15%	30%	35%	30%
Objectives of the analysis assignment	To find development areas and make suggestions for them	To find development areas and make suggestions for them	To analyze and concretize an idea of a potential operating mode	To analyze whether they should or should not apply a certain mode	To point out the possibilities and need to improve actions
Duration of the process	4 months	3 months	6 months	1 month	2 months
Number of formal meetings	3	3	7	1	2 + follow-up
Launchers	Staff function mgr	Staff function mgr	General manager + line mgrs	Function mgr	Function mgr
Implementers involved	Indirectly	Indirectly	Directly	Directly	Not at all
Expected changes of launcher / implementer	Confused / None	Minor / None	Confused / Major	Clear / Minor	Clear / None
Suggested changes	Major	Average	Minor	Minor	Average

Our case findings are summarized in table 3. In the following we present some examples of the situations and describe how these situations could have been handled by understanding the decision and implementation process better. Maybe the most prevailing and expected finding was the strength of preconceptions. If the analysis results did not match the decision-maker's judgments, the analysis was questioned or ignored.

Two similar market area unit studies, cases A and B were carried out. The product selection and delivery practices were analyzed. The conclusions and suggestions were very similar. One case unit implemented most of the recommendations almost immediately, the other did not. The most outstanding difference was the managing director's situation. The implementer had a recently nominated managing director, the other unit a person who had been in charge of the unit for decades.

Naturally there may be several underlying reasons related to persons and styles for why one unit adapted the recommendations and the other not, but there were indications that could be noted beforehand. The key issue is the person in charge of the final decision to implement the recommendations. In the first case the new manager was not committed to the current systems, the other had been in charge for the development of the current system. The long time in charge makes the manager an expert in his/her area, so the approach should have included qualitative analyses made together with the manager.

In the beginning of case C the unit managers' collective opinion seemed to be in favor to name one unit to serve those big customers that operate on most of the units' areas. When the customers and products were analyzed, it became evident that the centralization of the biggest customers' deliveries would cause the costs of stockkeeping for collecting customers for the rest to increase dramatically. Also the selection must be reduced in units for collecting customers. There were two reasons why an external analyst was involved. Firstly, the general manager did not feel confident enough to make the decision. Secondly, the unit managers did not know how to proceed to practice. In the analysis the focus was to get a clear picture of the business and the differences between the businesses.

It is important to note the structural tension caused by the management and performance measurement system of the firm, because it was the main reason why the situation could not be solved by analysis. The structure of the firm was based on entrepreneurial units, and the unit managers were not able to see themselves in any other kind of role than a manager of an autonomous unit. Now they were facing a question of how the centralized lost sales would be compensated to the units. The situation turned from a win-win situation to a win-loose situation without fundamental changes in the company's practices. It was not possible to continue with the means of analysis, the acceptance would have required bargaining between the company and unit management on structural issues.

In case D we were asked to analyze if the firm should establish a front line warehouse for certain key customers to enhance service. Our analyses indicated even a small monetary gain. However, the decision-maker decided right after the presentation ***not*** *to establish a front-line warehouse.*

This case could be seen as successful, because the possible distortions of the quantitative analyses were brought into the discussion and the possible gains were presented as a potential to be achieved item, by item starting from the most potential and ending up in the zero and negative potential items. The manager's expertise was then added to the decision making to evaluate how much of the potential could be gained in practice.

Case C started with basic, structural analysis with ABC-analysis and profits by customer segments and product groups. In the first meeting the analyst's presentation pointed out that one of the customer segments was clearly unprofitable. Though the segment was considered as an important one, it was obvious that the firm was not a preferred supplier for that segment. It was not until the third meeting that one of the participants raised the question: why do we give so large discounts to this segment.

In this case the analysis provoked the discussion. It is important to note that analyzed, obvious facts do not do it automatically. Especially in cases where the results challenge the basic assumptions of the business, the facts can be ignored. The case could be seen as a good example of a need for quantitative analysis. It is also a good example of a pitfall to an analyst "to get on the bandwagon". The suggested model seemed to be lucrative. The competitor's maneuvers indicated that the model should be adopted and also the aggregate level analysis supported the model.

Sometimes the solutions to lower the resistance to adapt the analyzed results are quite small. In case E the owner decided not to use a realistic 20-30% inventory cost but only a 15% rate, because there was a risk that if the responsible persons would not agree on that rate, they would not agree on any results.

Table 3 – Summary of the case findings

The need to change approach	*Indications of the need to change approach*	*The basic reaction*	*Suggested actions*
Shift towards bargaining caused by diverging objectives	- Strong diverging opinions - Diverging motivation - Diffuse power to make the decisions - Organizational solutions causing tension - Passive and hesitating management	To involve the decision-makers in the analysis and try to agree on joint objectives.	- Discuss the role of the analysis - Agree on the objectives first - Point out the problems of the performance measurement and organizational tensions - Calculate the benefits for every decision maker - Proceed in phases - Keep an eye on the intermediate results
Shift towards judging caused by lack of confidence on analysis	- Questioning the need to analyze - Questioning the parameters, models and intermediate results - Intuitive and fast decision makers	To involve the decision makers in the analysis and apply qualitative practices into the analysis process.	- Be sure that the key implementers are committed - Proceed in phases. Let the decision makers decide how to proceed to the next phase. Keep it simple - Create commitment to parameters, data and intermediate results - Avoid sensitivity analysis, calculate potential profits and losses and evaluate them with the experts subjectively - Calculate examples - Avoid using provocative values for parameters. One unaccepted parameter could drive the whole model to be unaccepted.

CONCLUSIONS

In this paper we have presented and discussed how the analysis process is tied to a strategic supply chain decision making process and what different roles analysis can have in the decision making process. We have also presented some guidelines of how to recognize the situations when the role of analysis changes, and how to react to those needs.

The study is based on the theory on strategic decision making presented by Thompson (1967). It suggests different approaches to particular decision making situations categorized on the basis of how clear the means of producing results and the objectives of the decision are. From this basis we have identified two basic needs to change the analysis approach and ways to react to them:

- Shift towards bargaining caused by diverging objectives - involve the decision-makers in the analysis and try to agree on joint objectives.
- Shift towards judging caused by lack of confidence in analysis - involve the decision-makers in the analysis and apply qualitative practices in the analysis process.

In this study we have focused on analysis in the decision making context. Further research work will focus also on the discipline of change management, to find ways to improve the factual understanding of the decision makers during the analysis process. The development will be tested in forthcoming cases and reported accordingly.

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Quantitative analyses in strategic supply chain decision-making – a tool for decision or a weapon for struggle?

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QUANTITATIVE ANALYSIS IN STRATEGIC SUPPLY CHAIN DECISION-MAKING – A TOOL FOR DECISION OR A WEAPON FOR STRUGGLE?

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ABSTRACT

The objective of the study is to find viable analysis practices to different strategic supply chain decision situations to improve the effectiveness of analysis. For this purpose the decision situations are first classified, then potential risks are identified in the situations and finally practices improving the analysis effectiveness are identified in a multiple case study. The results indicate that the approach to categorize the situations into two risk categories characterized with three factors can add value to the skills of supply chain analyst.

INTRODUCTION

Supply chain management (SCM) can be defined as "the integration of key business processes from end user through original suppliers that provides products, services, and information that add value to customers and other stakeholders" (Lambert, 1998). Today's hard competition requires that functions, units and firms in a supply chain constantly develop ways to improve the total performance of supply chain together. Although supply chain decision-making involves strategic, tactical, and operational levels and the respective time-frames, the competitive performance of the supply chain is mainly decided through the strategic level decisions. This decision-making includes all the decision-making aiming at improving the firm's long term competitiveness by changing present supply chain structures and operation models. In these decisions the supply chain experts are often in the frontline, analyzing the present practices and suggesting better operating models and practices to survive and win in the competition.

Since the evolvement of the disciplines of operations management and supply chain management, quantitative methods have formed the basis for decision-making when developing new ways to operate. The theoretical development and the progress of data processing capabilities and have made it technically possible to produce more and more sophisticated analyses. However, the results have not always led to the decisions the supply chain experts have suggested. Sometimes the results have been neglected. Sometimes the analysis results have led to an internal debate, where analyses have been used as ammunition in the battle. The supply chain expert has faced the reverse side of joint decision-making, organizational and managerial issues like diverging goals and motives, distribution of power, leadership styles, and even chemistry between individual persons.

The main research question arises from this lack of understanding: how these various organizational aspects should be taken into account to improve the effectiveness of the quantitative analyses in strategic supply chain decision-making? Our presumption is that if the analyst understands the characteristics of the decision situation better and adjusts the analysis

approach accordingly, the result would be more focused analysis work, quicker decision-making, and finally better decision quality. This study aims at better quality analysis work by presenting a framework to identify the decision situation where analysis is used, the risks in these situations and suitable practices for different situations identified in a multiple case study.

RESEARCH BACKGROUND AND DESIGN

Strategic supply chain decision-making, defined here as decision-making aiming at improving the firm's long term competitiveness by changing present supply chain structures and operation models, involves decision-makers and other stakeholders across the departments, units and companies in the supply chain. Quantitative analyses, encompassing here a wide range of techniques from a simple cost model to the most sophisticated modeling approaches, are widely used to support this decision-making in strategic supply chain decisions. In the decision-making context, concept analysis means that the decision maker evaluates the alternatives with available data and chooses the alternative that has the best characteristics to attain the objectives.

The quantitative methods and analyses are often seen to form the core of the supply chain experts' skills. However, many studies such as Gammelgaard and Larson (2001), and Mangan and Christopher (2005) have pointed out the importance of general management skills of supply chain managers. It is essential for a supply chain expert to have working knowledge in finance, IT and strategy, as well as good interpersonal, leadership and change management skills. For example Schein (e.g. 1999) points out the problems in traditional consulting approaches. He calls for a helping relationship in consulting approach but also points out how difficult it is to bring in the external expertise to the decision-making. However, the literature gives very little help in the question of how this kind of assignment should be carried out, simultaneously creating commitment, enabling decision-making and ensuring that the decision issue is the right one. It seems that there is room and need for practical decision-facilitation approaches for technically oriented analysis professionals.

The objective of this study is to recognize different decision-making situations, risks related to these situations and possible remedies to avoid the risks in strategic supply chain decision-making situations. From the researcher's point of view, the question is how to obtain simultaneously detailed data from as many decision-making processes as possible. To answer this question, the research approach was to complement a multiple case study with action research approach.

Case study is a preferred strategy when "how" and "why" questions are posed, when the investigator has little control over the events, and when the focus is on a contemporary phenomenon within some real life context (Yin, 1989). However, with a single case study it would not be possible to reveal the influence of the multiple situational factors. E.g. Gummesson (2000) lists some definite advantages of action research approach over more "hands-off" ones. Firstly, it provides the possibility to closely observe an organization in a way that would not be possible for outsiders. Secondly, it ensures the direction of research to be of guaranteed managerial relevance, as the company management is closely involved in the research effort in progress. Thirdly, it indirectly generates close relations and common understanding, which make it possible for the researcher to revisit the company when he is no longer directly involved. In this study, the action research approach gives the necessary deep understanding on the situations.

To avoid the risk of failing to fulfill scientific requirements (Gummesson, 2000), the conclusions drawn from the cases have been derived as far as possible from the written reports, slide shows of studies, meeting minutes and other written material like offers and agreements. However, because of the nature of the research subject, the tacit information of the researcher involved plays an important role in the study. To collect and verify the tacit information in a scientifically acceptable way, the researcher has participated in sessions where the co-author has acted as the "devil's advocate" (Schweiger and Sandberg, 1989), questioning the assumptions made during the study.

The empirical part of this study consists of eight strategic supply chain decision situations where one of the authors has been involved as an external consultant. An overview of the cases is presented in Appendix 1. The main objective is to find working practices an analyst can utilize during the analysis process aiming at increasing the effectiveness of the analysis. To find these practices, the case situations are classified with a framework described in the next section. After that the symptoms observed and both successful and unsuccessful actions taken in the case situations are discussed. Finally, the findings are summarized and guidelines for successful practices in different situations are presented.

DECISION SITUATION FRAMEWORK

In the decision-making context, analysis means that the decision maker evaluates the alternatives with available data and chooses the alternative that has the best characteristics to attain the objectives. The analysis approach demands that the alternatives are clearly defined and the variables, consequences and dimensions of the decision are well known (e.g. Nutt 1998a, 1998b, 2002; originally Thompson 1967). On the other hand, in strategic decision-making a pure analysis approach is very unusual because of its unstructured nature (Mintzberg et al. 1976). This contradiction between the strategic decision-making situation and analysis as a preferred approach of supply chain practitioners is one of the underlying phenomena behind the problems faced in decision-making situations.

According to Langley (1995) some organizations tend to exhaust themselves with analyses while some organizations tend to decide on intuition without adequate facts and analyses. She has identified five factors causing these risks. The factors and the risks they cause are presented in figure 1.

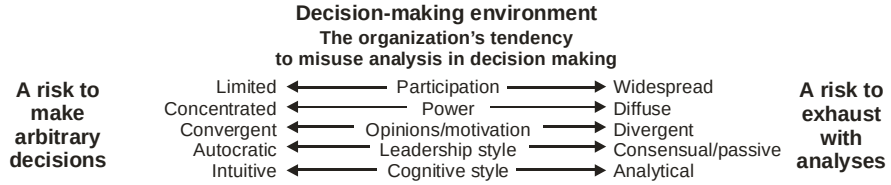

Figure 1. Factors that affect the quantity of analysis produced (Langley, 1995)

From a single analysis assignment's point of view it can be assumed that a risk to exhaust with analyses realizes as a process that does not end in a decision or the decision is substantially postponed. Accordingly, a risk to make arbitrary decisions realizes as a process where the analysis results are neglected in the decision-making. For reasons described later, the Langley´s

factors are reduced to three factors characterizing the decision-making situation: **decision-making structure, decision-making style and motivation and opinion divergence.**

The decision-making structure refers closely to Langley's term power diffusion/concentration. The question is who can make the decision to implement the actions suggested by the analysis. The structure is concentrated if the decision power and responsibility to implement the decision is mainly in one hand. The structure is diffuse if the decision requires multiple decision-makers. The multiple decision-makers are usually from same hierarchical levels, parallel units or consecutive links in the supply chain. It should also be noted that in many cases some expertise areas can play a much bigger role in the decision-making than could be expected on the basis of their status in the organizational hierarchy.

The decision-making style means the style how the decision-makers tend to make their decisions. It is a continuum between decision-oriented and fact and consensus-oriented styles. The decision-oriented style is usually autocratic, the ultimate decision-makers trust in their personal vision and judgment more than analysis results if they are opposite. At the other end of the continuum, the fact and consensus-oriented decision-making relies on analyses and facts in decision-making. Usually this style aims at consensus before the decision-making.

The motivation and opinion divergence and its influence can sometimes be difficult to handle for analytically oriented people. Though the motivation and opinion divergence is often of personal nature, opinion divergence often exists between organizational entities, units, functions and firms. In these situations structural factors like conflicting goals and distorted performance measurement can cause divergence. Motivation and opinion divergence can also exist between different hierarchical levels.

Langley (1995) presents wide or narrow participation as factor behind the misuse of analysis. However, in this study this has been left out for two reasons. Firstly, it can be seen as a consequence of diffuse decision power and consensual leadership style, which are already included in the framework. Secondly, participation can be seen as a tool used for example in a situation with divergent motivation between the decision-makers and implementers.

According to Langley's (1995) study, the risk of analysis process not to ending a decision or the analysis leading to exhaustive series of analyses is highest in conditions where decision-making structure is diffuse, decision-making style is fact and consensus-oriented, and motivation and opinions are divergent. In similar situation with the exception that the decision-making structure is concentrated, a lower risk of exhaustive analyses situation exists. Accordingly, the risk of analysis and analysis results to be ignored is highest in conditions where concentrated decision-making structure, decision-oriented decision-making style and convergent motivation are prevailing. In similar situation with the exception that the decision-making structure is diffuse, a lower risk of analyses ignorance situation exists. The risk and factor combinations which could be derived from existing research have been connected together in the framework presented in figure 2.

			Decision-making style	
			Facts and consensus oriented	Decision-making oriented
Decision-making structure	Diffuse	Divergent motivation / opinions	HIGH RISK Exhaustive analyses - no decision	
		Convergent motivation / opinions		RISK Arbitrary decision - analysis ignored
	Concentrated	Divergent motivation / opinions	RISK Exhaustive analyses - no decision	
		Convergent motivation / opinions		HIGH RISK Arbitrary decision - analysis ignored

Figure 2. Conditions and risks in decision-making situations

SUCCESSFUL ANALYSIS PRACTICES AND DECISION-MAKING SITUATIONS - CASE STUDY FINDINGS

This section presents the findings of the case multiple study. Firstly, the recognition of the decision-making situations is described. After that the risks of the identified situations are analyzed and compared to expected risks found from the former research. Finally, the findings are summarized and suggestions for an analyst are presented. The case codes used in the text refer to the overview of the cases in Appendix 1.

Recognition of decision-making situation

The aim of this phase was, besides performing the classification, to test how well the classification criteria, decision structure, decision-making style and motivation and opinion divergence can be identified in a real-world situation. Table 1 presents the criteria used to classify the case situations to concentrated or diffuse decision structure. The study showed evidently that the factors are of continuous nature and therefore the situation is sometimes quite difficult to classify.

Table 1. A summary of the classification criteria

Concentrated decision structure - A single decision-maker can decide on the implementation of the suggestions. - Wider participation in the analysis process aims at committing the implementers to possible outcomes of the decision.	Diffuse decision structure - Decision-making concerns several units, profit centers or other relatively independent organizational entities. - Suggestions can not be implemented without agreement between multiple decision-makers. - The main reason why the participants are involved in the process is that they are needed for the decision-making.
Fact and consensus-oriented style - The decision-maker wants to convince himself to make the decision. - The decision-maker is not willing to give his/her opinion beforehand. - Spontaneous questioning arises in joint meetings.	Decision-oriented style - The decision-maker wants to convince his/her superiors. - The decision-maker announces his/her opinion beforehand. - Only conforming comments arise in joint meetings.

Convergent motivation and opinions	Divergent motivation and opinions
- A win-win situation exists. - The suggestions are not in conflict with the departmental of personal objectives of the participants. - The opposite opinions are not presented even in face-to-face conversations.	- A win-loose situation exists. - The suggestions are in conflict with the departmental of personal objectives of the participants. - Implementation potentially requires reorganizing - The opposite opinions are presented in face-to-face conversations.

The decision structure is quite easy to recognize. In diffuse structure situations the number of participating people to the decision process can be quite large. In some cases it was difficult to distinguish between a participating key implementer and a decision maker. Especially in consensual environments and in large, complex organizational structures some people can have strong influence without formal power. In the study cases C and F represented diffuse decision structure. In case F the decision-makers represented sequential links in a supply chain. Case C represented the type of supply chain decision-making situation, where the decision power was in independent parallel profit units and the aim was to find more co-operative operating models. The actual decision makers were the unit managers, because there was no intention to change the profit unit structure. The rest of the case situations were concerned to represent the concentrated decision structure.

In many cases it was difficult to identify the decision-making style. The main problem was to distinguish between the organizations' style and the decision-makers' personal styles. The individual styles of involved decision-makers in a situation vary from analytical, consensus-seeking style to a highly decision-oriented style. Therefore, the style recognition is always to some extent arbitrary. In the case situations organizations A, D, F and H were identified to prefer the decision-oriented style, while in cases C, and E the style was clearly fact and consensus-oriented. The cases B, G and H had only a bit more features of fact and consensus-oriented than decision-oriented style.

The problem with the motivation and opinion divergence is that it has in many cases personal origins. The underlying structural factors causing opinion and motivation divergence show up as conflicting goals, often related to unsuitable performance measures for the suggested changes. It should also be noted that the motivation and opinions can change during the process. Especially if the suggested new operation models include changes in the power balance of the organization, an analyst can expect diverging motivation and opinions. Diverging motivation and opinions can exist also between decision-makers and implementers, like in case E and H. Cases A and D represented a situation where the motivation and opinions diverge between responsible managers and staff managers. In diffuse decision-making structure the motivations and opinion divergence was found in cases C and F.

A summary of the case situations recognition in the decision-making framework is presented in figure 3.

Observed risks and actions taken to avoid the risks in different situations

Two case situations, cases C and E, were identified to belong to the risk area "Exhaustive analyses – no decision" situation. Case C was classified to the category of highest risk of ending in no decision. The question in the case was whether the firm should change its operating model

by naming one unit to coordinate and centrally stock some items for other units. The units were independent profit centers, so the decision-making structure was clearly diffuse. The source of divergent opinions and motivation was that the suggested changes would jeopardize the independence of some parallel business units while one of them would get a better position. The director could also be characterized as analytical and consensual. He had a passive attitude to the question and the analysis assignment was given to an external analyst after one year of discussions and internal analyses. So, all the symptoms for no decision situation were present.

The case showed that one-to-one discussions between the analyst and all the decision-makers are extremely important to find out the different motivation and opinions of the decision-makers. The discussions were carried out as analyst excursions to the units with no clear agenda to find out the motivation and opinions. After these discussions the analysis was focused more on revealing the performance gaps of individual units compared to others and what the business of each unit looks like in the suggested operating model. The case also pointed out that the motivation can change during the analysis process. During the process quite neutral opinions turned to divergence when the preliminary results pointed out that obviously the suggested model would include more dramatic changes in the roles and independence of the units involved in the decision process.

In cases C and E the stepwise approach was seen necessary to introduce the suggestions to the decision-makers in smaller portions. In case E, where the decision situation was simpler, the approach was two-staged. In the first stage the analysis was only used to point out the problem area and to produce material to start own efforts to solve the situation. In the second stage, after a year, a sophisticated model was introduced to the group. In case C, this approach could not be utilized because the diffuse structure would have caused the solutions to diverge.

It could be expected that none of the analysis assignments could be classified to the categories where the risk of arbitrary decisions are present. However, four cases were classified in the "Arbitrary decision – analysis ignored" risk category, because the only exception from the expected extreme risk situations was that the motivation and opinions were divergent instead of convergent. Obviously, in a decision-oriented environment opinion divergence is required to launch an analysis.

Common for all these situations was that "somebody wanted to persuade somebody else to do or accept something". In case F the manufacturing phase of a supply chain wanted to persuade the distribution channel unit to give up its own further processing. In cases D and H the analysis was started to convince the superiors of the launcher. In case A a staff function started an analysis of the practices of a sales unit. In these situations the analysis had a role of changing somebody's mind, from which there is a very short step to a situation, where the analysis is used as ammunition in a battle, as described by Langley (1995).

From the analyst's point of view, there are two main risks in these situations. Firstly, there is a risk that the analysis assignment is distorted because of the strong opinions of the analysis launcher. Secondly, the revelation of divergent motivations might come too late and lead to ignorance of the analysis results because the analysis launcher wants to keep the analysis in his/her hands. For example in cases A and D the analyses were carried out and the analyst did not meet the final decision-maker until in the meeting where the results were reported. In these cases the arguments were not strong enough to persuade the decision-maker to change his mind. The

experiences from other cases show that it would have been useful for the analyst to get acquainted with all the decision-makers' motivation and opinions beforehand and adjust the analysis from those viewpoints. In a situation where the risk to be used as a weapon for struggle is strongly present, an analyst should at any cost aim at an objective role in the process. In practice this is not possible without committing the originally outsider decision-makers the process already in the objective definition phase of the analysis.

			Decision-making style	
			Facts and consensus oriented	Decision-making oriented
Decision-making structure	Diffuse	Divergent motivation / opinions	Analysis - no decision Case C	Analysis used as a weapon Case F
		Convergent motivation / opinions		
	Concentrated	Divergent motivation / opinions	Risk to forget implementation Case E	Analysis results neglected Cases A, D, H
		Convergent motivation / opinions	"Easy cases" Cases B, G	

Figure 3. The case situations in the decision situation framework

The decision-making style of the organization is certainly a factor to be taken into account in analysis process. The fact and consensus-oriented environment is a home ground for an analytically oriented person and an excellent breeding ground for excessive analyses. In these environments an analyst needs to consider what analyses are necessary and how to speed up and make the decision-making easy. In decision-oriented environments there seems to be significant risk that the analysis ends up being used as ammunition in a battle. In this situation it is essential to involve all parties to the analysis process in as early stage as possible. Rather unexpectedly, it was difficult to find any particular actions to different decision structures. It did not seem to have very much influence on the analysis approach, as far as the structure was known to the analyst. Instead the motivation and opinions divergence played maybe even bigger role than expected in the decision situations analyzed in this study.

Summary and suggestions

This study utilized a three-dimensional classification of a supply chain decision-situation, which was proved to be a quite difficult task. The main reason for this is the qualitative nature of the factors. However, as a main guideline found from the case study is that an analyst should keep in mind two aspects in a decision-making process. First issue is the motive for the analysis assignment. Especially in a decision-oriented environment the primary or at least important motivation for an analysis assignment can be persuasion of another party. The second issue is to understand and keep in mind the motivation and opinions divergence and that the opinions can change as a consequence of analysis results. The findings of the study can be summarized as the following six suggestions to the supply chain analysts. The motivation of these suggestions is to keep the analyst on track in organizational dynamics related to the analysis assignment. The suggestions are:

1. Identify all the key players, the decision-makers in the expected suggestions and also those who are supposed to be in charge of the implementation of the suggestions.
2. Identify the potential underlying sources of divergent motivation and opinions, such as conflicting objectives, imbalance between the required efforts and the gains to be achieved by the decision-maker.
3. Get in one-to-one discussion with all the key players. Actively dig out the motivation and opinions of all the decision-makers and implementers.
4. Prepare the analysis especially for those participants whose motivation and opinions are furthest from the potential outcomes of the analysis.
5. Identify the dominant decision-making style in discussions and first meetings. Prepare yourself to speed up the fact and consensus-oriented groups and slow down the decision-making oriented groups.
6. Proceed stepwise in as many steps as possible, producing intermediate results and re-directing the analysis as often as possible in joint meetings with the key players.

We argue in this study that by following these suggestions an analyst can get deeper in the decision situation, produce significantly higher quality analyses for that particular situation and facilitate rapid and effective implementation. However, getting involved in the decision-making process means taking responsibility and leads to ethical considerations. For example, should an analyst stick in the assignment even though a wider scope would give other results? Or should an analyst assent to tell partial truth when it serves “higher purposes”? One should keep in mind that these questions get more and more relevant when getting deeper involved in the decision-making process.

CONCLUSIONS

The main objective of the study was to find viable analysis practices to different strategic supply chain decision situations to improve the effectiveness of analysis. For this purpose the decision situations were first classified, then potential risks were identified in the situations and finally practices improving the analysis effectiveness were identified. The results indicated that the approach to categorize the situations into two risk categories characterized with three factors can add value the skills of supply chain analysts.

The major findings of the study derived from the successful and unsuccessful practices in all the studied situations have been presented as general suggestions to the supply chain analysts. The study has pointed out that the expected decision-making situations exist and there are different ways to handle the different situations. Though the recognition of the decision-making situation is a challenging task for an analyst, but understanding on the organizational, management style related and motivational factors of supply chain decision-making situation can prevent many inconvenient surprises during the process.

The approach used in the study has naturally some limitations. First of all, the case situations were carried out by an external consultant. This can distort the variety of analysis assignments and the case situations consist of the most demanding situations. This means that the suggestions might be too heavy to be applied in less demanding assignments. However, this can not be considered a serious problem. The second limitation of this study is that the analysis process was

detached from the analysis content. Naturally there are easy and difficult decisions to make even when the opinions do not diverge. This could be an interesting research issue by itself. An important issue related to this study is the implementers' role in analysis process and how the analysis process can support the implementation phase (Niemi et al 2004).

Is quantitative analysis in strategic supply chain decision-making a tool for decision or a weapon for struggle? This study has shown that it can be both. It has also shown that more research, education and applications are needed to better utilize the quantitative analysis techniques in supply chain decision-making.

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Appendix 1. **An overview of the case situations**

Case	A	B	C	D	E	F	G	H
Industry	Bulk manufacturing	Bulk manufacturing	Wholesale	Manufacturing	Process industry	Wholesale	Process industry	Manufacturing
Main objective of the analysis assignment	To find problem areas and make suggestions for them	To find problem areas and make suggestions for them	To analyze and concretize an idea of a potential operating mode	To analyze whether or not a certain mode should be applied	To point out the possibilities and need to improve actions	To optimize the further processing location in a supply chain	To reduce working capital by better inventory control	To build a model for logistical services business
Breadth of influence	Single unit as a part of supply chain	Single unit as a part of supply chain	Companywide	Companywide, supply chain strategic move	Single unit as a part of supply chain	Multiple units, stage	Single unit as a part of supply chain	New business area
Duration of the process	4 months	3 months	6 months	1 month	2 months	4 months	4 months	12 months
Number of formal meetings	3	3	7	1	2 + follow up	3	2	20+
Suggested changes	Major	Major	Minor	Minor	Average	Minor	Average	Major
Suggestions implemented	No	Yes	No	No	Yes	Yes	No	Yes
Analyses used in the study	- Material flow mapping - Supply chain cost analysis - ABC-analysis application	- Material flow mapping - Supply chain cost analysis - ABC-analysis application	- Material flow mapping - ABC-analysis application - Inventory parameter calculations - Total cost effect study	- Cost comparison between suggested models - ABC-analysis application - Total cost effect study	- ABC-analysis application - Inventory parameter calculations - Total cost effect study	- Material flow mapping - LP-modeling - ABC-analysis application - Total cost effect study - Analysis at customer / item level	- Material flow mapping - ABC-analysis application - Inventory parameter calculations - Analysis at customer / item level	- Material flow mapping - Investment calculations - Extensive what-if analyses - Analysis at customer level

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Improving the impact of quantitative analysis on supply chain policy making

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Abstract

The phenomenon of formulating and bringing in a set of a new way to operate, a policy, into the supply chain environment is examined. The general change management research findings are applied to the supply chain environment to identify the phases of policy making. The different roles of quantitative analysis in the process are identified using a multiple case study of eight policy-making processes. The study points out that the impact of quantitative analysis on supply chain policy making can be improved by adapting the different roles of the analysis in the different stages of the policy-making process.

Keywords: Supply chain management; Policy; Change management; Quantitative analysis

1. Introduction

Supply chain management (SCM) can be defined as "the integration of key business processes from end user through original suppliers that provides products, services, and information that add value to customers and other stakeholders" (Lambert et al., 1998). It follows from the definition that SCM requires the management of activities, resources and actors over the functional and organizational boundaries as well as through different levels of the organization. This wide scope of SCM both horizontally and vertically poses big challenges to the management. Along with new technical possibilities to plan and control the supply chain, it is necessary to introduce more sophisticated policies and new operating models for people operating the system.

The process of bringing in a set of new ways to operate into the supply chain environment, defined here as supply chain policy making, has not been a very popular research topic. The practice shows that the problem is undoubtedly a relevant one. The development of data systems and data processing possibilities has enabled not only better methods to carry out the operative tasks of SCM, but also more and more sophisticated modeling and numerical analyses for planning new operating models and policies. However, most OM practitioners involved in this kind of process have presumably experienced that even the most thoroughly calculated analyses and recommendations do not ensure quick decision making and smooth implementation.

In this paper, the analysis comprises a wide range of techniques from a simple cost model to the most

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sophisticated modeling approaches. The common factor is the target supporting the decision making and implementation of a new supply chain policy. Our aim is to find ways of making more successful analyses for the decision making and implementation of new supply chain policies.

2. Background of the study

As a response to the decision-making requirements in SCM, several types of approaches are in use. SCM, logistics and operations management in general, as a research discipline have a strong historical connection to operations research, which emphasizes quantitative modeling of strictly defined problems. Therefore, the dominant approach in operations management has been modeling.

Structured approaches to SCM decision making have generally evolved along three lines: optimization, simulation, and heuristics (Ballou, 1989). Optimization is potentially the ideal way to solve a decision problem. However, problem descriptions can rarely be as extensive and detailed as would be required for the model to be sufficiently close to reality to be convincing. With simulation models the problem description can be more easily made in sufficient detail, but these models leave the burden to the user to decide which decision alternatives to test and also to decide on their order of superiority. Heuristics, i.e. various rules-of-thumb, has been decision makers' pragmatic approach to avoid the burden of extensive modeling and still achieve satisfactory solutions to several decision problems. The obvious deficiency of heuristic rules is that it is not guaranteed that they will work well in various decision-making situations. Instead, the convenience of their use may encourage decision makers to apply them to situations they were not originally meant to without any attempt to test their appropriateness. However, heuristic rules are very popular in practical decision making, also with strategic level decisions, because strategic problems are not easily formulated into straightforward optimization problems. Heuristic rules are typically manifested as various decision-making principles and concepts, which are used to reduce the complexity of strategic planning.

Almost any analyst who has used sophisticated quantitative approaches to support decision making in the real-world environment has encountered problems. The problems are related either to the modeling and analyses themselves or to the implementation of the results. Powers (1989) has recognized the following disadvantages of optimization modeling:

- The size and structure of the problem is too complicated for a model to guarantee a globally optimal solution.
- "The black box syndrome": the decision maker does not understand how the model works and what its assumptions are, and therefore feels uneasy with its results.
- The aggregation level used in the model limits the level to which the model can give operating rules for implementing the results. It may be that a model of manageable size is at a too aggregated level to be practically relevant.
- Random behavior and great amount of detail are in some decision problems the necessary characteristics of the data to be used, and optimization models are not best suited for these kinds of problems.

A decade after Powers' observations, remarkable progress has been made with computer technology. It relaxes some of the above-mentioned limitations of modeling, but they all still exist to some extent. The black box syndrome may probably have become worse.

The recent development seems to lead to two different directions: it seems like that improving software and hardware improves the validity and hence the relevance of the modeling approach in solving many types of decision problems (e.g. Shapiro, 2001). But at the same time, there is a strong perception based on practical experiences that the implementation success of the results achieved by the more sophisticated methods is not essentially better than the one achieved with very simple approaches, i.e. heuristic type rules.

One way forward with these problems is to develop better approximations for the various parameters used in models (Shapiro, 2001). However, supply chain decisions typically involve different types of information and knowledge to be used to get a comprehensive view of the situation. It is possible that many strategic level decision-making situations are so unstructured that it is doubtful whether they can ever be convincingly dealt with one approach only, such as solving an analytical model. So far, the contemporary enterprise resource planning (ERP) and supply chain planning systems have not been effective with strategic level decisions (e.g. Chopra and Meindl, 2001).

Although supply chain decision making involves strategic, tactical, and operational levels and the respective time frames, the competitive performance of the supply chain is mainly decided through the strategic level decisions: service strategies, network design, changes in policies and operating models, and organizational choices. We believe that what is needed are approaches, which support this kind of decision making effectively. To develop these approaches, the features of the decision making and implementation processes have to be understood.

The perceptions described above bring up an important why-question: Why are the results of quantitative analysis poorly implemented? Obviously also this question is a complex one and requires approaches from many viewpoints and research disciplines. In this paper, we approach the supply chain policy making as a process with different phases having different types of requirements for quantitative analysis. Therefore, we propose that disciplines and theories on, e.g. decision making, change management and organizational learning can give new viewpoints to how quantitative analysis should be applied in a process starting from an old policy and ending in an implemented new one, and how the process can be made more effective.

Our aim is to find ways of making more successful analyses for the decision making and implementation of a new supply chain policy. To be considered successful in this study, the analysis should meet two criteria. First, the analysis should produce theoretically justified, valid and reliable answers. This has always been the target of OM researchers. Secondly, and this is the focus of this study, the analysis should facilitate the decision making and the implementation with the analysis means as much as possible. The analyst not only has to provide the "right" answer, but this answer must be convincingly imparted to many decision makers, taking into account their points of view. In the following sections, we present a theoretical framework of policy-making phases based on change management concepts and report the findings obtained when analyzing eight cases of assignments with the framework.

3. The phases of the supply chain policy making—a change management approach

3.1. Concept of supply chain policy making

The word policy can be understood in many ways, varying from a definite set of numerical parameters to an indefinite expression of how to act in a certain situation. In this study, we focus on higher, strategic and tactical level situations, for example changing the service level policy or reconfiguring the supply chain practices to take advantage of new IT solutions. These kinds of situations have three key elements:

- The policy-making process involves both parallel, more or less independent units and different hierarchical levels.
- The quantitative analyses to support the decision making and implementation require special analyst skills.
- Besides quantitative data, the decision making requires qualitative knowledge of different experts and managers.

For the purpose of this study, it is useful to see the supply chain policy making as a process starting from the emergence of the thoughts that "something should be done" to the point when the new way of working is "business as usual". In this process, we have identified three main types of actors: decision makers, implementers, and analysts. In the next sections we concentrate on the process from the analyst's viewpoint.

3.2. Concept of change management

The concept of change management has been adapted here from the strategic management and leadership literature. Evidently supply chain policy making is a far less complex procedure than the revolutionary strategic and cultural change processes described in the change management literature, but some of the change management findings can be adapted to all policy-making situations.

In the literature, the models and efforts for managing change in organizations are usually step-wise approaches, viewing change as a dynamic and ongoing process with multiple activities and stages. A multistage process makes the change more effective because each stage can be associated with one of the common obstacles in organizational change, like politics, low level of trust or lack of teamwork. Also controlling and managing of organizational transformation is easier with a systematic framework (e.g. Dawson, 1994; Kotter, 1996; Riis et al., 2001).

One of the most widely known processes to manage change has been introduced by Kotter

(1996). He distinguishes eight different stages: establishing a sense of urgency, creating the guiding coalition, developing a vision and strategy, communicating the change vision, empowering broad-based action, generating short-term wins, consolidating gains and producing more change, and anchoring new approaches in the culture. The change processes of, e.g. Dawson (1994), Kotnour (2001), Mohanty and Yadav (1996), Riis et al. (2001), and van Wingerden (2001) vary as to the number and content of the stages but similarities can be seen.

Organizations under time and profit pressure tend to skip phases in a major change effort, for example undertaking only the solution development phase. If these initial phases are skipped, it is often the case that the firm loses some of the coordination or commitment needed to ensure that the change is successfully carried out. Also without the follow-through phases it is very difficult to make the changes last. Therefore, it is apparent that successful change goes through all the above stages in some form. However, it is normal that an organization operates in multiple stages simultaneously and that some stages are considered more important than others, depending on the situation at hand (Kotter, 1996).

3.3. Phases and success factors of the supply chain policy-making process

As a synthesis of the nature of the supply chain policy making and the concepts of change management, we present that the supply chain policy-making process consists of four main phases:

1. establishing the change environment;
2. developing the options and making decisions;
3. implementing the decisions;
4. anchoring the achievements into practice.

The first phase, *establishing the change environment* has been adapted from the change management literature. For, e.g. Kotter (1996) argues that it is necessary to establish a sense of urgency or the need to change before the introduction of the solution. In the supply chain policy-making process this stage includes issues like realizing the need to change, identifying the problem areas, and creating a mutual understanding on the development needs.

Developing the options and making decisions is obviously necessary in a policy decision. The change management literature does not discuss at length the decision making itself, rather it views this as somewhat exogenous, a task of management which must have been done beforehand. Anyway, the nature of the supply chain policy making determines that the decision making is a collaborative process among the parties involved. Pragmatically decision making in a group includes two basic phases: the identification of the options and the evaluation and judging the decision (Kepner and Tregoe, 1982).

In the supply chain policy-making process the phase *implementing the decisions* can mean two things: the decision is taken to practice by the body which has made the decision or the planning of the actions is delegated and divided to subsequent hierarchical layers or to the units involved in the planning.

Change management research (e.g. Kotter, 1996; Mohanty and Yadav, 1996) also stresses the necessity *to anchor the achievements into practice* after the implementation. In a supply chain policy-making process this means efforts to maintain the achieved state of practice or boosting further development.

In Table 1 a synthesis of factors is presented, divided between the different stages of a change process (Dawson, 1994; Kotnour, 2001; Kotter, 1996; Mohanty and Yadav, 1996; Riis et al., 2001; van Wingerden, 2001, Kepner and Tregoe, 1982). The success factors presented in the table are used in the empirical part of the study to identify and organize the possible roles of the quantitative analysis in the supply chain policy-making process. The roles of the quantitative analysis are expected to contribute to the success factors of the supply chain policy-making process.

4. Empirical research design and objectives

The main objective of the paper is to identify the different roles of quantitative analysis in different phases of the supply chain policy-making process. As a theoretical frame, the phases of the policy-making process and the success factors of the phases have been identified from the literature. The empirical research design aims at finding the roles of quantitative analysis contributing to the success factors derived from the theory. The research design is illustrated in Fig. 1.

The empirical part of the study consists of eight case situations. The case study method was chosen to help understand the complex phenomenon with

Table 1
The general phases and success factors of the supply chain policy-making process

Phase	Success factors
Establishing a change environment	(a) Establishing the need and sense of urgency to change (b) Identifying and involving key persons/parties
Developing options and making decisions	(c) Finding out all available options for decision-making (d) Justifying and selecting the policy satisfying all the parties and their objectives best
Implementing the decisions	(e) Translating and communicating the decisions to the whole organization (f) Identifying and carrying out the needed organizational changes (g) Empowering the organization to apply the policy (h) Achieving and communicating the short term wins
Anchoring the achievements into practice	(i) Maintaining the achieved state of practice (j) Boosting the further development

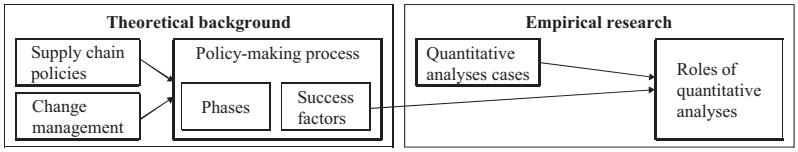

Fig. 1. The research design.

its important but often hidden details. Compared to other research methods, case study is a preferred strategy when "how" and "why" questions are being posed, when the investigator has little control over events, and when the focus is on a contemporary phenomenon within some real life context (Yin and Robert, 1989). A multiple case study was chosen instead of a single case study because of the main objective of the study, identifying the different roles of quantitative analysis in the supply chain policy-making process. The presumption was that all the expected roles of the analysis work could not be found in a single case, so multiple cases were expected to add value to this research context. An overview of the case situations is presented in Appendix 1.

This research was conducted so that one of the authors was involved in the case situations as a consultant. The research represents a particular type of the case study approach, action research. For e.g. Gummesson (2000) lists some definite advantages of this approach over more "hands-off" ones. Firstly, it provides the possibility to closely observe an organization in a way that would not be possible for outsiders. Secondly, it ensures the direction of research to be of guaranteed managerial relevance, as the company management is closely involved in the research effort in progress. Thirdly, it indirectly generates the close relations and common understanding that enable researcher to revisit the company when he is no longer directly involved.

To avoid the most widely mentioned risk of action research, risk of failing to fulfill the scientific requirements (e.g. Gummesson, 2000), the conclusions drawn from the cases have been derived from the literal reports, slide shows of studies, meeting minutes and other literal material like offers and agreements. The research has also involved sessions where the co-authors have been acting as "devil's advocates" (Schweiger and Sandberg, 1989), questioning the assumptions made during the study.

In the following section, the objectives of the analysis assignments and the analyses of the processes are discussed to illustrate the different roles the analysis work and the analyst can have supporting each success factor of the supply chain policy-making process.

5. The roles of analysis in supply chain policy-making process—case study findings

The research work aimed at finding multiple viewpoints to the research subject, though the differentiation between the viewpoints is not the

contribution of this study. The pre-determined objectives of each analysis assignment were used to reflect the managerial perceptions of the role of analysis whereas the analysis of the process itself reflects also the viewpoint of an analyst or consultant. In the next section, the case study findings are presented using the general phases and success factors of the supply chain policy-making process presented above.

5.1. Classification of the objectives of analysis assignments

The pre-determined objectives of the analysis assignments are presented in Appendix 2. The objectives have been collected from the analysis assignment documents made before the analysis work and classified according to the phase of the supply chain policy making they refer to.

None of the analysis assignments covered all the phases. Because external consultants carried out the assignments, there was a tendency to limit the assignment to a relatively well-formed question and limited time frame. As also expected, the majority of the assignments had objectives to support the decision-making phase, which is the most traditional way to utilize analysis.

The classification of the objectives shows the difficulty of evaluating the success of the analysis work by evaluating it with the supply chain policy-making process as a whole. We argue that the role of the analysis work is different in the different phases of the policy-making process. In the next section, the possible roles of the analysis work in different phases are described and illustrated.

5.2. The roles of analysis in supporting the success factors of the policy-making process

The summary in Table 2 gives an overview of the findings achieved by analysing the processes of the analysis assignments. The supporting roles of the analyses have been identified by each success factor. The last column of the table indicates the cases in which the role has been identified. As cases representing the occurrence of the identified role have been accepted the ones in which these roles play a major part.

In the next sections the major findings of the cases are briefly commented on.

5.3. The role of analysis in establishing the change environment

The nature of the supply chain policy-making process is that it involves many organizational units. An analysis can play an important role in establishing the need and sense of urgency to change. The role can either be pointing out the problem areas or pointing out the gains possible to achieve.

The idea of pointing out the development needs is to make the decision makers see the needs by themselves before bringing in any solutions. The aim of these analyses is to present the facts so that the decision makers can move on to the decision-making stages. The analyses in these situations typically include different kinds of ABC-analysis applications, material flow analyses, which are used to point out the development needs. Also activity based costing applications played an important role in cases C, E and G, simply because the use of more accurate cost drivers for, e.g. inventory and transportation costs and presenting the ABC-analysis with correct margins helps the decision makers to see the urgency to change.

The problems in cases A and G implementing the suggestions, and also the composition of parties in case C indicate that the analysis should be used to point out the gains achieved also at the participating unit and responsibility area level, not only at the aggregate level.

To identify and involve key persons/parties, the analysis can be of help by clarifying the extent of the change needed either by pointing out the need to involve some units and responsibility areas to the process or by pointing out that the needed change is deeper than expected. It must be mentioned that in some cases the process might be brought to an untimely end by indicating a large scope of needed change. For example case C ended up with strategic considerations beyond the scope of the management team. However, it is necessary to distinguish this situation from a situation like in case G, where the projected change needs of previous or consequent supply chain members were used as an excuse not to implement the suggestions.

5.4. The role of analysis in developing options and making decisions

A big dilemma from an analysts' point of view is the role they have in the decision making. Is their task to speak up for what they think the analysis

Table 2
Occurrence of the roles of analysis/analyst contributing to the success factors of the supply chain policy-making process

Phase	Success factors	The role of analysis/analyst	Cases with identified role of analysis
Establishing a change environment	(a) Establishing the need and sense of urgency to change	1. Pointing out the problem areas	C, E, G, H
	(b) Identifying and involving key persons/parties	2. Pointing out the gains possible to achieve to the stakeholders	E, G, H
		3. Pointing out the extent of change needed	E, G, H
Developing options and making decisions	(c) Finding out all available options for decision-making	4. Identifying the options and providing analysis of the total effects	A, B, C, F, H
	(d) Justifying and selecting the policy best satisfying all the parties and their objectives	5. Providing analysis from the point of view of the key parties in the decision-making	A, C, D, E, F
Implementing the decisions	(e) Translating and communicating the decisions to the whole organization	6. Providing easy-to-adopt and detailed solutions to all the organizational levels and units involved	D, F, H
	(f) Identifying and carrying out the needed organizational changes	Not possible to identify	Not found
	(g) Empowering the organization to apply the policy	7. Ensuring that the lower level adjustments fit the total solution	D, H
	(h) Achieving and communicating the short term wins	8. Pointing out the possible gains to a single unit involved	C, E
Anchoring the achievements into practice	(i) Maintaining the achieved state of practice	9. Identifying and calculating easy-to-understand follow-up variables	E
	(j) Boosting further development	10. Pointing out the potential of fine-tuning the policy	E

show or to stick in the assignment and present just the facts? Interpretation and presentation of the results is difficult because the decision making is seldom based solely on analysis. The decision makers bring in also their ambitions, perceptions, and opinions. There should be room to bring in the decision makers' and other experts' qualitative knowledge into the decision process—in how important a role is? It is a difficult question to answer, as evidently every case is unique. However, it is important to an analyst to understand the factors causing difficulties and distortions in the decision making and leave room to qualitative analysis as well (see Niemi et al., 2004; Langley, 1995).

Identifying all the available options for decision making is in practice a difficult task. In cases A, B, F, H the management and the stakeholders had only one option versus the present policy. This, as well as a too wide range of options (case C and to some extent H), cause difficulties in the decision making. It seems that the analyst should have a role in identifying the relevant options and provide analysis of the total effects of the different options.

5.5. *The role of analysis in implementing the decisions*

The change management literature stresses the importance of empowering the organization to apply the new way of doing business. Although the policy making process is often a small scale change process, the implementation phase is critical to the success of the process.

In the implementation phase the number of people involved in the process increases. It is essential to translate and communicate the decisions to the whole organization. The analyst has an important role in providing easy-to-adopt and detailed enough solutions to all the organizational levels and units involved. A successful implementation requires also an easy-to-understand description

of the suggested system as a whole, usually created in interaction between the analyst and the implementers, like in case H.

In all the cases where the implementation objectives were set in the analysis assignments, the support of the analysis to the implementation was limited to producing calculations to be implemented as such (e.g. inventory parameters). All the cases exhibited problems with the motivation or skills of the implementers in varying degrees of severity. Obviously a parameter implementation requires more interaction between the analyst and the implementers, perhaps already in the earlier phases of the process.

It is important to note that usually the policy decision triggers a similar, smaller scale internal process in the units involved. In this case the analyst can have the role of controlling that the lower level adjustments fit the total solution. However, this requires a clear mandate from the management, and in the case situations this role was not observed. This may be one reason, why the implementation.

All the cases lacked the calculations and support for achieving short term wins, especially from the viewpoint of a single unit involved. However, when analyzed afterwards, a closer interaction between the analyst and people responsible for the implementation of the policy at unit level would have enabled the implementation. The interaction can be educative, but also the cooperation between the implementers and the analyst to refine and "operationalize" the suggestions not only increases the quality of the solution but also facilitates the implementation.

5.6. The role of analysis in anchoring the achievements into practice

Kotter (1996) stresses the importance of consolidating the gains and to produce more change. In the case of a new supply chain policy, the task is to maintain the achieved state of practice and to facilitate further development.

In case E, where the analysis extended to the follow-up and to anchoring the achievements into practice, the follow-up study was carried out one year after the first study. In this phase it is important to identify and calculate easy-to-understand follow-up measures and to also implement them in practice. The follow-up study also pointed out the potential for further fine tuning of the policy.

6. Conclusions

In this paper, we have examined the phenomenon of formulating and bringing in a set of new way of working, a supply chain policy, into the supply chain environment. Our approach has been twofold. Firstly, the general change management research findings were applied to the supply chain policy-making process. As a result of this the generic phases of the supply chain policy-making process were identified and the relevant success factors of each phase derived.

Secondly, a multiple case study was carried out to identify the different roles of analysis influencing the success factors of the different stages. The roles were identified by success factors.

The supply chain policy-making process is derived from larger scale change processes. For the simplest policy-making tasks it is obviously quite exhaustive. Anyway, even in the simplest assignment, the phases can and should be recognized. The presented phases of the supply chain policy-making process can be used as a guideline on how to focus the work of the analyst.

It is difficult to give an explicit answer to the big question, how much effort should be paid to the preceding and subsequent phases of the decision making in different situations. Decision making is the "natural" phase where quantitative analysis has been and will be used. However, the policy-making framework used in the empirical research revealed that success in the decision-making phase was due to thorough work on the previous stage.

As an overall observation on the case study can be mentioned there is difficulty to support the implementation stage with quantitative analysis. The reason for this lies to some extent to the first phase, it is difficult to change if the implementers do not regard it necessary. The support of quantitative analysis to the implementation phase itself is a question that requires further research. A possible useful viewpoint for this is to see the policy-making process as a learning process.

The study raises a big question of analysts' role. Is their task only to bring in the "facts and just the facts" to the process or should they participate in the decision making and stand for a solution they prefer? Obviously the role depends on the situation, assignment and the person in question. This study gives a basic frame to the analysts to see their work as an essential part of the change process and also some guidelines to adapt to the situation.

Appendix 1. Overview of the cases

Case	A	B	C	D	E	F	G	H
Industry	Bulk manufacturing	Bulk manufacturing	Wholesale	Manufacturing	Process industry	Wholesale	Process industry	Manufacturing
Main objective of the analysis assignment	To find problem areas and make suggestions for them	To find problem areas and make suggestions for them	To analyze and concretize an idea of a potential operating mode	To analyze whether or not a certain mode should be applied	To point out the possibilities and need to improve actions	To optimize the further processing location in a supply chain	To reduce working capital by better inventory control	To build a model for logistical services business
Duration of the process	4 months	3 months	6 months	1 month	2 months	4 months	4 months	24 months
Number of formal meetings	3	3	7	1	2 + follow up	3	2	20+
Launchers	Staff function mgr	Staff function mgr	General manager + line mgrs	Function mgr	Function mgr	Staff function mgr	Line manager	Managing Director
Implementers involved	Indirectly	Indirectly	Directly	Directly	Not at all	Directly	Indirectly	Directly
Expected changes by launcher/ implementer	Confused/none	Minor/none	Confused/major	Clear/minor	Clear/none	Major/none	Confused	Major
Suggested changes	Major	Average	Minor	Minor	Average	Minor	Average	Major
Analyses used in the study	– Material flow mapping – Supply chain cost analysis – ABC-analysis application	– Material flow mapping – Supply chain cost analysis – ABC-analysis application	– Material flow mapping – ABC-analysis application – Inventory parameter calculations – Total cost effect study	– Cost comparison between suggested models – ABC-analysis application – Total cost effect study	– ABC-analysis application – Inventory parameter calculations – Total cost effect study	– Material flow mapping – LP-modeling – ABC-analysis application – Total cost effect study – Analysis at customer/item level	– Material flow mapping – ABC-analysis application – Inventory parameter calculations – Analysis at customer/item level	– Material flow mapping – Investment calculations – Extensive what-if analyses – Analysis at customer level

Appendix 2. Objectives set for the analysis work

Case	A	B	C	D	E	F	G	H
Establishing a change environment			To evaluate the development potential to improve the inventory management. To benchmark the depots to each other.		To allocate the supply chain costs correctly. To calculate the potential of better inventory management for a pilot product group		To evaluate the development potential to improve the supply chain management for a pilot customer.	To evaluate the business potential of specialized distribution services, needed investments and effects to core business
Developing options and making decisions	To create and compare the possible future operating models.	To create and compare the possible future operating models.	To compare the present decentralized model with the suggested new partly centralized model.	To find a policy making it possible not to invest on warehouse facilities. To compare the present one-level inventory model with the suggested partly two-staged model.	To create the options to reduce the inventories and calculate their potentials.	To calculate where to locate the two-staged manufacturing facilities in a supply chain.		To calculate the profitability of the investment.
Implementing the decisions			To calculate the inventory parameters for the current and new model.	To calculate which items could be moved to the two-staged system. To calculate which products to apply MTO and which MTS.		To calculate which items should be made to stock and which to order.	To calculate the inventory parameters for the current and new model.	To calculate the effects on certain distribution routes/areas.
Anchoring the achievements into practice					To evaluate the progress in the inventory management.			

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Publication 4

Petri Niemi and Janne Huiskonen (2008)

An approach to improve logistical performance with cross-unit benchmarking

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An approach to improving logistical performance with cross-unit benchmarking

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Abstract

Purpose – The paper aims to help identify the best logistical practices and to implement them with minimal organizational resistance in an environment with relatively similar business units utilizing an internal benchmarking approach.

Design/methodology/approach – A stepwise benchmarking process, where the use of basic inventory control practices is complemented with benchmarking analysis among business units that are of the same kind, but not entirely similar. The viewpoint is that of a supply chain specialist, and the main objective of the paper is to present how the analysis should be carried out.

Findings – Four principles were found useful when carrying out the analysis for internal benchmarking: refining stepwise the precision of the analysis, accepting the practical limitations of the data, disaggregating the task to be benchmarked to manageable sub-areas, and engaging the management and key implementers in the analysis work.

Originality/value – The approach is a complementary approach to the traditional inventory models, which often rely on more or less arbitrary parameter values. The analysis provides realistic, individual inventory objectives and gives suggestions for focused improvement actions.

Keywords Benchmarking, Performance measurement (quality), Inventory management

Paper type Research paper

Introduction

Benchmarking has established its position as an important approach in improving business processes, as can be seen in the wide body of academic literature published during the last 15 years (Yasin, 2002; Dattakumar, 2003). Much of the research is strongly practice based, which makes benchmarking, one can justifiably claim, an applied discipline (Camp, 1989) that is well-grounded in managerial practice. Its effectiveness has been proven in large companies, such as Xerox, which was the first to implement it (Camp, 1989), as well as in small- and medium-sized enterprises (Cassell *et al.*, 2001).

Theoretically, the concept of benchmarking has evolved from the early days of reverse engineering through the core of performance, process, and strategic benchmarking towards such forms as global benchmarking, competence benchmarking, and network benchmarking (Kyrö, 2003). While, as a maturing discipline, benchmarking research tends to search for new innovations and broaden its scope, its hard essence is still in the "process of identifying the highest standards of excellence for products, services, or processes, and then making improvements to reach those standards – commonly called best practices" (Bhutta and Huq, 1999). Benchmarking and best practice-based improvement are closely related to two other disciplines popular in current academic discussion, namely organizational learning

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(Argyris, 1993; Senge, 1990) and change management (Dawson, 1994; Kotter, 1996). Fundamentally, benchmarking is about learning (from best practices) and change (to better practices). When learning is systematic and involves the majority of stakeholders in activities such as internal benchmarking, it is highly probable that the changes emanating from such learning will be more readily implemented within the organization (Hyland and Beckett, 2002). Benchmarking can be seen as a tool for organizational learning (or even a research method (Kyrö, 2004)), and learning fosters change by creating commitment implementing the changes as the participants gradually see the benefits during the learning process.

Especially, in large multinational companies, internal benchmarking has been found to have the several change catalyzing benefits. It can be used to avoid some barriers to change that have been observed when using ambitious external benchmarking processes (Hyland and Beckett, 2002). Also, when benchmarking internally, it is easier to ensure that the processes are comparable enough in terms of operating environments. Even though companies can get hard data on explicit practices, much of the knowledge on business processes is tacit in character and thus tied up to the minds of individuals, and thus hard to access from totally external sources.

There are some principles that are important to make a learning and change process successful (Hyland and Beckett, 2002). The process must have a clear focus on outcomes: improving the bottom line in the short term, and improving competitiveness in the long run. The data used has to be clear and understandable: to stimulate learning, the data needs to be converted to knowledge and couched in the language of the organization. The data must be collected in a meaningful way that are understood and accepted by the people involved. These principles pose rather strict limitations to the complexity of the benchmarking data and the process. They may tip the balance in favour of internal benchmarking, even though external sources often provide more innovative practices to compare with. To get the most benefits of the characteristics of internal and external benchmarking, an analysis across several business units of a company often gives a good combination of variation of practices and performance, as well as enough similarity in the operating environment and access to the relevant data sources, including tacit and confidential business knowledge.

This study applies a cross-unit performance benchmarking approach to find out the improvement potential and possible actions for a regional construction product distributor operating six business units. The object of the benchmarking was selected to be the logistical process of the business units, or more specifically, inventory control efficiency, which is one of the key success factors of a distributor company. Since the company had no earlier experience in benchmarking, it was decided to begin with performance benchmarking, which best fulfils the above-mentioned principles of outcome focus, as well as the clarity and understanding of data. It is also the most potential way to provide quick wins and create belief in the necessity of change, which are important early phases of a change process (Kotter, 1996; Niemi *et al.*, 2007).

This paper presents a stepwise benchmarking process, where the use of the basic inventory control practices is complemented with benchmarking analysis among business units of same kind, but not entirely similar. The viewpoint is that of a supply chain specialist, the main objective of the paper is to present how the analyses should be carried out taking into account the suggestions presented in Niemi *et al.* (2007).

In the following sections, we describe the benchmarking procedure tailored for the specific activity, inventory control, in detail.

Application environment as basis for analysis

The case company is an independent distributor of a focused range of products, serving wholesale buyers, industrial customers and consumers. It has a countrywide network of regional distributors, which are independent profit centers, six depots of which were considered to represent well enough the diverseness of practices and policies. The total annual turnover of the case depots is roughly €100 M. The regions and regional competitive situations are very different, and therefore the product mixes of the distributors differ from each other quite a lot. The decisions on product variety are basically made locally, and that is why some of the distributors are strictly focused on a core product variety, some serve their customers with a larger variety of additional, related products. Inventory management is in practice decentralized to salesmen, so that a salesman is responsible for replenishments of a named group of products. The culture of the company is very selling-oriented, and the whole personnel of the depots participate in and consider selling as their main task, and inventory management as their secondary task.

Efficient inventory management has a major impact on profitability in wholesaling and retailing businesses, which are characterized by a wide product assortment and narrow contribution margins. In managerial practice, the management of product inventories often relies on rather straightforward and simple-to-use models, such as economic order quantity, ABC-analysis, and statistical safety stock algorithms (Silver *et al.*, 1998). These models are based on quite restrictive initial assumptions in terms of, e.g. demand patterns and cost-parameters. At the same time, the relaxation of the assumptions leads to an increasing complexity of models, which may undermine their practicality. This presents one of the most challenging questions in management research: how to provide tools that improve the quality of decisions without complicating the analysis too much.

Since inventory management is regarded as a secondary task by the salesmen, and therefore run by simple rules of thumb, it is obvious and understandable that skills, resources and motivation to implement sophisticated inventory decision-making practices are missing. The very discrete and fluctuating demand of individual items, and the useful practice of combining orders of several items from the same supplier make the inventory parameter calculations very challenging even for a skilled practitioner. The parameters that would be needed even for the simplest models are difficult to define reliably. However, also in this company, it is seen necessary to improve the inventory decision making. There is obviously need for a different kind of approach, one that does not rely on arbitrary parameters or too complex algorithms, but which reveals the most important improvement objects. The approach selected to respond to this need was learning by benchmarking. The approach can naturally be criticized of only being able to provide as good results as the benchmarks are, and even that with a time lag. However, it can be a useful tool for learning efficiently from the company's internal practices.

The starting point of our approach was the assumption that despite the perceived differences of the distributing units, the best or at least better practices can be found and distributed within the company. The organizational structure, which consists of

independent units, gives a good ground for benchmarking the inventory practices of the units. One of our goals was to keep the analysis practically relevant and facilitate the implementation as much as possible, taking into account, as far as possible, the roles of an analysis presented in Niemi *et al.* (2007). Therefore, our approach follows the following four principles:

(1) *Refining stepwise the precision of the analysis.* The analysis should proceed stepwise from higher aggregation towards details only that deep that is seen necessary.

(2) *Accepting the practical limitations of the data.* The work of estimating parameters for the calculations with the management should be avoided as far as possible. The calculations should be done in order to find and point out the different development areas of the inventory management of each depot.

(3) *Disaggregating the task to be benchmarked to manageable sub-areas.* Though it could be seen in the aggregate performance figures that none of the units was a good benchmark as a whole, it can be expected that acceptable performance and practices will be found in disaggregated areas.

(4) *Engaging the management and key implementers in the analysis work.* The aim of each analysis phase is to present reliable figures so that it is easy to combine with the management's subjective knowledge.

Quantitative inventory data is used to reveal two kinds of possible deviations in the performance of the individual units:

(1) The actual inventory levels of a particular unit are potentially too high when compared to items with a similar demand structure in other units.

(2) The actual inventory levels of a particular unit are potentially too low to maintain the service level when compared to items with a similar demand structure in other units.

The purpose of the approach is to find out specific cases where the outcome of the effort gives the highest performance improvement. Besides, resulting in quick wins in some areas, the approach prepares the organization to a more disciplined way of managing their inventories. The following section presents the benchmarking procedure in detail, using the case company data as an illustration.

Benchmarking analysis framework

Underlying logic of the benchmarking analysis

The units of analysis in the study are groups of products at the various levels of aggregation. The data of the products was gathered from six business units, which should apply the same inventory policy for similar products in terms of inventory replenishments and service level targets. The starting point for the analysis was the assumption that, despite the aligned policies, there would exist differences in actual inventory performance between the units, even when comparing similar products. The reason for this is that the units either intentionally deviate from the agreed policies or do not pay enough attention to implementing the policies and achieving the performance targets. One determining factor for the differences in performance may be differences in the demand structures of the units. To eliminate the last option, the units

had to be made comparable with each other. This was achieved by creating logistically similar product groups, so-called generic product groups. It can be claimed that logistically similar products should be controlled similarly across the different units, thereby leading to similar performance. Generic product groups were created by categorizing the products according to three variables: demand value, demand variation, and replenishment lead time. The rationale behind the variables is that they are the main variables used in defining the optimum levels of cycle and safety inventories for products in general (Silver *et al.*, 1998). The performance across the units was compared by calculating the differences in the actual inventory turnover (ITA) of the generic product groups in the individual units. The product groups showing the greatest inter-unit differences in performance were analyzed further to find out the underlying reasons for the disparity.

The objective of the benchmarking framework is to make the different units comparable with each other with analyses that are reasonably tractable for managerial practice. This is achieved by starting with aggregate level analysis using simple performance measures. With the successive phases the analysis focuses on more detailed aspects of the benchmarking (Figure 1). The idea of the step-wise framework is that, based on the results of each step, the management is asked to decide whether the analysis is sufficiently detailed for taking actions or whether the analysis should be refined further. With this interactive manner, analyzing resources are saved, and also the commitment of the management to taking action is improved. In the following, the phases of the benchmarking process are illustrated with the case example of six business units.

Phase 1 – general view: aggregate indicators

In the first phase, the total performance of the units and the possible differences in the operating environment were analyzed to reveal the possible structural reasons for performance differences. The standard ABC analysis shows the differences in terms of total demand volume, the width of product assortment and the dispersion of the demand to the product assortment (Figure 2).

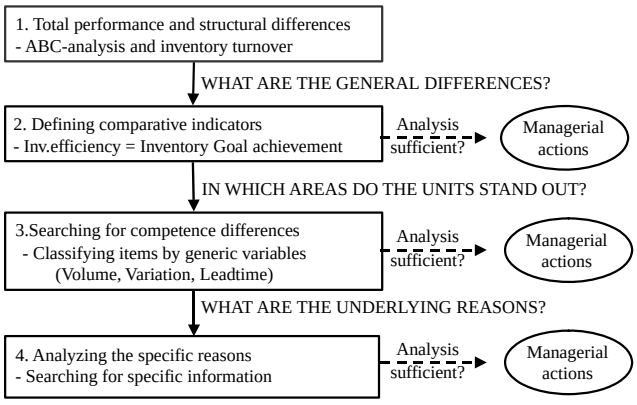

Figure 1.
The phases of the cross-unit benchmarking analysis

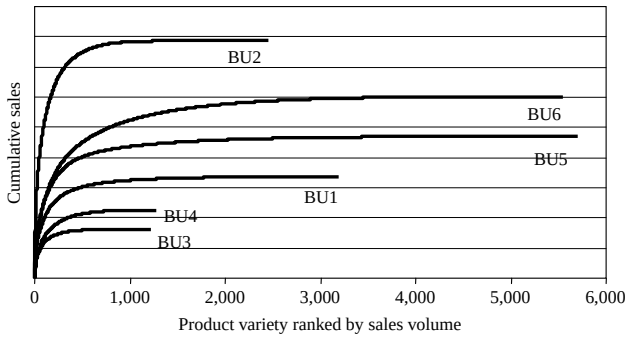

Figure 2.
ABC-analysis of business units by sales

The ABC-curves show for example that two of the units (BU5 and BU6) have almost double the assortment than the unit with the highest total sales (BU2). This indicates differences in the customer and demand structures of the units, which may have an impact on their inventory performance. The general rule in logistics states that it is easier to achieve high-inventory turnover (ITO) when volumes are high and the product variety is low than in the opposite case. The inventory performance at the aggregate level was assessed by ITO (Figure 3). In this case, this indicator did not show that the units with higher volume would have a better ITO. It was decided that some kind of a comparative indicator would be needed to determine how the units perform in comparison with each other.

Phase 2 – goal achievement: comparative indicators

To make the units comparable with each other, the differences in the demand structure had to be neutralized somehow. This was done by determining the inventory turnover goal (ITG), which depends on the unique demand patterns of the units, and then comparing the actual performance (ITA) to the goal. ITG was based on the inventory control policy employed in the units. The inventory control policy was a version of a

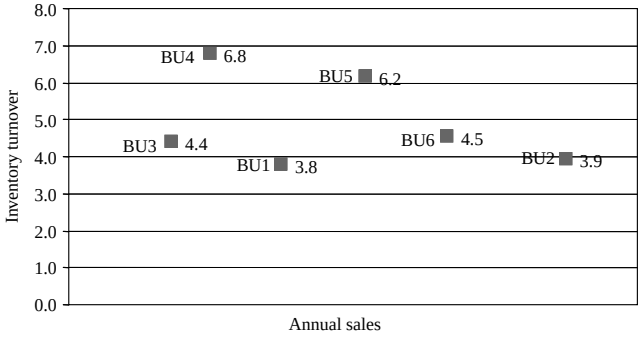

Figure 3.
Actual inventory turnover of the units

re-order point –system (s, Q) in which the order-point (s) was determined in a traditional manner based on average leadtime demand and safety stock:

$$s = \bar{D}L + z\sigma_{\mathrm{D}}\sqrt{L}, \tag{1}$$

in which, D – daily demand; L – typical leadtime for a product; z – safety factor based on normally distributed demand; σ_{D} – standard deviation of daily demand.

In the units, regular replenishments were a desired practice, and it was decided that the length of the order cycle should follow regularly the replenishment leadtime of the products. Therefore, the order size was determined so that the in-coming order fills the stock just over the level of the order-point. So the order size was approximately the amount of leadtime demand:

$$Q = \bar{D}L. \tag{2}$$

With this kind of policy, the average inventory level depends on the magnitude of the demand variation and the length of the replenishment leadtime. Thus, the policy determines the ITG, which reflects the different environments the units are operating at. The relative and neutral performance indicator for comparing the units was determined simply as the relation of the observed ITA to the goal and it was called inventory efficiency (I_{eff}):

$$I_{\mathrm{eff}} = \frac{\mathrm{ITA}}{\mathrm{ITG}}. \tag{3}$$

The differences in the inventory goals between the units and the comparison with the ITA are shown in Figure 4. It can be seen that there were considerable differences in the inventory efficiency figures between the units.

The result of this phase of the analysis is basically the answer to what unit seems to be performing best, when the differences in demand and supply structure are neutralized in terms of demand variation and replenishment leadtimes. Sometimes even this simple result is enough to make the managers of the weakly performing units to think what might be going wrong in their inventory management. If so, then the

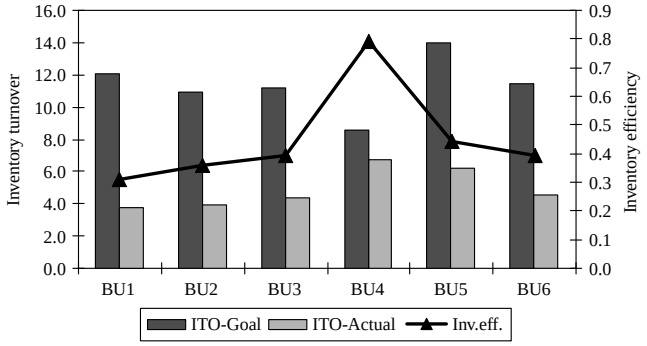

Figure 4.
Inventory efficiency of the units

analysis has fulfilled its purpose: pointed out the improvement need. More often, however, the typical reaction by the managers is that "but we have so many special orders and customers, etc." This argument maybe justified, for one simple performance indicator is naturally too rough to neutralize all the aspects of the different operating environments. For this reason, it is necessary to try to neutralize the units of analysis further to make the units more comparable with each other. This is done in the third phase of the analysis, purpose of which is to reveal whether there are real differences in the performance due to different managerial practices.

Phase 3 – competence or policy differences: classification to generic product groups

The purpose of the more refined analysis is to find out whether there are differences in the performance of the units that do not depend on external conditions but only on managerial practices, and ultimately, the differences in managerial competence. This was done by applying the idea of logistically generic product groups. By comparing the differences between the units in terms of the logistically generic product groups, it was expected that areas of competence where some units have improvement needs would be revealed. The use of logistically generic groups in the comparison is important because it makes it possible to connect the performance with the type of control situation that seems to be difficult to manage in a particular unit. In other words, it is an attempt to generalize the reasons behind the low performance. This is the reason why we did not compare the same products with each other at this phase of the analysis. Identical items can be compared, if certain specific cases are studied more thoroughly in phase 4.

In order to create logistically generic product groups, relevant variables have to be selected for the classification. Two often used factors for classifying products logistically are demand volume and demand variation (Childerhouse *et al.*, 2002). In this example, we decided to use these two, complemented with leadtime as the third generic variable. By cross tabulating all the three variables, generic product groups could be created for the purposes of comparison. However, this led to too few observations in each class so that the information did not have enough general meaning. Classification with one or two variables at a time was the suitable level of precision to provide meaningful differences between the units. Some of the results of the analysis are shown in the following.

The products were classified into three categories in terms of demand variation (using coefficient of variation (CV) as a measure: $CV = \sigma_D/D$): low ($CV < 1.5$), medium ($CV = 1.5$-3.5), and high ($CV > 3.5$). The analysis revealed some exceptional performance values, which could be taken into further examination in those units (Figure 5). For example, BU4 performs well with high-variation products ($CV > 3.5$), and BU6 with low-variation products, but naturally it was necessary to find out whether the high performance was gained at the cost of the service level. Since there was no systematic monitoring of the service levels in place, this had to be based on the unit managers' perceptions and experiential knowledge on actual service levels. As an improvement, control limits (upper and lower) for acceptable performance in different classes could be set in co-operation with the managers to make them in the future find out whether there is some systematic reason for performance deviations.

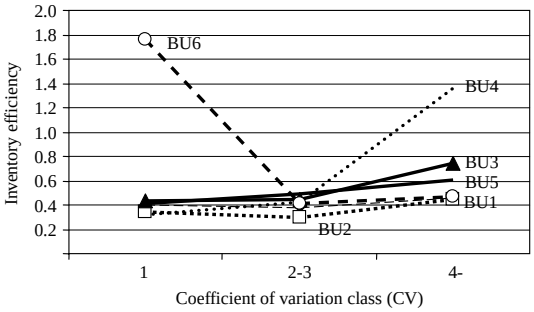

Figure 5.
Inventory efficiency in variation classes

Phase 4: cause analysis: item-specific information

The purpose of phase three was to show to the managers the differences in performance in certain generic conditions. After this phase the managers may have an idea of what lies behind the low performance, or at least they have the suggestion of the potential objects of further analysis. This is the purpose of phase four of the process: the managers search for specific information taking the case products under examination. At this phase, the analysis takes place at the item level and requires the managers to have full experience of the products and their logistics process. This phase is based on combining the numbers and subjective information.

Detailed analysis of some selected items showed, e.g. that in some units the purchasing lot sizes were considerably bigger than the policy recommendation. This caused extremely low ITO and high-cycle inventories with these products (Figure 6). For example, with one item (in the category of leadtime 12 days, and CV = 3-4), one of the units (BU2) had the biggest sales volumes, but an ITO of 3.7 compared to 7.7 of another unit (BU5). When the cost-effects of this excess inventory were evaluated using the 27 percent inventory cost-factor, the cost-saving potential of this one item counted almost €13,000 (Table I). In a similar manner, the managers were encouraged to find the items with the biggest differences in inventory performance and analyze the reasons behind the low performance, as well as the potential cost-savings.

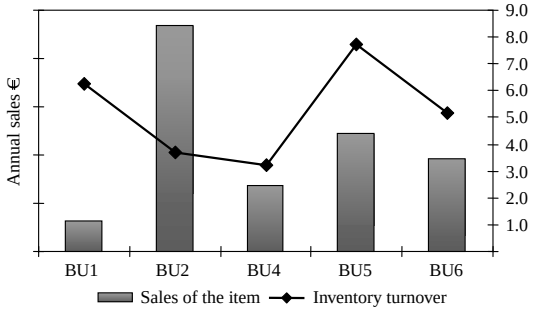

Figure 6.
Sales and ITO of a specific item (product group $L = 12$, CV = 3-4)

Discussion

In managerial practice there has to be a balance between the effort and the aimed level of precision. The benchmarking approach presented in the paper has been proposed to satisfy the managerial need for simple but effective tools to find the improvement objects in the field of inventory management. The main difference of the benchmarking approach to, e.g. optimizing approaches is that only the relative differences need to be analyzed instead of determining the absolute optimums of the selected variables. This choice considerably decreases the effort needed, and is also more in line with the level of reliability of the data that can be achieved in practice. According to the authors' experience, in most practical situations it is also sufficient to point out the differences in performance, and the managers have an intuition of the potential reasons behind the low performance. The value of the approach is not in its theoretical sophistication, but it is a complementary approach to the traditional inventory models, which often rely on more or less arbitrary parameter values. The analysis provides realistic, individual inventory objectives and gives suggestions for focused improvement actions.

The presented approach relies on the assumption that finding differences is enough to get improvement efforts going, and this can be done by means of simple comparisons. In optimizing approaches, the validity of the used parameters is always more or less questionable, and the approach of relying on sharing practices already in use avoids the problems of lacking and questionable parameters. In the presented approach, quantitative inventory data is used to reveal whether the actual inventory levels of a particular unit are potentially too high when compared to items with a similar demand structure in other units, or the actual inventory levels of a particular unit are potentially too low to maintain the service level when compared to items with a similar demand structure in other units.

The logic of the benchmarking approach follows four principles which were, as the main finding of this study, found useful in carrying out the inventory benchmarking approach. Firstly, the analysis proceeds stepwise from higher aggregation towards details only as deep as is seen necessary. Besides, this, the approach potentially saves analysis effort, as already the first steps may point out the development needs, which can have a significant effect on the commitment of the managers and make them involved in the process. Secondly, the process shows how most of the parameter estimation work can be avoided. Traditionally, the logic of inventory management is to start with setting the service level objectives and fixing variables for calculations. By accepting the practical limitations of the data, e.g. in the case study, the fact that the company was not able to quantify actual and therefore the target service levels, either, the approach bringing in the quantified ITOs to be joined together with tacit knowledge on actual service levels can serve as a learning process and lead towards

Unit	Sales in €	Actual inventory turnover	Inventory value in €	Inventory efficiency	Excess inventory in €	Potential cost savings in €
BU1	31,823	6.3	5,076	0.59	2,084	563
BU2	234,641	3.7	63,205	0.25	47,483	12,819
BU4	67,781	3.2	21,058	0.26	15,674	4.231
BU5	122,570	7.7	15,822	0.51	7,727	2.086
BU6	96,168	5.2	18,617	0.46	10,091	2,724

Table I.
Cost-saving potentials of a specific single item in the business units

better measurement and better abilities to adapt traditional optimizing approaches. In the case, avoiding the estimation of parameters for calculations with the management and replacing it with discussion on the causes and effects of performance differences between generic product groups turned out to be a recommendable practice.

The third principle, disaggregating the task to be benchmarked to manageable sub-areas to find the best performance and practices in disaggregated areas was a bit more exhaustive task than expected beforehand, mainly because it was necessary to go to a more disaggregated level than expected to find clear performance differences and their explanations. Finally, a prerequisite for the whole approach is engaging the management and key implementers in the analysis work. It can be said that without it the stepwise approach would be obsolete.

To conclude the main finding of the study, we suggest that the behavioral elements of decision-making should not be underestimated in the implementation of all kinds of new tools and practices: resistance to change is inherent in all improvement work, and the credibility of the input data is often in a decisive role. It would be highly recommendable to take this aspect into consideration already in the analysis stage and to develop analysis procedures that have a positive effect on the management's commitment to the implementation of the results. In the presented approach, the managers are asked to comment on the findings after each phase, and encouraged to provide their intuitive views about the reasons behind the observed differences in performance. Using as reliable information as possible, by means of generic variables, the need for change gains the necessary credibility among the managers.

In the analysis, we introduced the idea of using logistically generic product groups for comparison purposes, and suggested three variables, demand volume, demand variation, and replenishment leadtime to be used in the grouping. The selection and use of the generic variables needs more thorough examination and remains the subject for further research. As the performance indicator we used inventory efficiency, which aims at neutralizing the performance differences due to environmental and structural conditions by relating the actual performance to the goals, which are based on unified policies among the units. Inventory efficiency, which is formed as a quotient of two relative performance measures, perhaps too theoretical for practitioners to perceive, and it needs to be further considered what would be the best way to measure and demonstrate the performance differences in practice.

One important reason for carrying out a case study is to raise questions on phenomena behind the observations. From the authors' point of view, maybe the most interesting one is the perception that there seems to be a fit between the sophistication level of the adapted techniques and some organizational factors. The benchmarking approach producing practical, easy-to-asses guidelines to manage inventories, is suitable for situations where the parallel structure of similar units is considered best from organizational point of view. An interesting question is what are the organizational determinants besides skills defining the sophistication level of tools and practices to be implemented?

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Understanding the knowledge accumulation process—Implications for the adoption of inventory management techniques

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ABSTRACT

Knowledge maturity models are used to identify the stages of the evolution process and assess the management attributes when improving the inventory management practices and adopting more sophisticated inventory management techniques. The management attributes are (1) technical tools, (2) skills, (3) roles and responsibilities and (4) performance measurement and incentives systems. The management attributes that are related to each other are identified for development stages. Two case companies are analyzed with the model. The model is found useful in assessing the current situation on inventory management practices, identifying the development focus areas and prioritizing the development effort.

1. Introduction

Any researcher who has been involved in projects that study inventory management in practice must have observed that, despite all the theory available, the inventory management techniques in use in companies are often very elementary. What might be behind this obvious contradiction between theory and practice? Possible reasons that come to mind are that the benefits of inventory management techniques are not clearly seen and/or the techniques themselves are perceived difficult to learn and use. If the benefits cannot be demonstrated, other, more profitable, development projects get the priority. It is true that it is not easy to show a direct connection between inventory management and the firm's performance (Vastag and Whybark, 2005), although there is some evidence for a positive relationship in the long perspective (Chen et al., 2005). However, besides direct financial benefits, it has been claimed that the adoption of inventory management techniques may have positive side-effects, so called knock-on effects, on the use of other management techniques, which in turn may lead to better performance (Vastag and Whybark, 2003). Therefore, it would be ideal to develop approaches which could show the improvement gap as well as the improvement path for adopting inventory management techniques.

Although the benefits could be shown, the adoption of management theories into practice is not always straightforward and easy. In their research on the implementation of management practices Vastag and Whybark (2003) found that firms learn through their business and trade contacts rather than through management literature, consultants or academics. This claim poses a serious challenge for academic researchers to provide new means of transferring research-based management knowledge into practice: how could we improve and speed up the adoption of new knowledge? If we look at the present situation concerning supply chain and inventory management, the problem is not lack of data and tools, but rather lack of knowledge of how to use them. As Shapiro (2001, p. 25) puts it: 'barriers to integrated supply chain management are organizational, not technical'. It means that we have technological solutions, i.e. various analytical tools, but what we need are new organizational

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solutions, i.e. redesigning of processes and revising of measurement and incentive schemes to promote the utilization of new technologies. This new situation also creates a need to reconsider the roles and skills of the people in the new processes. As a matter of fact, we believe that the failure to see these organizational and managerial aspects has been the main reason for the slow adoption of supply chain and inventory management techniques in many companies. We use this proposition as a starting point for searching for new ways to facilitate and speed up the adoption of new techniques, especially in the area of inventory management.

Inventory management techniques comprise here a variety of tools and working practices to handle the uncertainty of the demand and/or the product and service offering in the supply chain, ranging from simple rules-of-thumb to scientifically validated models. They represent a reasonably unambiguous subset of supply chain management techniques easy to identify and evaluate as to their sophistication level in different environments.

The aim of this paper is to get deeper into the conditions suppressing and promoting the adoption of inventory management techniques. In our search for approaches that take organizational and managerial aspects into consideration, we have concentrated on the research of technology management, which has produced several models on the adoption of complex practices in organizations. We assume that the adoption of inventory management techniques can be evaluated with similar models to deepen our understanding of the process of adoption. Consequently, the adoption of inventory management techniques can be accelerated. On the basis of our search, we have decided to use a stage model, described in the following sections, for our purposes. This approach has led us to the following research questions:

1. Can we identify different stages of knowledge in inventory management?
2. Can we operationalize the general stages to support the adoption of inventory management techniques in the implementation processes of inventory models in practice?
3. Can we identify organizational aspects that need to be considered to support the adoption of inventory management techniques?

The paper is organized such that in the next section a brief review of the relevant technology adoption models is given, and as a synthesis a framework of technology adoption is introduced. After that, two case studies are described and analyzed utilizing the framework. Finally conclusions are drawn from the cases, and the applicability of the framework is discussed.

2. Research design

To achieve understanding of a complex phenomenon occurring as development of daily work concerning inventory management, and to demonstrate it to the reader, the empirical part of this study utilizes the development history and future plans of two case companies. The first case company represents large-scale manufacturing with multiple global manufacturing facilities and sales organizations. The second case company is a regional specialized technical retailer.

The case study method emphasizes a qualitative, in-depth study of one or a small number of cases (Larsson, 1993). Compared to approaches with a larger number of observations and quantitative data, the case approach gives some definite advantages when studying a complex phenomenon happening gradually in a period counted with years. Firstly and pragmatically, it can give results in an acceptable time-frame. Secondly, it can be applied in a situation where the boundaries between the phenomenon and the context are not clearly evident (Yin, 1989). Ellram (1996) states that a case study can contribute to the theory in two ways: the multiple-case approach represents replications that allow development of a rich theoretical framework, while a single case represents a critical case to test a well-formulated theory. This study represents a case to test a formulated theory. According to Yin (1989), a formulated theory development prior to the collection of data is essential to provide guidance as to what data to collect, but the long-term involvement and observation of the researchers in the development process of inventory management in the case companies has also contributed to the development of the framework.

When studying a development process of a complex issue, long-term participation in the development work of the case companies has the advantages of the action research approach over more 'hands-off' ones. As Gummesson (2000) lists, firstly it provides the possibility to closely observe an organization in a way that would not be possible for outsiders. Secondly, it ensures the direction of research to be of guaranteed managerial relevance, as the company management is closely involved in the research effort in progress. Thirdly, it indirectly generates close relations and common understanding, which makes it possible for the researcher to revisit the company when he is no longer directly involved. In this study the researchers have used earlier observations of several inventory management development projects where they have been involved in both companies, for the last ten years, to formulate focused, semi-structured interviews to verify the earlier observations and to gather new information. This way the interviews with the people responsible for inventory management development could be carried out efficiently. In addition to the case studies, because neither of the case companies represents leading environments in inventory management techniques, the inventory management adoption process in grocery wholesales and the retailing sector has been studied from public sources as a benchmark of best practices.

3. Knowledge maturity framework

There are various models describing the organizational adoption of innovations, which can be used to study the adoption of, for instance, various tools and techniques (and roughly speaking, also new related knowledge), such

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as the well-known and widely cited adoption model of Rogers (1995). Since the Rogers' model describes the various factors that affect the organizational adoption of new innovations such as organizational practices and tools, they are commonly used in the prediction and comparison of the organizational adoption of various practices. However, in the case of the development of organizational processes, such as supply chain and inventory management processes, the organizational adoption of new knowledge takes place gradually, as well as the adoption of various related techniques and practices. Rogers' model is not particularly well suited for analyzing and facilitating the gradual development of processes and related practices. Our aim is to identify practices and norms to facilitate and potentially accelerate the development of inventory management processes and of the systematic tools to support this facilitation. Therefore, a more practice-oriented model than e.g. the Rogers' model is called for.

Our presumption is that generally the adoption of inventory management techniques and the related knowledge takes place gradually, at least roughly following the stages of the knowledge maturity model described below. According to various studies concerning knowledge accumulation in companies and especially in their business processes (e.g. Niazi et al., 2005; Marshall and Mitchell, 2004; Housel et al., 2001; Moore, 1999; Bohn, 1994), knowledge development and accumulation can be categorized and described in distinct phases or stages. These models are usually called 'maturity models'. Maturity models can be described as roadmaps for implementing practices in an organization. The purpose of the models is to help in continuous improvement of the capabilities of an organization in certain application or management areas, such as software development (Niazi et al., 2005), R&D (Berg et al., 2004), process development (Moore, 1999) or processes related to knowledge management (Paulzen and Perc, 2002). Their basic idea is that because an organization cannot implement all the best practices in one phase, maturity models are used to help to introduce them in stages. Maturity models also seem to offer systematic guidelines and norms for continuous learning and improvement in organizations.

Typically, various types of capability maturity models identify five or six 'maturity'—or 'capability'—levels, from low to high (Jokela et al., 2006; see also Paulzen and Perc, 2002). Simultaneously, the number of organizational 'foci of assessment', i.e. the viewpoints through which the organizations are examined and evaluated according to the maturity levels, varies from 1 to over 20 (Jokela et al., 2006), being typically around 3–10, depending on the model.

There are various models that describe the process maturity and knowledge accumulation in companies. These models have been developed to describe the accumulation at various levels of analysis. The accumulation of knowledge and knowledge maturity can be described at the employee, process or organizational level. At the employee level, the approaches generally concentrate on the attitudes of employees towards knowledge management or their resistance to necessary changes (e.g. De Gooijer, 2000; Paulzen and Perc, 2002). The organization-level knowledge maturity models assess the overall knowledge management performance of a whole company or a business unit, including for instance the estimation of the knowledge capital of the company. However, neither of these approaches is very helpful in the determination of the activities suitable for adding value directly into a company's business processes, such as the logistics and inventory management processes. This is because the level of detail in organizational-level analysis is too low for the evaluation of inventory management and related processes, and the one of the employee-level is too high, considering the usefulness of the resulting information for further development of inventory management.

Therefore, process-level maturity models designed and applied directly for the assessment and development of specific business processes, such as the inventory and supply chain processes, are needed. The process maturity concept has been earlier developed and tested in the context of the software development process (e.g. Harter et al., 2000) and the project management process (e.g. Ibbs and Kwak, 2000). However, there have been no published studies so far examining the concept relative to supply chain management (Lockamy and McCormack, 2004), or relative more specifically to inventory management, which is the focus area of this study.

Continuous process improvement is based on many small evolutionary rather than revolutionary steps (Lockamy and McCormack, 2004). This continuous stepwise improvement is reflected in the maturity stages of process-level maturity models, such as our process-level knowledge maturity framework applied to the topic of inventory management.

The process maturity concept is analogous to that of a lifecycle, which occurs in various developmental stages. Concerning the process-level maturity models, the concept of process maturity proposes that a process has a lifecycle (i.e. a sequence of maturity levels) that is evaluated by the extent to which the process is explicitly defined, managed, measured and controlled. The concept of process maturity also implies growth in process capability, richness and consistency across the entire organization (Lockamy and McCormack, 2004). In addition, as processes mature, they move from an internally focused perspective to an externally focused, more holistic system perspective (Dorfman and Thayer, 1997). As organizations increase their process maturity, institutionalization takes place via e.g. policies, standards and organizational structures (Hammer, 1996).

In knowledge maturity models (Paulzen and Perc, 2002; Langen, 2000; De Gooijer, 2000; Bohn, 1994), knowledge is seen to develop gradually through stages starting from initial 'darkness', evolving from awareness via more systematic approaches to the quantitatively managed and, finally, to the optimized or automatized level. A maturity level or stage is an evolutionary plateau at which one of more domains of the organization's processes have been transformed to reach a new level of organizational capability. A key presumption in this study is that the process development state can be described

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with management attributes following the knowledge stages and, to achieve sustainable results, the development related to these management attributes should proceed more or less parallel from stage to stage. In the next section these attributes are described in more detail.

3.1. Management attributes of the adoption of techniques

In order to be able to assess and develop the knowledge maturity stages of inventory management processes better, the stages need to be divided into separate management dimensions or areas. We call these factors describing the situation in management areas *management attributes*. Some process-oriented knowledge maturity models like the model of Bohn (1994, 1995) do not include separate management attributes in the maturity stages, contending with merely the general-level description of the separate maturity stages. However, we want to be able to operationalize the maturity stages into manageable tasks, norms and clear maturity descriptions, and see that including separate managerial attributes will clearly support this aim.

There are many ways to categorize and describe the management environment in the context of knowledge and process maturity models. Some maturity models such as CMMI (e.g. Niazi et al., 2005) and SPICE (see e.g. Marshall and Mitchell, 2004) utilize a process dimension, because the software development process that the model is concerned with is connected to many other company processes that need to be managed. However, in our research we found the categorization used by Paulzen and Perc (2002) more useful. They divide the maturity stages of their knowledge process maturity model (the Knowledge Process Quality Model, or KPQM) into three separate management areas, organization, people and technology. The aim is to take into account important knowledge management system elements, and to operationalize them into managerial areas.

Taking another viewpoint to the management attributes, the holistic approach, for example the well-known 7S framework of McKinsey (see e.g. Pascale and Athos, 1981), determines seven different management attributes: Skills, Systems, Staff, Structure, Strategy, Style and Shared values. In this study the management task is reduced to the management of a single task. From the viewpoint of developing and managing a single task and tasks related to it, the perspective of some attributes is certainly too broad: at least strategy, style and shared values are obviously beyond the scope of this study. We have slightly adapted and utilized the management attribute division of Paulzen and Perc's (2002) generic quality improvement-oriented process-level knowledge maturity model to suit the purpose of evaluating and facilitating inventory management processes better. In our categorization, Paulzen and Perc's 'Technology' corresponds to '*Technical tools*', referring also to 7S 'Systems'. The organization has been divided into more detailed areas like '*Skills*' and '*Roles and responsibilities*', which have been adapted from 7S. Paulzen and Perc's description 'People' is more precisely named as '*Performance measurement and incentives*'. In the following section we briefly describe the attributes, which after that are used as a frame for further framework development, and finally as areas to collect and classify data in the cases.

4. Climbing the knowledge stairs—case study findings

In this section the case companies are first described briefly. Then the management attributes are refined to fit the inventory management environment, utilizing the observations in both case companies. Thirdly, the observations and existing theory of knowledge maturity models are merged as knowledge maturity stages and attributes of technology adoption as applied in inventory management. After that the transitions from stage to stage are pointed out by using the framework. Finally the current development activities are reflected to the framework.

4.1. The retailing case

In the mid 90s, the retailing case company consisted of relatively independent units/profit centers managing their assortments and inventories themselves. The development process started with an investment on a new common materials management system. The first time in the history the system gave an opportunity to manage the inventories systematically. The possibility also revealed a lack of inventory management skills. The people operating the inventories, employees whose main task was to sell, were not trained to define order quantities, safety stocks, etc. It was decided to improve the sales personnel's skills in inventory management with a training program. The program was successful and it resulted in remarkably higher aggregate inventory turnover rates than before.

The problem of excess inventory levels was to some extent solved, though the methods used to define the levels were at a low sophistication level. As the data system brought out vast differences in product assortments and purchasing sources between the units, the management considered assortment harmonization and inventory management as potential development areas. For this reason the purchasing of some product segments was centralized to headquarters-based purchasing managers.

The next step the company took was to invest in an IT planning tool to manage the inventories. The system helps the units to manage their product variety and inventory parameters. At the implementation stage a question rose, who should operate and utilize the system? Basically, the units are responsible as profit centers, and the well-adopted main task of the salesmen acting also as inventory operators is selling. Do they have enough time, incentives and skills to utilize the system? Or, should the purchasing managers take the responsibility of inventory management? Consequently, how is responsibility defined and what are the incentives and performance measures for the purchasing managers?

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4.2. The manufacturing case

The manufacturing company produces customer-specific goods for further processing. Production and sales are organizationally separated. In practice the sales organization operates the stocks in the supply chain. A common practice in the business is that the sales organization agrees with the customers to keep dedicated stock for the customer in a market area warehouse. The inventory management skills are at quite low level in the sales organization, for example the concept service level is not widely understood ('100% service level is required'). For a decade, several projects to cut down the excess stock have been carried out with varying results. Any particular effort to train the stock operators or to improve the performance measurement and incentives systems has not been carried out.

In the late 90s the effort to improve the supply chain inventory management focused on forecasting the consumption. Firstly, a coordination and development function was established. This team introduced a prototype of an IT tool to plan the sales units' orders from the mill. Better results were achieved in some units. Above all, the project highlighted the problem of how to motivate the operators to manage the inventories better and to give more accurate forecasts.

5. The management attributes

As a first step of the case study the management attributes presented above were refined to fit the supply chain and inventory management environment. Also conclusions were drawn on the development stages or evolution paths in the areas of the management attributes.

Technical tools refer to planning tools and operative data systems to carry out the inventory management task. Both the cases indicate that the awareness of the inventory management task has evolved hand in hand with the evolvement of the operative data systems. However, the early systems did not include tools to analyze the supply and demand and to set the parameters accordingly. As a matter of fact, the present operative systems are mainly transactional and do not facilitate the planning of inventory management task in the supply chain.

An important issue is the evolution path of the planning tools and the interface between the planning systems and the operative systems. It seems that the evolution of the planning tools starts from local or personal applications. In the next stage, the common tools are introduced. Finally the planning tools are gradually integrated to operative data systems, which is going on in the companies today.

The word *skills* comprises a wide variety of knowledge and professional skills. From the point of view of techniques adoption, skills can be aggregated to three wider categories. Firstly, there are operating skills. They are practical skills like running the inventory replenishments, but they also include skills to handle one-off situations, exceptions and errors. The second distinct skill category is here called planning skills, which comprise the using of quantitative methods needed to carry out the planning task. The third skill category, organizational development skills, comprises general management skills and organizing. The evolution path on the skills area of a certain technology in an organization seems to follow the path operating skills, planning skills, and, finally, management and organizing skills.

The roles and responsibilities evolve in three stages: from the role of an operator through that of an expert to the role of manager. In the beginning an operator carries out the inventory management task in practice. There are often multiple inventory operators and the inventory management task forms only a part of their job. In the early stages of the techniques adoption, the skills development of an operator plays a key role in the development. However, it seems that there is a turning point, where the skills development of the part-time operators is not feasible. The situation calls for a new role, the role of an expert. For an expert, the inventory management task is a central or sole part of his/her job, which gives the possibility to adopt more complex approaches to inventory management. The expert role includes also the responsibility to develop the systems and practices: to give advice and recommendations and finally to formulate policies to help the operators to achieve higher performance. After the finalization of the policies, it is possible to shift the responsibility from operators to the role of a manager. At this stage, the operators no longer have the option of not following the policy, because the manager's role is responsible for the inventory performance.

The evolution of roles and responsibilities can be identified at the individual person level, but, as can be seen in the grocery wholesales and retailing sector, the role formation can also happen at organizational unit level. There the evolution starting from independent retailers created an expert organization to help the retailers to manage their varieties and stock levels. In the second phase the expert organization took the responsibility for managing the assortments and retail stocks.

The performance measurement and incentives system refers to practices of how the inventory management performance is measured and who is measured. Even today a common problem is the difficulty to measure the people or unit actually responsible for the inventory management. The problem is often that the trade-off between the service levels and the capital costs is difficult to handle. The performance measurement and incentives system can be seen as a manifestation of roles and responsibilities, but on the other hand the problem is also related to the skills and technical possibilities to carry out the measurement. Consequently, the key issue in incentives is that they should be adjusted to the roles and responsibilities as well as to the skills of the organization.

5.1. Knowledge maturity stages and the attributes of technology adoption

As stated above, the development related to the management attributes should proceed more or less

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parallel from stage to stage. It is assumed that attributes falling behind cause the development to slow down or even cease. Based on the knowledge maturity model theory and on the case studies, the evolution stages of different management attributes are connected together in Table 1. The key connecting the stages together is the nature of knowledge utilized in different stages (see e.g. Paulzen and Perc, 2002). In the following the model is evaluated by describing the development in the case companies with the framework, paying attention especially to identifying the development gaps, the management attributes falling behind the development of the other attributes.

5.2. Climbing stages in the case companies

It is difficult to say whether the implementation of the operative data systems was a consequence of the awareness of inventory management issues or vice versa. One should keep in mind that these systems are created to manage the daily tasks, and the inventory management is only one part of it. However, these systems made it more or less easy to gather practical, tacit knowledge on the relationship between supply, demand and inventory levels.

The transition from awareness to establishment started in the retailing case with the training of the operators, while in the manufacturing case a prototype of a planning tool was introduced to the operators. The knowledge maturity framework gives three reasons why the retailing case was more successful than the manufacturing case. Firstly, the organizational responsibility structure posed a pressure to implement the techniques in daily use, because the achievements increase quite directly the return on capital employed. Secondly, though the performance measurement of inventory management was in both cases quite elementary and at an aggregate level, there was no connection between the effort to manage inventories better and the unit's success in the manufacturing case. Thirdly, in the retailing case the training program gave the needed conceptual tools.

All the prerequisites for inventory management systematization exist in the establishment stage. From knowledge point of view, understanding of basic concepts and control variables like safety stocks and replenishment lot sizes exists. From organizational point of view, there is a clear operations responsibility in the area. The performance measurement and incentive systems should be at a sophistication level where it is possible to point out the progress at least at aggregate level. Naturally, operative systems are required.

Both of the cases have mainly achieved the establishment stage and the aim at the systematization stage. In neither case are the IT and planning systems definitely bottlenecks for proceeding. Putting the case situations in the knowledge maturity framework gives an insight to the problem: the establishment stage is reached only partially, especially the roles and responsibilities and also the performance measurement and incentive systems are falling behind in the development. The maturity stages of the case companies are illustrated in Fig. 1, where the black box indicates the present stage of the attribute. The gray box indicates the attributes the company is focusing on today and in the near future. The explanations of the attributes at different stages are presented in Table 1.

In both cases the management sees the operators' motivation and/or resources limited to fully utilize the possibilities of the IT and planning systems. At the operator level this is a relevant question, because inventory management is only a part of the operators' work. An easy and obvious solution for the management is to improve the performance measurement and incentive

Table 1
Knowledge maturity stages and the attributes of technology adoption

Stage	Nature of knowledge	Technical tools	Skills	Roles and responsibilities	Performance measurement and incentives
1—Initial	No knowledge	Transaction systems	No skills, inherited practices	Operator role, task not recognized	No performance measurement and incentives
2—Awareness	Tacit knowledge and assumptions on basic causalities	Transaction systems Local, non-replicable planning tools	Ability to identify basic causal effects in a qualitative manner	Operator role, task recognized	Aggregate-level measurement
3—Establishment	Knowledge on basic causalities	ERP systems, local, non-replicable planning tools	Ability to identify control variables and state parameters empirically	Operator role, task supported by expert	Measurement by responsibility area
4—Quantitative management	Basic causalities expressed quantitatively	Advanced planning tools, manual link to ERP	Ability to identify causal effects in most common situations using theoretical approaches	Expert role to give policies to be followed by operators	Focused measurement and incentives by responsibility area (expert, operator)
5—Optimization	Causalities understood thoroughly	Advanced planning tools, automatic link to ERP	Ability to model almost all situations, causal effect understood thoroughly	Manager role	Diagnostic measurement

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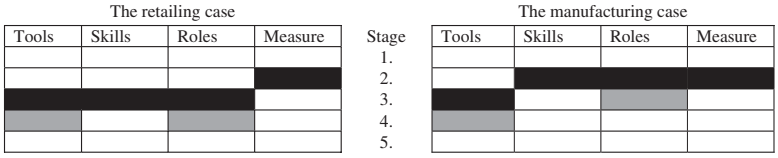

Fig. 1. The inventory management techniques adoption stage (black) and current focus (gray) of the case companies.

system and/or train the operators. However, there is a trade-off between the tasks of the operators. Focusing on selling efforts can be more profitable than focusing on inventory management development.

The development in the reference business, grocery wholesale-retailing, gives a suggestion of a development path to quantitative management and further to the optimization stage: the introduction of an inventory management expert role. At the moment some grocery supply chains approach the optimization stage in inventory management: the replenishment in the retailing units happens automatically with optimized lot sizes. In grocery the path from establishment has led from forming a supporting and advisory organizational unit to centralized inventory management.

Considering the progress in grocery wholesale-retailing business, it should be noted that in the retailing case a potential advising role already exists. The task of the purchasing manager could be expanded first to support the utilization of planning tools, later to being responsible for policy suggestions and finally taking responsibility of the inventory management as a whole. Naturally, the centralization of expertise requires also changes in the performance measurement and incentive systems. More detailed and more sophisticated practices are needed, but above all it is essential to focus the follow-up and incentives to the expert function.

To summarize the case study, the clearest and least contradictory contribution of the knowledge maturity stage framework was to point out the development areas in the inventory management task. In the case companies the roles and responsibility area and the performance measurement and incentive systems area have not been developed at same pace as the IT and planning systems. The reference case gives an interesting but a contradictory path for the future, through centralization of the expertise to optimized and automatized inventory management.

6. Conclusions

As George Box (1979, p. 373) said, 'all models are wrong; some models are useful'. We believe that the presented model has many benefits and advantages that make it useful for pragmatic assessment and facilitation of inventory management processes. First of all, the maturity model and management attributes help to see the development problem in a wider scope. It provides one way to solve the problem that 'barriers to integrated supply chain management are organizational, not technical' as Shapiro (2001, p. 25) stated it. As a practical tool the maturity model helps to prioritize the development actions, when to train people, when to invest on IT tools, when to reorganize, and when to improve performance measurement and incentive systems. Finally, the tool can be useful when deciding on the goals for development of inventory management.

The case study presented a path for how companies can gradually adopt sophisticated inventory management techniques. The path included quite strong organizational changes which seem to be important for adopting new techniques as quickly as possible. However, the question still remains whether it is possible to bypass the expertise centralization stage and adapt the optimization practices as a 'black box', implement and use tools without changes in the organization and management practices. In this study we did not find a path for such an approach, but, on the other hand, the research on organizational learning has focused on seeking an environment where this kind of adopting is possible. However, these changes in the corporate values, climate, etc. are fundamental and difficult processes for a company.

Our major presumption in this study was that the process development state can be described with management attributes and, to achieve sustainable results, the development related to these management attributes should proceed more or less parallel from stage to stage. In the case studies the framework worked as expected. It helped to assess the development and the current situation, and pointed out the development focus areas. However, a case approach always raises the question to what extent the findings can be generalized. In this case the question is twofold. Firstly, can these findings be generalized to other environments than the environments of the case studies? Secondly, can these findings be generalized to other similar technique adoption processes?

To answer the question of the generalization to other environments, the environments of the case studies should be characterized. The cases represent totally different business sectors, different sizes, and breadths of business (local and global), and therefore they give a good insight to the research topic. A potential problem is that neither of the cases is a frontline company considering inventory management, but, on the other hand, the progress in the frontline sector of inventory management, grocery wholesales and retailing, seems to have followed the same path.

The answer to the generalization to the adoption of different techniques may lie in the perceived potential or

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importance of the technique for the business. It can be expected that the techniques in the frontline considering the company's competitiveness draw in the development effort while the others, even considered as lucrative when isolated from the whole picture, do not. This should be taken into account with the generalizations made from the grocery wholesale-retailing sector. For the grocery sector inventory management is in the core of the business, while in manufacturing the importance of inventory management can be substantially lower. The relative importance might affect only the prioritization of the development focuses and that way the pace of the evolution of inventory management in the company. However, it is an interesting question for further research.

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Publication 6

Petri Niemi, Janne Huiskonen and Hannu Kärkkäinen (2008)

Supply chain development as knowledge development task

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Supply chain development as a knowledge development task

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Abstract: The study utilizes two research streams of knowledge management, knowledge maturity models and strategies of accelerating the knowledge creation in an organization, to understand and support the adoption of complex practices of supply chain management. Generic development strategies called bottom-up, top-down and middle-up-down are derived from the theories and evaluated in two case companies representing different industries but the same development area, inventory management. The case study is organized into two parts. First, the development to date is presented in both case companies and the cases are used to identify the basic prerequisites, advantages and disadvantages of the bottom-up and top-down strategies. Second, potential development strategies for the future are analyzed. The findings of the case studies suggest that the selection between different strategies is related to the cultural and organizational environment, the complexity caused by the issue itself and by climbing the knowledge maturity stages and the relative importance of the issue to be developed. As a guideline for strategy selection the study suggests that when deciding to accumulate the knowledge to the top level, the organization needs to be capable of setting clear rules in an explicit form and following them. If improving shop-floor or operator-level skills is chosen, it has to be accepted that the knowledge is accumulated at the shop-floor in a tacit form and may be difficult to share later. Integrating tacit and explicit knowledge requires an organizational entity, a home, where the development issue is of high importance, which can be a challenging task.

Keywords: supply chain management; knowledge management; knowledge creation approaches; knowledge maturity models; knowledge development strategies; organization; planning and control; implementation; adoption; inventory management;; case studies.

1 Introduction

For decades, a lot of expectations have been set on the astonishing progress in IT tools, together with the more and more sophisticated methods of managing the supply chains. However, it seems that the possibilities to manage supply chains quantitatively have been diffusing to practice reasonably slowly. So far, companies have mainly focused on implementing operative transactional data systems (such as ERP, enterprise resource planning systems), which do not support tactical or strategic supply chain planning very well. Even though there are lots of promises about more advanced planning systems, their applications seem to be rather rare, and various local heuristic rules of thumb are often used in practice. Focusing on the tools and techniques of supply chain management, (SCM), this paper deals with the slow adaptation of the seemingly promising management tools and techniques.

Though many distinguished SCM scholars, like J. F. Shapiro (2001), have noted that the barriers to implement more sophisticated SCM tools and techniques are not technical but organizational, the research on the area has been quite modest. Besides the general management literature concerning issues like change management or business process re-engineering, there are studies on the implementation of ICT tools, as for instance the one on ERP implementation by Tchokogue et al. (2005), who point out strategic, tactical and operational prerequisites in an ERP implementation, as well as Sarker and Lee (2003), who have studied organizational enablers for ERP implementation. These studies give some practical guidelines for implementation, but for getting a grip on the slow adoption,

these approaches are too narrow. Presumably, understanding the underlying reasons of slow adoption requires a wider scope than implementation, as well as an ability to see the development more comprehensively than as IT system development.

A more comprehensive view to technology adoption has been presented by Patterson et al. (2003). They have developed, on the basis of a survey, a model of the key factors influencing the adoption of supply chain technology. They suggest that seven variables have a significant impact upon the pace of technology adoption: firm size, organizational structure, integration of supply chain strategy with the overall corporate strategy, past financial performance, supply chain partner pressure, transaction climate, and environmental uncertainty. However, this kind of a study gives a snapshot of the influencing factors to a phenomenon, it does not answer the question of how the organization has evolved or should develop itself to adopt more complex and demanding tools and techniques.

Above, we have presented three challenging requirements for research to create more thorough understanding on the tools and technology adoption. Firstly, the adoption of tools and techniques adoption needs to be seen in a wider scope than implementation, secondly the adoption needs to be seen in a wider scope than IT tool implementation, and thirdly, the adoption needs to be seen as an organizational development process. We believe that approaches based on the general knowledge management theories and frameworks can contribute meeting these requirements. In the following, two frameworks of knowledge management are utilized: knowledge maturity framework is used as a platform to depict the adoption as an organizational development process, and then three generic supply chain development strategies are developed. The usefulness of these models is tested in a double case study dealing with the adoption process of inventory management tools and techniques, representing here typical SCM tools and techniques. Inventory management is defined here as the task of handling the uncertainty of the demand and/or the product and service offering in the supply chain, comprising a variety of scientifically validated models, tools and practices to carry out the inventory management task.

2 Knowledge-based development strategies

It is obvious that the organizational reasons for the slow adaptation of management tools and techniques are numerous (see Patterson et al. (2003). Especially relevant for SCM seems to be the cross-functional character of the task: the material flows that need to be controlled span through several functional and organizational boundaries (Korhonen et al., 2007). However, many companies' organizational structure is still mainly functional. This creates tensions that affect the adaptation of management tools. First, adopting tools that affect beyond one functional area set high skill requirements at all organizational levels from operators to developers and managers. Second, even if the skills can be acquired, the traditional functional organization may not be able to show the place where the skills can be located, or even more importantly, by whom they should be developed. Thirdly, the incentives to support cross-functional objectives in mainly functional type organizations are difficult to create, which may reduce the motivation to use and develop the skills and tools. These examples of the potential reasons that may complicate the implementation of management tools and techniques show that in trying to understand the problem, we need a multi-disciplinary approach. As the point of the problem seems to

be in organizational and business process related skills development with possible change requirements in organizational structures and/or responsibilities, especially relevant approaches seem to be provided by knowledge management theories complemented with views from organizational theories.

The rather novel research paradigm of knowledge management gained popularity after the mid-1990s, and has evolved together with the growing complexity of practices and techniques companies need to deal with, especially in order to produce more and more complex products faster and faster for the markets. A fundamental aim in the research area is to understand how knowledge is accumulated in different organizations, and especially how the knowledge accumulation and creation can be intensified and supported by organizational and managerial solutions (see e.g. Hlupic et al., 2002; Hoegl and Schulze, 2005). This study applies the theories of knowledge management to a single task of supply chain management and its development. We argue that by seeing the challenge of developing supply chain management as a knowledge development task widens the scope from blinkered implementation of the technology and tools to organizational and managerial skills.

The study utilizes mainly two research streams of knowledge management to understand and support the adoption of complex practices of supply chain management. The first of them, knowledge maturity models, describe the knowledge accumulation as stages of how the organization develops itself to utilize the particular knowledge, for instance the adoption of new tools, systems and practices, such as inventory management tools. The second stream offers guidelines on strategies of accelerating the knowledge creation and adoption in an organization, in our case particularly related to inventory management. In the next section these approaches are briefly introduced, after which the theory is concluded as a development strategy framework.

2.1. Knowledge maturity framework

We have demonstrated in our earlier research (Niemi et al., 2006) that the adoption of supply chain management techniques can be described and evaluated with business process-oriented knowledge maturity models. According to various studies concerning knowledge accumulation in companies and their business processes (e.g. Housel, 2001; Bohn, 1994; Moore, 1999), knowledge development and accumulation can be categorized and described in distinct phases or stages. These models are usually called “maturity models”. Maturity models can be described as roadmaps for implementing practices in an organization. The purpose of the models is to help in the continuous improvement of the capabilities of an organization in certain application or management areas, such as software development (Niazi et al., 2005), R&D (Berg et al., 2004), process development (Moore, 1999), or knowledge management (Paulzen and Perc, 2002).

The basic idea of the maturity models is that because an organization cannot implement all the best practices in one phase, maturity models are used to help to introduce them in stages. The knowledge is seen to develop gradually through stages, starting from initial “darkness”, evolving from awareness via more systematic approaches to a quantitatively managed, and finally to an optimized or automatized level. A maturity level or stage is an evolutionary plateau at which one or more domains of the organization’s processes are transformed to achieve a new level of organizational capability. In order to be able to assess and develop the knowledge maturity stages, the

aggregate knowledge area needs to be disaggregated to manageable management attributes. In line with the maturity-level thinking, the development related to these management attributes should proceed more or less parallel from one maturity stage to the next (see e.g. Paulzen and Perc, 2002). The attributes are categorized as follows:

- Technical tools are planning tools and operative data systems to carry out the inventory management task.
- Skills comprise a wide variety of knowledge and professional skills. From the point of view of techniques adoption, they can be divided to operating skills, planning skills and organizational development skills.
- Roles and responsibilities evolve in three stages: from the role of an operator through that of an expert to the role of a manager. The evolution of roles and responsibilities can be identified both at personal and organizational levels.
- The performance measurement and incentives system refers to practices of how the performance is measured and who is measured.

If the development related to these management attributes is carried out separately, with no consideration of the other attributes; for instance technical tools, such as inventory management tools, are developed without developing the other attributes (skills, roles and responsibilities, and the performance measurement and incentives) simultaneously, the likely result will be that the development activities are not successful, the tools are not properly adopted in the organization, and as result, the organizational knowledge will not increase during the development process. The evolution stages and attributes in this process-oriented maturity model, considered specifically from the inventory management standpoint (see Niemi et al., 2006), are summarized in table 1.

Table 1 Knowledge maturity stages and attributes of technology adoption (*Adapted from Paulzen and Perc, 2002)

*Stage**	*Nature of knowledge**	*Technical tools*	*Skills*	*Roles and responsibilities*	*Performance measurement and incentives*
1 – Initial	No knowledge	Transaction systems	No skills, inherited practices	Operator role, task not recognized	No perf. measurement and incentives
2 – Awareness	Tacit knowledge and assumptions on basic causalities	Transaction systems Local, non-replicable planning tools	Ability to identify basic causal effects in a qualitative manner	Operator role, task recognized	Aggregate level measurement
3 – Establishment	Knowledge on basic causalities	ERP systems, Local, non-replicable planning tools	Ability to identify control variables and state parameters empirically	Operator role, task supported by expert	Measurement by responsibility area

4 – Quantitative management	Basic causalities expressed quantitatively	Advanced planning tools, manual link to ERP	Ability to identify causal effects in most common situations using theoretical approaches.	Expert role to offer policies to be followed by operators	Focused measurement and incentives by responsibility area (expert, operator)
5 – Optimization	Causalities understood thoroughly	Advanced planning tools, automatic link to ERP	Ability to model almost all situations, causal effect understood thoroughly	Manager role	Diagnostic measurement

2.2 Strategies for knowledge creation

From the standpoint of knowledge creation and knowledge management, according to Nonaka (1988) and Nonaka and Takeuchi (1995), "top-down" and "bottom-up" management focus on information flow and information processing. While the top-down management approach (centralized knowledge management systems; see e.g. Civi, 2000) emphasizes the process of implementing and refining decisions made by the top management when they are transmitted to the lower levels of the organization, and bottom-up management (decentralized knowledge management systems; Civi, 2000) emphasizes the influence of information coming up to the top from lower levels for management decision-making. Hellström et al. (2001) argue that top-down perspectives on knowledge have probably dominated knowledge management and knowledge work initiatives.

Bottom-up systems tend to put more emphasis on people than on information systems. From the knowledge management standpoint, in bottom-up systems, when knowledge is available, the internal market decides how valuable it is. Also, as the knowledge is built by the users themselves, it is more likely to be relevant and easy to use. However, downside is that the system is very reactive, and people are not pushed to build knowledge or do research, for instance. Top-down management is basically the classic hierarchic strategy, and it is typically based on quite advanced information technology. In this system, selected information is passed up to the top executives, who determine the vision, create plans etc. These plans pass down the hierarchy, and first the middle managers take the orders, changing them to be better suited for the operational conditions of front line employees (Civi, 2000)

The approaches of individual firms are usually seen to be located somewhere on the continuum between the above two types (Nonaka, 1988). The new proposed management concept, which Nonaka and Takeuchi (1995) call the “middle-up-down” approach is a process that aims to resolve the contradiction between the visionary but abstract concepts of the top management and the experience-grounded concepts originating on the shop-floor, by assigning a more central role to middle managers. Middle managers are positioned at the intersection of the vertical and horizontal flows of information in the company, which makes them key persons for organizational knowledge development. The knowledge is accumulated in an organizational knowledge base, which involves both

tacit and explicit dimensions of knowledge. Concerning the organizational knowledge base, at the general level, the tacit knowledge is primarily accumulated in the corporate vision and the organizational culture, while the explicit knowledge is primarily accumulated in the developed technologies, products and concepts. According to Nonaka and Takeuchi (1995), this process is particularly well suited to the age of fierce market competition and rapid technological change. For knowledge leadership to work efficiently, the middle-up-down is a mechanism of key importance (Nonaka and Toyama, 2005), and it is the best fitting strategy for bringing about organizational knowledge creation (Civi, 2000).

Examples of the approaches presented above are General Electric governed by the former Jack Welch (top-down), 3M (bottom-up), and the Mini Copier development process at Canon is an example of the middle-up-down approach. The three approaches are described in more detail in table 2.

When carrying out an in-depth literature research, we found some studies that utilized the concepts of top-down/bottom-up/middle-up-down approaches of Nonaka and Takeuchi in the generic context of knowledge management or organizational learning (e.g. Corso et al., 2006; Mulholland et al., 2005). Some studies discussed the concepts in the context of specific types of organizations or industries, for instance in software engineering firms (Hellström et al., 2001). However, we did not find such related studies in the specific context of inventory management or supply chain management.

Table 2. Approaches regarding knowledge creation (adapted from Civi, 2000)

	Bottom-up	*Top-down*	*Middle-up-down*
Agent of knowledge creation	Entrepreneurial individuals	Top management	Team
Role of top management	Sponsor / mentor	Commander	Catalyst
Role of middle management	Autonomous entrepreneur	Information processor	Team leader
Accumulated knowledge	Tacit	Explicit	Explicit and tacit
Knowledge storage	Incarnated in individuals	Database / manuals / policies	Organizational knowledge base
Organization	Project team and informal network	Hierarchy	Hierarchy and task force
Communication	Self organizing principles	Orders / instructions	Dialogue
Weakness	Cost of coordinating individuals	High dependency on top management	Cost of redundancy

2.3 Generic strategies for supply chain development

Some strategies are more successful than others, also when talking about development strategies for supply chain development. As described above, the cross-functional and organizationally boundary-spanning character of the supply chain management task makes it challenging for development actions. When considering an active strategy in a development area, in this study in supply chain management, the general approaches to

knowledge creation raise two main questions. Firstly, where do we expect the knowledge to be accumulated, and secondly, in what form? As described above, the bottom-up approach stores the knowledge in a tacit form to individuals, and top-down in an explicit form as policies and manuals. In the middle-up-down approach the knowledge is accumulated in both an explicit and tacit form to a team dedicated to the issue, and to common, developed processes. The above questions lead us to three different generic development strategies for a single development issue. In the next section these strategies are introduced briefly.

Bottom-up strategy – investing on shop-floor skills

The strategy relies on training operator-level people. After the training the operators are given a more or less free hand to improve their work. The knowledge is accumulated at the operator level to individual operators in tacit form.

Top-down strategy – management as the motor of change

In this strategy the knowledge is expected to be transformed to an explicit form and stored and communicated as rules and policies. The management uses the general managerial tools without touching the organization to bring about the sought-after change, and utilizes the established hierarchy by setting targets. The tools range from just paying attention and pinpointing the development issue to setting up a project team or task force to create explicit rules and policies for the operator level. An advisory role can be established to help the operators carry out their work.

Middle-up-down strategy – making the mid-level of the organization responsible

In the middle-up-down strategy the knowledge is accumulated in both explicit and tacit form to a team dedicated to the issue, and to common, developed processes. Usually this means changes in the organization, because the mid level of the organization needs to be made responsible for the area as well, and empowered to develop it. The mid level commits itself to the objectives set by the management and takes responsibility for the development of operator skills and tools.

3 Strategies for supply chain development – case studies

3.1 Research design

The aim of this study is to show how a development strategy is more or less consciously selected, what are the main factors affecting the selection, and how it guides the development effort in supply chain development and adoption of SCM tools and techniques. Consequently, the aim of the empirical part is to test the derived theory in order to find out whether we actually gain a deeper understanding on the phenomenon with these theories, and whether they guide the managers to select an appropriate strategy for the situation. Therefore, the research questions of the study can be posed as:

- Are the generic strategies for supply chain development based on general knowledge management theory applicable in the supply chain management environment?
- Why has a company adopted a certain strategy for supply chain development? What are the prerequisites, when is it applicable and what are the risks of the strategies?

To characterize the research subject, it is obvious that we are in the middle of a phenomenon of SCM development in its real-life context, where the research questions drive us to in-depth exploration of the phenomenon. The aim of this study is to find answers to the questions why companies have adopted something and how they can select something else. All these characteristics advocate for the selection af the case study approach (Yin, 1989), above all the need to dig deep into the organizations choices and decisions. Therefore, as an empirical part of this study, the past and future development of inventory management is described and evaluated utilizing the concepts developed in two case companies representing different industries, retailing and manufacturing. The development issue is similar in both cases, to adopt and develop more sophisticated inventory management techniques, which represent a typical development area of supply chain management.

Though there are two case companies, the aim is not to compare the performance of the two case processes, nor is the aim to carry out replications that allow a more reliable development of a rich theoretical framework as a multiple case approach (Ellram, 1996). The aim is the one of a single case study (Ellram, 1996), the cases represent a critical case to test a formulated theory. We need at least two case companies if we want to describe and evaluate two different strategies. The fact that we were not able to identify with pre-understanding a case company representing the third generic strategy, the middle-up-down strategy, it led us to the following research design.

The case study was organized in three phases. Firstly, the development in both case companies to date was described with the help of the knowledge maturity framework. This was mainly done by utilizing the pre-understanding the authors had gathered through the experiences of several inventory management development projects with both companies. The descriptions were verified in a meeting with the managers responsible for the development of inventory management. In the second phase, the basic prerequisites, advantages and disadvantages of the bottom-up and top-down strategies were identified in semi-structured interviews with the same managers.

Thirdly, mainly because of the lack of a middle-up-down case, but also to deepen the understanding on the current strategies, two scenarios of future development for each company were created by the authors, together with the managers. The scenarios were to continue with the current strategy and to adopt the middle-up-down strategy. The opposite of the current strategy was left out because the change from a centrally managed top-down strategy to an entrepreneurial bottom-up strategy or vice versa would have required so fundamental cultural and organizational changes that the scenario would have been based on too many layers of assumptions. The prerequisites, advantages and disadvantages of the strategies were identified as result of the scenario work.

An important enabler for the study was the fact that the authors had experience of several inventory management development projects with both companies, dating back to a decade. This made it possible to observe the organization closely in a way that would not be possible for outsiders. It also ensured the direction of research to be of guaranteed managerial relevance, as the company management was closely involved in the research

effort. Also generated close relations and common understanding, which made it possible for the researcher to revisit the company when he was no longer directly involved. Though the research can not be defined to follow the pure methodology of action research, Gummesson (2000) lists similar advantages in the action research approach.

3.2 Development strategies applied so far

The case companies were selected to represent different orientations in development strategy. The most unambiguous criteria to identify the applied development strategy of those presented above in table 2 were the agent of knowledge creation, the form of accumulated knowledge and communication of the knowledge. The retailing case has followed the logic of bottom-up strategy: as an agent of knowledge creation the system has relied on individual operators who have had a relatively free hand to develop and apply their own knowledge and practices, whereas in the manufacturing case the development has clearly been top management-driven. The knowledge has been stored to individuals in the retailing case, while in the manufacturing case the increased knowledge has been expected to be stored in policies and instructions. Similarly in the retailing case the communication system has relied on communicating self organizing principles, while the means to communicate in the manufacturing case has been more or less instructions and orders.

The development to date has not been very systematic or goal oriented, the strategy has more or less emerged rather than followed a pre-written plan. However, the distinction in strategies is easy to see, and the cases give an insight into how the environment affects the strategy selection. In the terms of the knowledge maturity framework (Niemi et al., 2006), both case companies have reached the establishment stage in inventory management. This means that they have operative transaction systems facilitating operative inventory management. In at least some parts of the organization they are familiar with the basic causalities of inventory management.

Bottom-up strategy - the retailing case

In the mid 1990s, the retailing case company consisted of relatively independent units / profit centers managing their assortments and inventories themselves. The development process started with an investment in a new common materials management system, which gave an opportunity to manage the inventories systematically. The possibility also revealed a lack of inventory management skills. The people operating the inventories, employees whose main task was to sell, were not trained to define order quantities, safety stocks etc. It was decided to improve the sales personnel's skills in inventory management with a training program. The program was successful, and it resulted in remarkably higher aggregate inventory turnover rates than before.

The company seems to have been driven to the bottom-up strategy mainly for structural and cultural reasons. The company has a culture of internal entrepreneurship, and the headquarters avoids direct intervention with the practices of the units. A training program provided by the headquarters was considered a "soft" intervention, leaving the units the freedom to select the ways of how to apply the new knowledge. As a result of the program, the practical training together with the already installed operative IT systems produced better inventory performance. After the training program, the problem

of excess inventory levels was to some extent solved, although the methods used to define the levels were at quite a low sophistication level.

The operative IT system revealed differences in product assortments and purchasing sources between the units. The importance of assortment harmonization and inventory management was recognized widely. As a consequence, the purchasing of some product segments was centralized to headquarters-based purchasing managers. The company also invested in an IT planning tool aimed to help the units to manage their product variety and inventory levels. At the implementation stage, the question of who should operate and utilize the system rose. Basically, the units were responsible as profit centers, and the well-adopted main task of the salesmen acting also as inventory operators was selling. Would they have enough time, incentives and skills to utilize the system? Or, should the purchasing managers take the responsibility of inventory management?

The case indicates two major handicaps in the bottom-up strategy. Firstly, the achievements deteriorate in the course of time. Secondly, the degree of adoption, and accordingly, the performance vary between the units. It is obvious that inventory management requires lots of work and the main task of the operators is to sell, not to manage inventories. The success of the strategy lays on the operators' motivation and know-how to carry on and develop the adopted practices and techniques. It is important to note that the performance measurement and incentive system was not changed. To motivate or not the effort for better inventory management remained the unit managers' responsibility. In the case company the unit managers' commitment varied substantially, which clearly affected the operators' prioritizations. A reason for the performance variation is the difficulty to control the spreading of knowledge when its main source is at the operator level. Tacit knowledge and heuristics are difficult to share and utilize widely.

Top-down strategy - the manufacturing case

The manufacturing case company is a global producer of relatively low value-added customer-specific goods for industrial customers. It is among the biggest companies in its industry branch. The industry is quite capital-intensive, which is one reason why the culture in the company is very risk-avoiding, compared for example to the retailing case presented above. As in many multinational companies, the organizational hierarchy is quite rigid. Especially between the sales and production organizations, the organizational boundaries are high, making joint development difficult. The production and sales are situated to a large extent in geographically different areas, which makes the problem more complicated. The common business practice of the industry is that the sales organization agrees with the customers to keep a dedicated stock for the customer in a market area warehouse. In practice the sales assistants manage the inventories by deciding on the replenishment date and quantity within the limits of the agreement, which is quite difficult because of the discrete demand at item level. The inventory management skills are also at quite a low level, not only among the sales assistants, but also among their superiors.

For at least a decade there have been recurrent attempts to improve the inventory management with quite poor results. From the viewpoint of inventory management, the approach has been quite incidental. The projects or stated objectives have always been driven by the headquarters, so the strategy can be defined as a top-down strategy. Projects aiming at reducing the capital employed for the market area inventories have faced both true and fictitious reasons for why inventory level reduction is not possible. The latest

effort to solve the problem has been to name a staff coordinator to develop IT tools for inventory management and to guide the operators to use them. The coordinator has faced opposition in the form of strong tendency to remain in the current practices. From the viewpoint of the operators, the problem is that they are left quite alone with conflicting goals, to reduce inventory levels and to maintain 100% service level, even without required skills to manage the issue. A possible remedy for the problem can be changing the incentives and performance management, to motivate both the sales unit managers and the operators.

The case points out some pitfalls of the top-down strategy. Firstly, above all, the organization above the operators needs to be able to produce precise enough policies and rules for the daily work. Secondly, the operators' skills need to be adequate to change their behaviour, and the operators need to be motivated with incentives to change their working practices by standardization of the working procedures. Otherwise there is a high risk that the risk-avoiding culture and force of habit tame the effort. The big question to be solved is the accumulation of knowledge to the headquarters to the level where it can give exact policies for different situations without loosing the customer service focus.

3.3 Scenarios for future development

As described above, both case companies have more or less reached the establishment stage in their inventory management. They have operative transaction systems facilitating operative inventory management, and IT planning tools for inventory management at the implementation stage. The ultimate goal in both cases is to reach a quantitative management stage where quantitative tools for inventory planning are fully utilized. In the following, possible strategies for development are evaluated for both case companies. For both cases, a middle-up-down scenario was created and compared with an alternative scenario based on the strategy applied to date. The opposite of the current strategy was left out because the change from a centrally managed top-down strategy to an entrepreneurial bottom-up strategy or vice versa would have required so fundamental cultural and organizational changes that the scenario would have been based on too many layers of assumptions.

The retailing case

The management of the retailing company is tackling with the question of how to implement the new inventory management planning tools to daily work. The management considered it obvious that despite the selected strategy, there is need for training in inventory management. An advantage of the bottom-up strategy is that it does not call for organizational changes and it does not necessarily affect the management and performance measurement systems. The strategy supports the creation of tacit knowledge at the operator level, causing differentiation of practices and differences in performance levels between the units. This differentiation needs to be taken into account if the company aims at harmonized practices, or if the company has more ambitious goals to reach in the area.

The transformation to tacit knowledge is a problem from the viewpoint of knowledge management when climbing the knowledge maturity stages in inventory management. The inventory planning tool shifts the competence needed to a totally different level, so it

is certainly necessary to consider whether the salesmen should really divide their effort between inventory management and their main task, selling. In practice this means that the strategy sets high standards to the planning tool, and the more applicable it is as a black box, the better. The big question remaining with the bottom-up strategy is how much more of their time and effort the salesmen are willing and able to invest on inventory management.

The main idea of the middle-up-down strategy is to make the middle management responsible for and give it a mandate to develop the inventory management area independently. In this case there are two groups of middle management who can be made responsible for the development issue, the unit managers and the centralized purchasing managers. The problem with the unit managers is the same as with the operators, is it best for the business that the unit managers focus more of their effort on inventory management with the cost of cutting down their effort on selling?

Moving the responsibility for supply chain management to purchasing managers is quite a strong intervention of the headquarters in the culture of the retailing company. It can be expected to meet resistance because it can be seen to limit the independence of the units. As an advantage, it can release the effort of the units more to selling. The purchasing managers are a natural group to become a knowledge concentration of inventory management. However, there are lots of questions to solve on the practical level.

The manufacturing case

In the manufacturing case company, there are ongoing attempts to bring new tools of inventory management to the operators. The results have been quite modest so far. From the knowledge management perspective, not very much accumulation has happened, which is a primary concern if the company selects to continue in the development of inventory management with the current strategy. The problem to be solved before continuing with the top-down strategy is that people are responsible for the development of the supply chain, but they are not empowered, maybe also not skilled enough, to give binding rules and policies for the inventory management.

As in the retailing case, the first question in applying the middle-up-down strategy is defining what the middle management to be made responsible for inventory management is. The problem is that both the sales unit managers and the production managers might be hierarchically and mentally too far from each other and too committed to their own perspective, so the adaptation process can turn out to be long and difficult. It is also questionable whether they are committed enough to gather knowledge. From the viewpoint of knowledge accumulation, the best solution seems to be the creation of a new middle management to be made responsible for the inventory management and empowered to develop the supply chain from the mills to customers. The middle-up-down strategy is quite a big change organizationally, which has to be analyzed not only from the point of view of inventory management, but also from other functions and aspects.

3.3 Implications of the case studies

It seems that a company has a preferred developing strategy depending on its culture and organizational environment. For a company with a strong entrepreneurial culture and a

structure utilizing it, the bottom-up strategy seems to be quite an obvious solution to start the development process. It can be expected that the entrepreneurial culture encourages trial-and-error behaviour and motivates the operators to improve their skills and practices. A hierarchical structure and a risk-avoiding culture naturally applies the top-down strategy. It tries to solve a problem by giving instructions and developing at a higher organizational level and implementing the results after that. However, it should be kept in mind that the approaches of individual firms are usually seen to be located somewhere on the continuum between these two types (Nonaka, 1988).

Not only the cases, but also the knowledge management (e.g. Nonaka, 1988) literature suggests that the complexity of the development issue should affect the selection of the development strategy. The middle-up-down strategy is particularly well suited and the most fitting strategy for bringing about organizational knowledge creation to complex issues in rapid technological change (Nonaka and Takeuchi, 1995). The complexity in a single issue can be caused by the issue itself or by climbing the knowledge maturity stages. In the cases of the present study, the success factors for the bottom-up and the top-down strategies were quite easy to find at lower knowledge stages, but climbing the stages made the middle up-down strategy more lucrative. A very potential approach at least to supply chain development issues where organizational border-crossing is a major challenge, the middle-up down might mean new organizational structures to be specialized in supply chain management.

The relative importance of the issue to be developed is often a difficult question. Today's firms facing hard competition find themselves in a situation where the management needs to allocate resources between numerous issues. To understand the development work in a company, the first and most important perception is that in practice the development issues compete for resources with each other. Often the allocation of resources is considered to be the money invested and the time consumed in project, and sometimes even the time consumed in training is seen as an investment. The resources needed to overcome organizational, motivational and skill-related limitations are often underestimated. For example with the top-down strategy it might be quite difficult to achieve quick results in the case company, but it should be kept in mind that even concerning the sales units and the operators there are numerous development issues competing with the inventory management issue. The bottom-up strategy is applicable only in cases where the gains are higher than the investment to skills improvement.

Derived from the knowledge management theory and the case study findings, the main contribution of this study for supply chain practitioners and planners can be summarized in two questions to be asked when selecting the appropriate development strategy:

- Where do you expect the knowledge to be accumulated?
- In what form do you expect the knowledge to be stored and communicated?

The questions are interlinked: if you choose to keep the knowledge at the top level, it must be in an explicit form, clear rules to be obeyed. If you want to improve the shop-floor or operator level skills, you have to accept that the knowledge is accumulated at the shop-floor in a tacit form and maybe difficult to share later. Integrating the tacit and explicit knowledge requires an organizational entity, a home, where the development issue is of high importance. The applicability of the development strategies is summarized in table 3.

Table 3 Findings and suggestions of the applicability of the development strategy

	Bottom-up	*Top-down*	*Middle-up-down*
*Knowledge management-related positioning factors (*Adapted from Nonaka and Takeuchi, 1995)*			
Key element	Operator skills	Standardization	Specialization
Knowledge accumulation*	Individual operators	Top management, advisors	Responsible experts / middle management
Knowledge used in practice*	Tacit	Explicit	Explicit and tacit
Knowledge transfer form*	Heuristics, rules of thumb	Rules, policies, recommendations	Models
Observations on the applicability of the development strategies			
Prerequisites	Resources, skills and motivation at operator level Trial and error tolerance	Ability to formulate explicit rules and policies	Organizational entity to take responsibility Empowerment to develop
When applicable	At startup from low maturity stage The importance of the issue is relatively high at operator level In an entrepreneurial environment	At startup from low maturity stage The importance of the issue is relatively low at operator level In a hierarchic environment	From establishment stage onwards The issue can be isolated organizationally The issue is important enough to carry out the costs of organizational change
Risks	Heterogeneity of practices Performance differences Distortion of the priorities among tasks	Standardized but low performance Slow development Mixed messages at operator work	Isolation from the practice

4 Conclusion

The aim of this study was to show how a development strategy is more or less consciously selected, what are the main factors affecting the selection, and how it guides the development effort in supply chain development. The study applied two research streams of knowledge management, knowledge maturity models and generic knowledge development strategies, to demonstrate what can be achieved if the development is guided consciously and systematically. As a theoretical framework, the knowledge maturity stages approach presents the development of knowledge as an organizational development process, where the speed of the progress depends on how the different management attributes match each other. The generic development strategies based on the work of Nonaka and Takeuchi (1995) provide an active way to influence or speed up the development process in general, by selecting between three generic development strategies:

- bottom-up strategy, relying on investing on the shop-floor skills,
- top-down strategy, the traditional way where the management is expected to act as the motor of change, and
- middle-up-down strategy, which makes the mid-level of the organization responsible for development and knowledge creation.

The two cases analyzed in the study were selected to represent the same development area, inventory management, while being very different organizational and cultural environments and having different strategic orientation in inventory management development. For supply chain practitioners and planners, the study suggests two main decisions to be made when selecting an appropriate development strategy. The first one is to decide where in the organization the knowledge is wanted to be accumulated, to the top or bottom level or to the mid-management. Linked to the first decision, the second decision to be made is in what form the knowledge is wanted to be accumulated, tacit, explicit or both. The findings of the case studies suggest that the selection between different strategies is related to

- the cultural and organizational environment
- the complexity caused by the issue itself and by climbing the knowledge maturity stages,
- the relative importance of the issue to be developed

The case studies and also the work of Nonaka and Takeuchi (1995) imply that the middle-up-down strategy can handle more complex development issues than top-down and bottom-up strategies, but the shift from the bottom-up or top-down tradition to the middle-up-down strategy requires quite fundamental cultural and organizational changes to be successful. The development issue needs to be important enough to justify the investment.

As a final remark the study highlights the fact that the mid-managers have been under attack, as organizational downsizing and reengineering have reduced their number (Balogun, 2003). Downsizing has been referred to as the dead end of mid-management, either because some of their responsibilities have been pushed down the hierarchy, or because they have been allocated to higher management (Rabin 1999). The delegation of mid-management responsibilities to lower hierarchical levels has been argued to be related to the advent of so-called ‘knowledge work’ (Butera et al. 1997), which would absorb the skills and responsibilities of mid-management. Mid-managers are also frequently portrayed as obstructive and resistant to change. However, our study, among other research results, suggests that managers and experts at the middle levels in organizations may be able to make a strategic contribution, or even act as key players in development activity.

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