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UNIVERSITATIS OULUENSIS

Amol Gore

EXPLORING
THE COMPETITIVE
ADVANTAGE THROUGH
ERP SYSTEMS

*FROM IMPLEMENTATION TO APPLICATIONS
IN AGILE NETWORKS*

FACULTY OF TECHNOLOGY,
DEPARTMENT OF INDUSTRIAL ENGINEERING AND MANAGEMENT,
UNIVERSITY OF OULU



AMOL GORE

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From implementation to applications in agile networks

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Supervised by
Professor Harri Haapasalo
Professor Pekka Kess

Reviewed by
Professor Petri Helo
Professor Tuomo Kässi

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Faculty of Technology, University of Oulu, P.O.Box 4000, FI-90014 University of Oulu, Finland,
Department of Industrial Engineering and Management, University of Oulu, P.O.Box 4610, FI-90014 University of Oulu, Finland

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Abstract

The purpose of this thesis is to contribute empirical evidence focusing on sustainable competitive advantage through ERP systems. It identifies the shift towards strategic positioning while moving in different ERP stages and industrial environments. The work starts from the premise that advanced ERP processes are simply commodities insinuating competitive convergence. The literature considers IT and strategy but few texts deal with understanding ERP resources over time in order to become source of sustainable advantage. As companies undergo transformation or strive to develop new approaches to competition, it is particularly significant to investigate this venture.

The exploratory inquiry in this dissertation aims to develop insights by a combination of qualitative and quantitative research traditions. The dual approach seeks to integrate the best research practices for contribution to the pertinent stakeholders. The first section is the introductory part followed by publications including case studies and surveys conducted on the basis of the gaps identified between theory and practice.

The work is limited in scope and the intention is to appreciate knowledge acquired from the studies instead of drawing rigid extensive conclusions. However, the study traces that the ERP systems do provide competitive advantage, the sustainability depending on integrating to meet the business needs and building uniqueness. The implication is to capitalize on the potential of ERP, the idea being not to imitate competitors but to tailor applications to the company's overall strategy.

Keywords: agile, competitive advantage, customize, ERP II, ERP systems, exploratory research, supply chain

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This thesis is my voyage towards new knowledge and experiences and reflects the work initiated in 2003. It provides the opportunity to present my abilities and motivation to conduct research and make recognized contributions to academia and industry.

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Oulu, January 2008

Amol Gore

Abbreviations

APICS	The Association for Operations Management, USA.
ATO	Assemble-to-order
BPM	Business Process Management
CRM	Customer Relationship Management
ERP	Enterprise Resource Planning
ETO	Engineer-to-order
IT	Information Technology
MES	Manufacturing Execution System
MPC	Manufacturing Planning and Control
MRP	Material Requirements Planning
MTO	Make-to-order
MTS	Make-to-stock
PLM	Product Lifecycle Management
RFID	Radio Frequency Identification
ROP	Re-order Point System
SCM	Supply Chain Management
SME	Small and Medium Enterprises
SOA	Service Oriented Architecture

List of original papers

The author of this thesis was responsible for most of the work in the papers, as first author or major contributor. The contribution included collaboration, negotiation, confidentiality agreements, data collection, observation, analysis and computation, planning and developing the papers.

- I Gore A & Kess P (2007) Managing the impact of ERP implementation on organization structure: A case study. *UP, The Journal for Practising Managers* 31(1): 1-13.
- II Gore A, Muhos M & Jokinen T (2006) Teamwork in Multisite ERP Implementation. International Workshop IWOT 10, The Netherlands.
- III Gore A, Haapasalo H & Kess P (2007) Production Planning through Customized ERP at KPT Nordic. Manuscript.
- IV Gore A & Kess P (2006) Developing a Perspective on Tackling the Post Implementation Issues in ERP Systems. International Symposium, ATINER, Athens, Greece.
- V Gore A, Haapasalo H & Tähtinen T (2009) Agile Manufacturing Enablers for Finnish Steel Products Network. *International Journal of Industrial and Systems Engineering IJISE* 4(3). In Press.

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1 Introduction

The planning and controlling operations is largely dependent on managing the substantial information generated, not just of relevance to the operations function but seamless integration of all business functions. It is towards this aim that the Enterprise Resource Planning (ERP) systems are developed to provide the information backbone needed to support business decisions and execute the operations. So ERP is described as software system that integrates application programs in manufacturing, logistics, sales and marketing, finance, human resources and the other functions in a firm (Vollmann *et al.* 2005). The noted experts Tom Wallace and Bob Stahl prefer to express ERP as enterprise-wide set of management tools that help balance demand and supply, thus encompassing the roots of ERP and the decision support capability.

The ERP systems have evolved from the original Material Requirements Planning (MRP) philosophy (see Fig. 1) to a huge industry with dedicated professionals and service providers. The ERP vendors such SAP, Oracle, i2 technologies and enterprise consulting companies such as Deloitte, Infosys and Tata Consultancy, have become notable brands in this field. Earlier when operations planning and MRP calculations were progressing to ERP, the ideology was geared for goods manufacturing, databases for real time information and single site implementations, but later the primary interest of practitioners and researchers shifted to customer-centred supply chain management, with global competition in standard mode of operations. In fact, this shift impacted growing technology firms and evidence suggests that this is often the case when existing market knowledge is regarded as only factor for exploiting opportunities (Sämundsson & Dahlstrand 2005).

Today, there is transformation of ERP to ERP II and next generation enterprise applications with ERP II essentially being the componentized ERP, e-business and collaboration in the supply chain towards agile networks. The traditional organizations are learning to craft flexible but tightly intertwined chains with the hope of securing tremendous competitive advantage (Karmarkar 1996). The term e-business has particularly referred to the adoption of internet to foster the emerging tools for reinforcing the business processes and accelerate the goal of supply chain integration (Cagliano, Caniato & Spina 2003), while the developing ERP systems have been referred as business strategy and set of industry domain-specific applications that build customer and shareholder value

by enabling and optimizing enterprise and inter-enterprise, collaborative-operational and financial processes (Møller 2005).

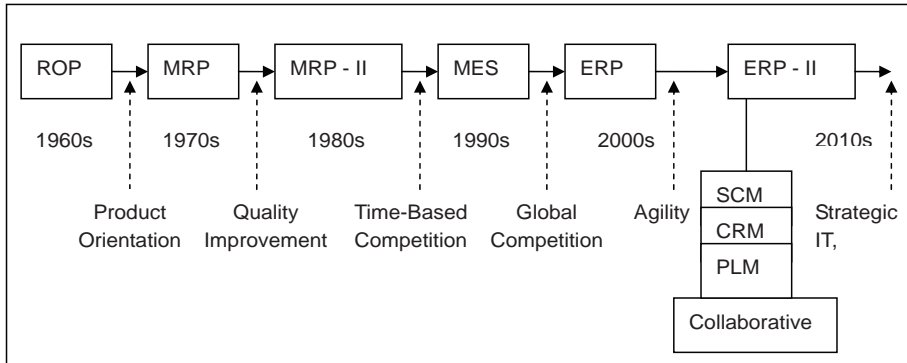


Fig. 1. Evolution of ERP systems (Adapted from Rondeau & Litteral 2001).

A recent study by AMR Research indicates that the enterprise application market is expected to grow to \$ 64.8 billion by 2009 with the consideration of ERP as an important IT-enabled business innovation (Beatty & Williams 2006). This means that the ERP concept (Klaus, Rosemann & Gable 2000) can be viewed from the perspective of IT product to the perspective as key element of an infrastructure that delivers a solution to business. In either case it is important to analyse how the technologies have influenced the competition at company level and whether the fast moving companies achieve real gains and sustained competitive advantage. This would require several variables including historical considerations that affects the opportunities available and the effectiveness with which the competitors exploit or attempt to gain an edge (Ghemawat 2002), thus leading to a broader outlook. However, competitive advantage cannot be understood by looking at a firm as a whole. It stems from the many discrete activities a firm performs in designing, producing, marketing, delivery and supporting the product and each of these activities can contribute to a firm's relative cost position and create a basis for differentiation (Porter 1998). This translates to exploring the competitive advantage in a matrix of the activities or structure at various stages, for example, ERP implementation, stabilization, post implementation and further advances.

1.1 Background

This dissertation has emerged from the empirical work in manufacturing planning and control as a research topic covered under Industrial Engineering and Management. The body of knowledge has been recently branched under Operations Management or referred to separate academic departments for example Operations, Information and Technology or Decisions, Operations and Technology Management.

APICS define Operations Management as a field of study that focuses on the effective planning, scheduling, use and control of a manufacturing or service organization through the study of concepts from design engineering, industrial engineering, management information systems, quality management, production management, inventory management, and other functions as they affect the operations (APICS Dictionary). The quest for increased knowledge based on experience and observation laid the foundation of this doctoral dissertation that was strengthened by rigorous research studies.

During the early surveys and interviews that I conducted with industry managers, entrepreneurs, academics, software vendors and consultants, I identified several gaps between the academic know-how and practice. The bridging of this gap is in itself a gargantuan task apart from the conflict of loyalties created between the demands of researcher role and management consultant role. The academic research is intended to make contribution to theory and achieve the recognition of academic community. But this leads to the dilemma between employing positivistic and hermeneutic paradigms; the academia favouring positivistic research centred on description and explanation while hermeneutic paradigm conceding subjectivity and concentrating on understanding and interpretation. According to Gummesson (2000), the mainstream scientists who just apply 'approved' methods without being aware of the subjectivity of their activities are not scientists, they are technicians. So, the business solutions research has to maintain the critical balance whilst existing in scientific pattern of researcher's preunderstanding and understanding focusing on theory and support from practice (see Fig. 2). However, the research avenues in the ERP theme (Majed 2003) highlight the dimensions related to structures, technologies and implementation capabilities insinuating the apprehensions of industry strategists about gaining competitive advantage through the ERP systems.

Many models and theories on IT and strategy are found in the literature (e.g. Silk 1992, Klouwenberg *et al.* 1995, Agarwal *et al.* 1997, Cegielski 2001, Kohli & Devaraj 2003) but fewer on IT and processes that lead to competitive advantage. Furthermore, the texts that describe processes or deal with understanding the ERP resources over time in order to become source of sustained competitive advantage are yet smaller. The packaged enterprise application software vendors claim that ERP systems are a source of competitive advantage but there are arguments that there is commoditization (Carr 2003) leading to competitive convergence evoking conscious technology follower strategy.

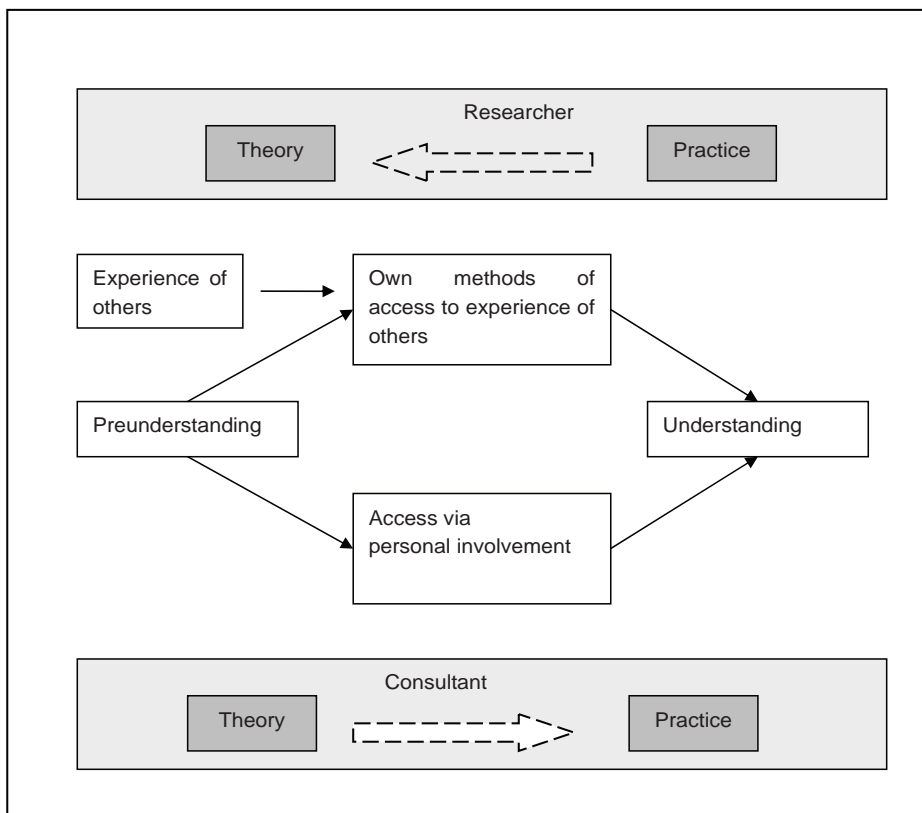


Fig. 2. Preunderstanding and understanding in researcher and consultant paradigms (Adapted from Gummesson 2000).

ERP systems provide benefits such as improved information visibility, personnel and inventory reduction and productivity improvement but long term implications are unknown (Davenport 1998, Davenport, Harris & Cantrell 2004). Probably since ERP is available for years, it is unlikely to provide competitive advantage (Seddon 2005). But then there is a difference between installing software and implementing a solution (Mark 2003) and competitive advantage can be influenced over time. According to Kalling (2003), the process of building competitive advantage can be seen as holding different phases such as identification, development, protection, distribution and usage. Identification phase includes clarifying a business strategy, feasibility studies, vendor selection, etc. Development is initiated with commitment to continue and the firm takes actions to secure uniqueness, hence protection efforts take place in parallel. Distribution follows upon having prepared a system and finally in usage, managers move to new ways to conduct business and improve the system. Therefore, the motivation is to trace the competitive advantage through the ERP systems and fill the gap between theory and practice with moving target phenomenon of rapidly diffusing technologies.

1.2 Scope, objectives and delimitations

The overall purpose of my research is to contribute empirical evidence and attempt to provide response to the anxiety existing over the actual competitive and strategic value delivered by ERP systems as a particular entity.

The research problem can be stated as follows:

How can ERP systems be managed to become source of sustainable competitive advantage?

This problem extends to form the five research questions (RQ) as below:

- RQ1 How ERP implementation influences the structure of the organization?
- RQ2 How to control the evolving aspects in complex ERP implementation?
- RQ3 How customized system can be preferential?
- RQ4 How to deal with post implementation issues?
- RQ5 How agility elements impact competitiveness?

The exploratory nature of the research implies that the results do not conclude in rigid decision-making but develop considerable insights into the situations. The initiation of exploratory study necessitates a holistic look with consideration of every element from different viewpoints. The understanding of organizational paradigms and study of views about change, performance, competitive analysis and so on led to deeper understanding about transformation during ERP implementation phase. This deeper understanding became fundamental understanding for more complex implementation studies over time and in turn channelled to further viewpoints. This is depicted in the Fig. 3 that affirms how the deeper understanding could reveal new aspects of the topic with simultaneous utilization along the time dimension. So, the research themes in the papers are related to each other, even though their focus is seemingly different. The objective is concerned with the theory of ERP systems in different manufacturing environments to understanding what is happening out there when the focus is on competitive advantage through ERP systems in progression towards agile networks and next generation systems. The studies recognize that one of the unique attributes of ERP implementation is the simultaneous influence the technology has on multiple processes, within multiple implementation sites.

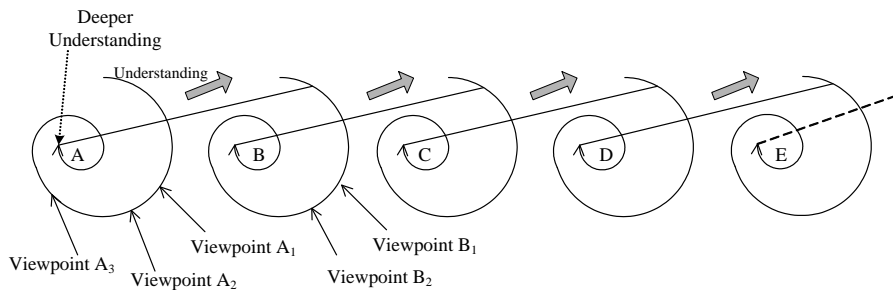


Fig. 3. Research approach.

One school of thought is that ERP users can gain competitive advantage from the way they implement the system and exploit the resulting data (Weston 1998). With every industry currently undergoing transformation, most companies strive to develop new approaches to competition and value creation. However, the capacity to change embedded in the technical and social infrastructures lags the desired strategic direction. Prahalad & Krishnan (2002) discuss the steps in

getting applications to support strategy by use of application-portfolio scorecard to spark shared agenda for senior managers. So, ERP is only set of building blocks that have to be put together to produce advantage. The ERP remains tied to basic evolution of planning tools that began when computers were applied to material planning for production (Okrent & Vokurka 2000). Thus, ERP would be expected to take the functions of operational planning and control combining with all of the other business functions to create a synergistic, knowledge-based management environment (Langenwalter 2000, Heizer & Render 2004). This thought process leads to the indication that the answer might lie in capacity to experiment and innovate. Today's global companies work with numerous countries in dynamic collaborations and therefore, getting the enterprise information infrastructure to connect internal and external systems seamlessly remains a foremost task. Bovet & Martha (2000) suggest intelligent information flow as neural system of the value net, connecting customers, suppliers and value adding activities. They propose IT as one key enabler among the five characteristics of customer alignment, collaboration, agility and scalability, fast flow and digitalization. Others have considered research subjects in this regards as those included in dynamic framework of business (Fine 1998), strategic flexibility (Lau & Hurley 2001, Abbott & Banerji 2003, Holtius & Malaska 2004, Reddy 2006) and agile supply (Hoek *et al.* 2001, Hämäläinen 2003, Davies 2004). So, the outline of the research could be progressively formed to some extent on this basis (see Fig. 4) towards compiling the research findings as a whole.

The influence moves from narrower to wider context while the preliminary notions have gradually gained precision. The first area (RQ1) covers organization structure changes during ERP implementation stage to explore the roots of competitive advantage. Then the research theme develops from the understanding of organizational notions to more complex implementations (RQ2). Further, the research goes deeper in the technology strategy aspects (RQ3) and ERP management for examining the sustainability of advantages. The next area (RQ4) investigates the issues at advanced stages of ERP, reviewing the vision for the agile networks. Finally, the theme broadens to explore the agility enablers (RQ5).

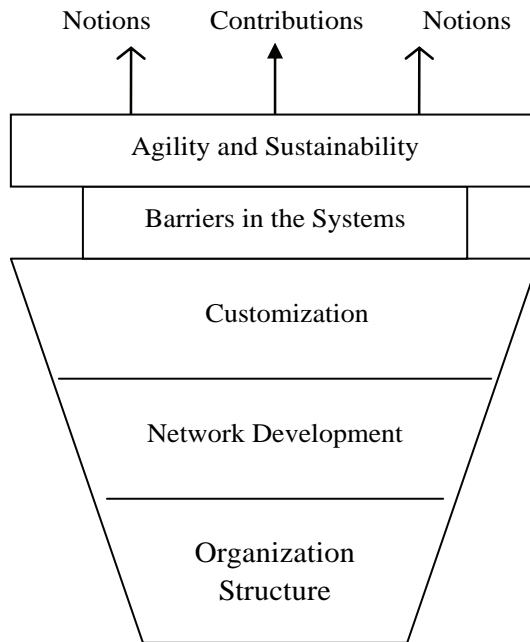


Fig. 4. Research outline.

Although the outline can be traced, it is difficult to divide the exploratory study into clear phases or define what is relevant in advance that would become apparent only through analysis. The scope of the thesis is the influence of ERP in stages of application to questions that originate in the aspects impacting competitiveness. More precisely, the thesis rests on organization theories drifting towards agility principles.

The data collection for this thesis has included various techniques and sources such as interviews, observations, available literature, manuals, etc. But, the limitation is the extent of generalization of results; the pitfall indeed would be to draw extensive conclusions rather than the comprehension of valuable understanding and knowledge gained through the studies.

1.3 Structure of the thesis

The dissertation comprises two sections, the introductory section and the research papers. The first section explains the origins, aims, scope and methodology of the

dissertation. The purpose of this section is to specify the nature of the research and the premise for the inferences drawn during the process. The difficulties faced during the course of the research, resource availability, access of industrial or commercial data, sample size and freedom to express the fine details based on agreements can also be derived. The second section consists of the publications. Please see the Table 1 for the overview of the dissertation.

Table 1. Structure of the thesis.

PART I: INTRODUCTORY	PART II: PUBLICATIONS
Introduction	Publication I
The study, its domain and objectives	Managing the impact of ERP implementation on organization structure: A case study
Research Methodology	Publication II
Alternatives, research design and agreements	Teamwork in Multisite ERP Implementation
Frame of Reference	Publication III
Introduction to the field, links to theoretical base	Production Planning through Customized ERP at KPT Nordic
Summary of Papers	Publication IV
Overview of publications	Developing a Perspective on Tackling the Post Implementation Issues in ERP Systems
Evaluation and Discussions	Publication V
Summary of contribution and discussion	Agile Manufacturing Enablers for Finnish Steel Products Network

1.4 Definitions

Some concepts relevant for the thesis have been defined here and terms have been elaborated.

System (from Latin *systema*) is a set of entities comprising a whole where each component interacts with or is related to at least one other component. System has also been defined in other words as a group of objects that are joined together in some regular interaction or interdependence towards the accomplishment of some purpose.

Technology is the practical implementations of intelligence. ‘Practical’ requires that technologies not be wholly ends in themselves and ‘implementations’ entail that technology be somehow concretely embodied, normally in implements or artifacts or simply in social organization (Ferré 1988).

Business Process is any set of activities performed by a business that is initiated by an event, transforms information, materials, or business commitments, and produces an output (Harmon 2003). Business Process Management refers to aligning processes with the organization's strategic goals, designing and implementing process architectures, establishing process measurement systems that align with organizational goals, and educating and organizing managers so that they manage processes effectively.

Sales and Operations Planning is a process to develop tactical plans that provide the management the ability to strategically direct its businesses to achieve competitive advantage on a continuous basis by integrating customer-focused marketing plans for new and existing products with the management of the supply chain (APICS Dictionary).

Agility is the ability to thrive and prosper in a market characterized by continuous change and to respond quickly to emerging developments driven by customer-based valuing of products.

Supply Chain Management (SCM) is the management of upstream and downstream relationships with suppliers and customers to deliver superior customer value at less cost to the supply chain as a whole (Christopher 1998). The agile networking concept stems from development of networks of connected and interdependent organizations, mutually and cooperatively working together to manage, control and improve the flow of materials and information from suppliers to end users.

Customer Relationship Management (CRM) is one of the newer modules in ERP systems. CRM creates a window into the customer's interactions with the business, consolidating the customer's interactions from inquiry, to purchase, to after-sales support. Thus, companies manage their relationships with customers, the capture, storage and analysis of customer information.

2 Research methodology

The methodological orientation of the thesis is discussed first on a general level followed by research methods used. The emphasis is on expressing the research design and framework for the research papers. This would enable the readers to comprehend the thought process evolved during the period of study and thereby assess the findings produced by the research effort.

2.1 Philosophical perspectives and problems

In science, a paradigm consists of the researcher's perception of what one should be doing and how one should be doing it. Considering that the notion of 'absolute truth' is lacking or discredited, one creates a reference point, the concept of paradigm, representing people's value judgements, standards, norms, theories and approved procedures governing their thinking and action (see Kuhn 1970). The Greek researcher Archimedes, in 250 BC, exclaimed, "Give me somewhere to stand and I will move the earth."

So, there is a convention on what does and does not constitute knowledge, termed as 'scientific method' and only by applying the rules of scientific method can knowledge be generated that is acceptable to the scientific community. Moreover, the boundaries of what constitutes science remain open to debate but, of greater pertinence to this dissertation is the discussion of the widely-adopted classification of research approaches. One such classification is provided by Burrell & Morgan (1979), distinguishing nomothetic and ideographic methodologies. Nomothetic methodologies stress the importance of basing research upon systematic protocol, controls, technique and deduction. On the other hand, ideographic methodologies emphasize the analysis of subjective accounts, explanation by understanding and induction. Therefore, these polarities can be situated at opposite ends of a continuum, of which one end represents a very subjective and the other a very objective view of the world. But whatever the position on the continuum, the fundamental problems faced by researchers is: How do I know what I know and How do I acquire knowledge. This essentially means confronting with the philosophical choices (see Table 2).

Ontology refers to dealing with being or the nature of phenomena.

Pluralism is founded on realist assumptions about ontological status of social reality which postulates that the world is a real world made up of hard, tangible

and relatively immutable structures. Thus, social reality has a concrete existence independent of human consciousness and cognition.

Nominalism sees the world as an emergent social process and ontological status of social world is viewed as problematic.

The operationalization of theoretical concepts and assignment of independent variables would imply concrete social reality apparent in positivist surveys and experiments and hence once nominalism is accepted, methodological pluralism and methodology of positivist become inappropriate. As pointed out earlier, knowledge is from particular points of view and those who would take a 'practical' view are likely to lament that the 'theory' is of little relevance to 'real' world. This has come a long way from Plato and Aristotle who severed theory and practice distinguishing between episteme (genuine theoretical knowledge that was an end in itself) and doxa (opinions or beliefs suitable only for the conduct of practical affairs) to the learning cycle that might start with the experience of an event or stimulus proceeding to making sense of it (see Fig. 5).

Table 2. The philosophical choices and research paradigms (Adapted from Gill & Johnson 1997).

Philosophical Choices	Non-recognition of the relevance of human subjectivity	Recognition of the relevance of human subjectivity
Methodology	Nomothetic	Ideographic
Ontological Realism	Positivist methodological parochialism	Methodological pluralism
Ontological Nominalism		Interpretative methodological parochialism

When research process is described, it would be naive to express the whole as rational, foresighted activity. Gill & Johnson (1997) articulate the philosophical, social, political and practical influences on the researcher's conceptualization of the research problem as shown in Fig. 6. Quoting Becker (1965): "As every researcher knows there is more to conducting research than is dreamt of in philosophy of science, and texts in methodology offer answers to only fraction of problems one encounters. The best laid research plans run up against unforeseen contingencies in the collection and analysis of data.....the finished writing is the result of hundreds of decisions, large and small, made while the research is underway....."

However, it is possible to reflect on one's difficulties and inspirations and see how they could be handled more rationally the next time round. In short, one can

be methodological about matters that earlier had been left to chance and improvisation. I would reflect that many difficulties could be resolved and effective decisions made with clear vision, hard work and perseverance.

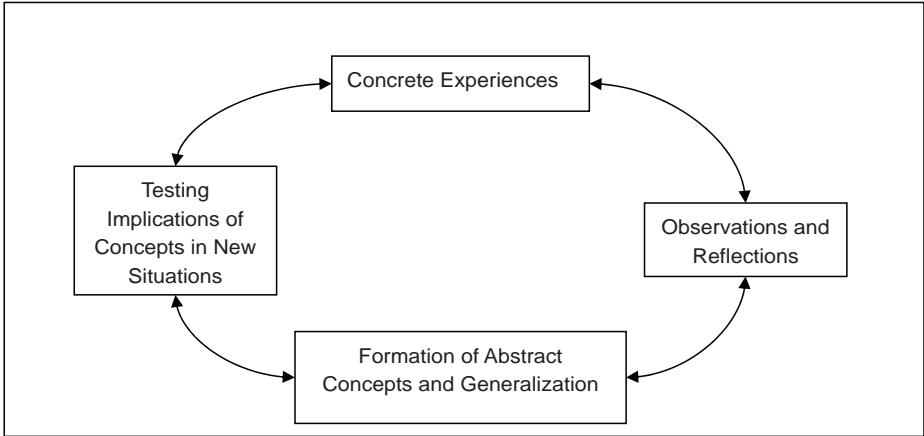


Fig. 5. Experiential learning cycle (Kolb et al. 1979).

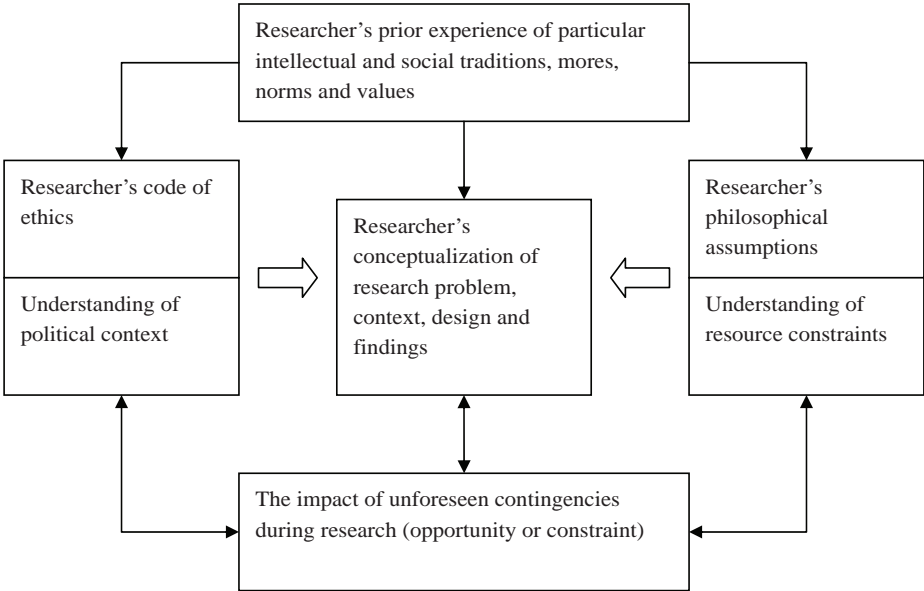


Fig. 6. Research dilemmas (Adapted from Gill & Johnson 1997).

2.2 Research design

The research presented in this thesis is built on a number of different studies and relevant research strategies. This is an exploratory research involving both qualitative and quantitative aspects. It aims to produce new knowledge through a combination of qualitative and quantitative data designed to widen the scope of the study, as alluded by some authors (see e.g. Miles & Huberman 1994, Yauch & Steudel 2003, Mangan *et al.* 2004). According to Drejer *et al.* (2000), the Scandinavian tradition with respect to research methods is defined by stress on the need for strong links between firms and research and use of mainly qualitative research methods in contrast to the American tradition in operations management that relies more heavily on quantitative than qualitative research methodologies. However, both qualitative and quantitative research traditions are important elements of research work. Qualitative research is pursued in order to study and express episodes, actions, norms and values from the perspective of the subjects under study (Bryman 1988). The intention is to understand a phenomenon as a whole (Patton 1990). The data collection could be by in-depth open-ended interviews, direct observation or written documents. The data from interviews consist of direct quotations from people about their experiences, opinions or knowledge and data from observations can be about detailed descriptions of people's activities, behaviours, actions or organizational processes that are part of observable human experiences.

Quantitative research, on the other hand, is the systematic scientific investigation of quantitative properties or phenomena and their relationships. There are number of methods such as surveys, simulation and experiments that are considered to belong to the quantitative tradition (see e.g. Black 1999, Cramer 2003). The advantage of a quantitative approach is that it is possible to measure the reactions of a great many people to a limited set of questions, thus facilitating comparison and statistical aggregation of the data. According to Schmenner & Swink (1998) the hypotheses and their tests are basic blocks of scientific inquiry but when the hypotheses are supported by more and more evidence, especially evidence of different kinds, they can be organized into laws. Theories then exist at deeper level and construe the phenomenon as manifestations of entities and processes that lie behind or beneath them. Borland (2001) summarizes that the relationship between qualitative and quantitative research should not be considered in terms of a mutually exclusive dichotomy but rather as a continuum of complementary paradigms within systematic scientific inquiry. Therefore,

although qualitative and quantitative research has different origins, they can be conducted in parallel for the same study. If a research study is mainly quantitative, qualitative research can for instance be used either to develop a quantitative tool or find an explanation for the quantitative results. If a qualitative study is the main strategy, quantitative methods can, among other things, be used to enlarge the initial study.

Since this is an exploratory research it is more about understanding new aspects and developing significant insights rather than pure discovery, as ordained in this research typography (see e.g. Dane 1990, Stebbins 2001, Beall 2002, Martin 2003). The fundamental debates have roots in the intricacies of accounting for ways of working in real world setting illustrated for example by the Munich School of Exploratory Research (e.g. Reichwald *et al.* 2004, Berger *et al.* 2005) aiming at the co-creation of knowledge in close collaboration between management research and practice. Berger *et al.* (2005) list three characteristics of the exploratory research process as conceptual preunderstanding, systematization plus case study research and refinement. In this thesis, I have mainly utilized case study and survey methodologies and hence an overview of these methodologies has been subsequently included while the Fig. 7 diagrammatically shows the studies conducted.

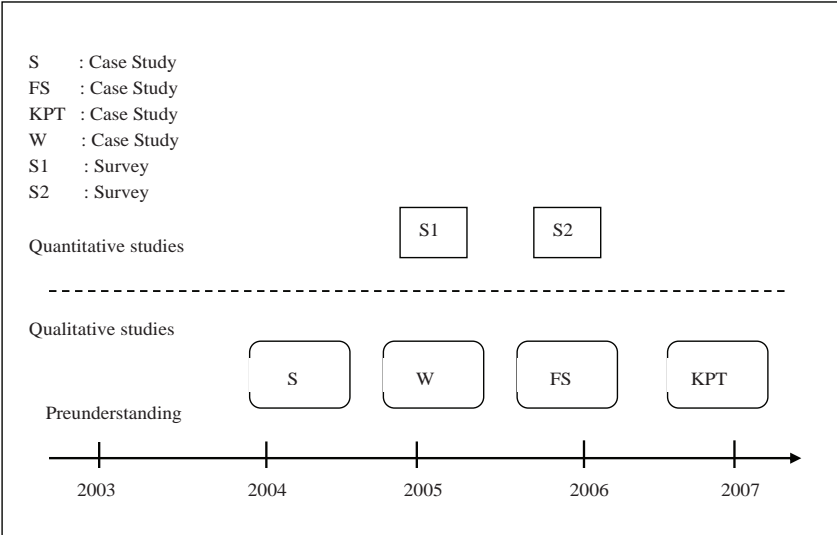


Fig. 7. Studies performed during the course of this research.

2.2.1 Case study research

The case study approach to qualitative analysis is a specific way of collecting, organizing, and analyzing data. Case studies are suitable for understanding the dynamics within a single setting (Eisenhardt 1989). According to Yin (2003), a case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when boundaries between phenomenon and context are not clearly evident. Yin (2003) goes on to propose three research applications of the case study approach as exploratory, explanatory and descriptive. Exploratory cases, as the name suggests, have the goal to explore a situation. They are carried out as a precursor to further investigations. Explanatory cases serve the purpose of explaining the link between cause and events. Descriptive case studies are used to portray the situation where actual events have occurred, the intention being representation rather than criticism. In an investigation of broader scope, all three types may be appropriate at different stages. Woodside & Wilson (2003) suggest that case study research may serve any one or combination of purposes such as description, understanding, prediction or control. However, they propose that the researchers should principally stress on the deep understanding of actors and behaviours occurring for specific processes through time.

Yin (2003) writes about the importance of the role of theory in design work. The use of theory, in doing case studies, is not only an immense aid in defining the appropriate research design and data collection but also becomes the main vehicle for generalizing the results of the case study. Analytical generalization is considered the more acceptable mode and if two or more cases are shown to support the same theory, replication may be claimed.

2.2.2 Survey research

The survey method is one of the most common empirical methods used. A survey is a means of gathering information about the characteristics, actions or opinions of a large group of people, referred to as population. Survey research is usually a quantitative method requiring standardized information from subjects being studied and is structured in the sense that sampling and questionnaire construction are conducted prior to start of data collection. It is necessary to think through the whole research process before deciding on sample and questionnaire (see e.g. Moser & Kalton 1971, Bryman 1988).

2.3 Confidentiality agreements

The obligation to honour assurances of confidentiality, both as matter of self-interest and as a matter of ethical obligation to research targets is generally accepted. Hofferbert (1976) says that when information is gathered from individuals or institutes for research purposes, assurances of confidentiality are formally offered or implied. Thereby, all necessary efforts have to be made to guarantee fulfilment of that assurance, especially in sensitive fields, so as to retain credibility and prevent crippling of future research capacity. Many authors have discussed the factors such as data ownership, conflicts of interest, protection of human subjects, ethical dilemmas confronting international management researchers and so on (see e.g. Manderson & Wilson 1998, Hubbard *et al.* 2001, Guillemin & Gillam 2004, Stening & Skubik 2007). This means that the confidentiality concerns are commonly encountered by researchers although resolving them could be situation specific or an ongoing challenge. According to Payne (2000), the ethics of research and knowledge construction often needs clarification during the course of research.

The data for this research has been collected by various techniques and through access to several sources, industries, institutes and researchers. The major industrial collaborations included Steel, Wood and ICT companies. I had to formally or informally reach agreements regarding the dissemination of results or portions of the work that could be disclosed and this has to be recognized when reviewing the thesis. For example, identity of companies has been protected by labelling them as company S, KPT, etc. or the specific identity of individuals and in some cases nationalities has not been revealed.

3 Frame of reference

This portion covers the theoretical links and related literature. The notions in the research outline have moved forward through these links in order to contemplate the studies on macro level and facilitate analysis. However, the emphasis here is on laying the foundation rather than reiterating the theories or reviews presented in the publications section. The strategic issues in ERP are first discussed in a broader sense considering the available literature and seminal work in the field.

3.1 Strategy-oriented ERP literature

The strategy-oriented ERP literature is focused on success factors in ERP implementation, project phases or reasons for ERP venture. Several authors (e.g. Sumner 2000, Umble *et al.* 2003, Gargeya & Brady 2005, Sun *et al.* 2005) have designed the research to identify the success ingredients. This is capped with views about organizations turning to ERP and beyond. Ross *et al.* (2000) assert that the rationale for ERP implementation has proved interdependent enabling new capabilities that in turn could be expected to generate performance outcomes (see Fig. 8).

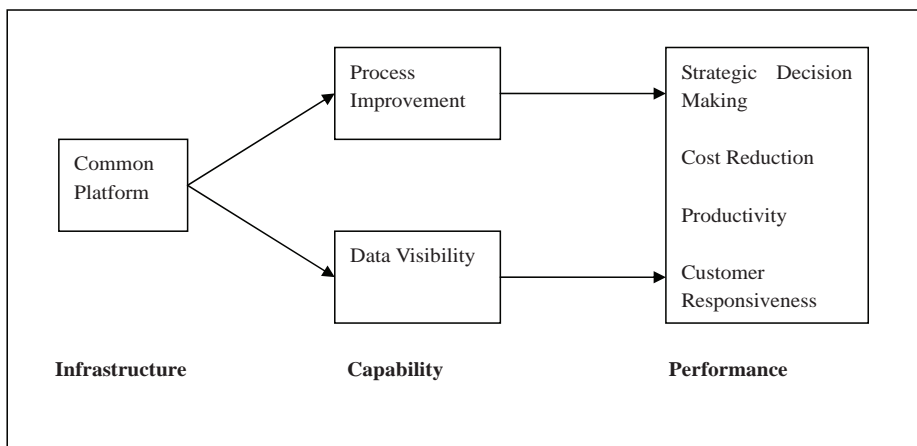


Fig. 8. Rationale for ERP (Adapted from Ross & Vitale 2000).

Many firms deployed ERP to replace the legacy systems that had been built on myriad of outdated technologies causing high support costs. At other firms, the integration challenge was initiated by mergers and acquisitions or need to

improve specific processes in logistics, production scheduling or customer service. Therefore, the success factors have remained attached to this base; for example success can be achieved through organizational commitment, clear communication, selecting compatible ERP system, data accuracy, resolving multi-site issues, project management techniques, eliminating old systems, close monitoring, change management, education and training, and so on (Birks 1997, Umble 2002, Chin-Fu Ho *et al.* 2004). The need to contribute to strategic concerns has been implied, for example, by proposing stage maturity model (Holland & Light 2001). One consulting company has further attempted to summarize whether an executive views an ERP system to be a success by asking questions such as: Is ERP system meeting the expectations? Is the business more competitive as a result of ERP system? Has the ERP system captured significant financial benefits?

However, the 'success' in the ERP success factors literature is constrained to having the functional system up and running and not sustainable competitive advantage (Parr *et al.* 1999, Markus & Tanis 1999, Somers & Nelson 2001, Kalling 2003). Again, the frameworks are relatively close to technology and functional operation, not strategy or sustainability of advantages.

3.2 Generics of competitive analysis

In most organizations, the competitive strategy grows out of a sophisticated understanding of the rules of competition, managers ultimately aiming to change the rules in the favour of the organization. For this information systems technology is a key driver since it is pervasive in the value chain and every value activity creates and uses information. The information systems strategy has come a long way from isolated focus issues of the day towards seeking competitiveness (see Fig. 9). Today, the profitability is under pressure in many industries and ERP systems have been utilized as the major information technology in hopes of making a difference. However, the fundamental basis of superior performance in the long run is sustainable competitive advantage (Porter & Miller 1985, Porter 1998) with ERP to serve this purpose. The analysis is primarily about two types: cost advantage and differentiation. This could be achieved by operational effectiveness or strategic positioning. Operational effectiveness means doing the same things as competitors but doing them better. This can take myriad forms such as superior inputs, new versions, better management structure, better trained people, etc. But, it is perceived that simply improving operational effectiveness

would not provide competitive advantage because it is necessary to sustain the high levels and that is exceedingly difficult since the best practices also eventually lead to competitive convergence.

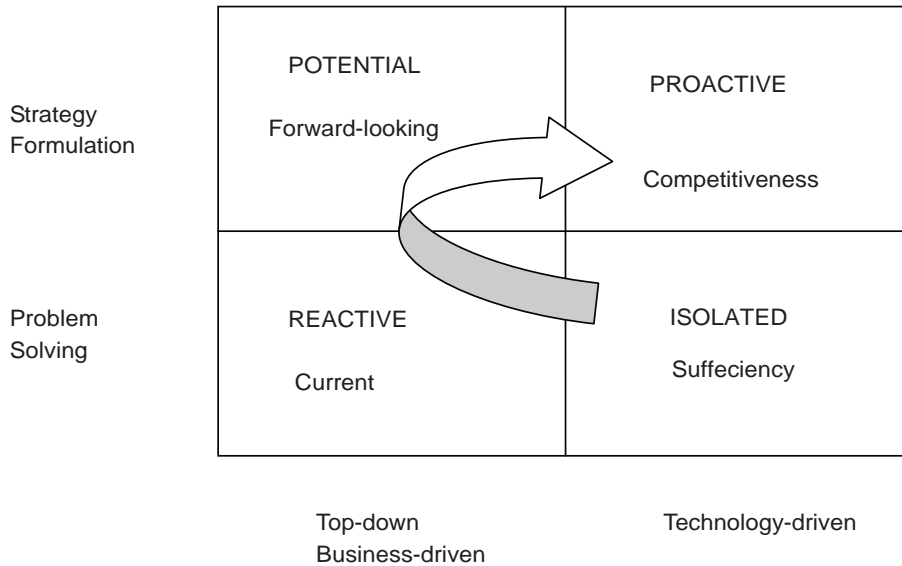


Fig. 9. The information systems strategy towards competitiveness (Adapted from Galliers & Newell 2003).

The other way is strategic positioning, which means doing things differently from competitors by delivering unique value to customers for example offering different set of features or different array of services. The Porter's six principles of strategic positioning remain fundamental (Porter 2001):

1. Set the right goal - superior long term return on investment.
2. Deliver a value proposition - set of benefits different from those that competitors offer.
3. Provide a distinctive value chain.
4. Make trade-offs. Some activities have to be abandoned in order to be unique in others.
5. Ensure fit to increase competitive advantage and make strategy harder to imitate.
6. Ensure continuity of direction.

This approach is inspired by the ideology that speed and flexibility bereft of distinctive strategic direction lead nowhere and is unlikely to create competitive advantage.

Hamel & Prahalad (1994) have proposed more revolutionary models emphasizing the importance of strategic intent. They consider strategic intent as the capstone of strategic architecture with strategic intent implying significant stretch for the organization. So, the questions posed have to be about the basis of current and future competitive advantage. The philosophy behind this is that the competitiveness problem faced by companies is not a problem of 'foreign' competition, but a problem of 'non-traditional' competition. It is not Europe versus Asia versus United States but the real competitive problem is laggards versus challengers, incumbents versus innovators, the inertial and imitative versus the imaginative.

3.3 ERP in different industrial environments

When ERP systems are treated from economic value creation perspective the focus shifts towards determinants of profitability such as industry structure and sustainable competitive advantage. The segment analysis could be embodied in five competitive forces: rivalry among existing competitors, entry of new competitors, threat of substitutes, bargaining power of suppliers and bargaining power of buyers (Porter 1998, Porter 2001). In my research, I chose to plot the observations on the basis of original manufacturing planning and control (MPC) classification schema (see Fig. 10) since the theme was emerging and the structural dynamics could be comprehended better from the roots of ERP systems. Thus, examination in wide range of industries could be feasible to reveal the trends but distancing from drawing general conclusions about impacts on long-term industry profitability.

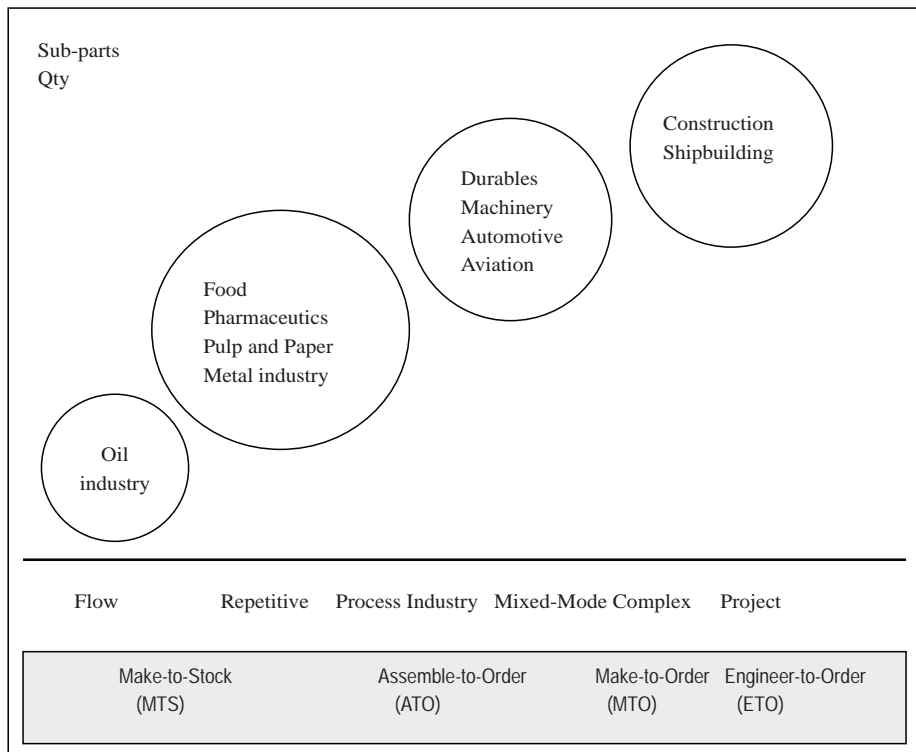


Fig. 10. Characterizing the industrial environments.

The schema expresses the complexity, number of subparts and repetitive nature of production. So, ERP systems can be observed together in environments characterizing make-to-stock, assemble-to-order, make-to-order or engineer-to-order situations. Firms that serve their customers from finished goods inventory are known as make-to-stock firms. Those that combine a number of options together to meet a customer's specifications are called assemble-to-order firms. Those that make the customer's product from raw materials, parts, and components are make-to-order firms while engineer-to-order firms will work with the customer to design the product, and then make it from purchased materials, parts, and components (Vollmann *et al.* 2005). Moreover, some firms will serve a combination of these types or all simultaneously. Babu (1999) argues that the ERP systems have been founded for MTS businesses that are in a repetitive batch manufacturing environment or for large companies. Therefore, SMEs have to be particularly wary about traditional integrated solutions and as such, selection of

appropriate ERP system strategy is not a simple one. Bendoly & Jacobs (2004), note that the underlying issue is one of alignment between corporate operating functionality and IT architecture. They discuss the questions faced by IT decision such as concentration of centralized versus decentralized control, accounting of day-to-day processes, dealing with core processes and meeting the distinct needs of market interests. According to Siau (2004), the methodologies to support ERP systems implementation remain vital and can be distinguished further as first, second and third generation (see Table 4) to next generation systems.

Thus, the management decisions regarding acquiring the packages have proved crucial with awareness that this could have direct consequences for competitive advantage. The options are off-the-shelf packages, customization, in-house applications or outsourcing. Each option has pros and cons with regards to costs, compatibility, implementation time, skills, and security. Bernroider & Koch (2001) say that every organization has to independently weigh the criteria and set priorities. Lall & Teyarachakul (2006) suggest selection in stages such as initial stage, evaluation stage and final stage. They propose data envelopment analysis (DEA) for selection purposes. DEA converts multiple critical attributes into a single relative efficiency measurement that can facilitate decision making.

ERP vendors argue that ERP software will assist client firms to achieve superior profitability by enabling them to run processes, providing them with more detailed, accurate, relevant, integrated or faster information and responding to market conditions more effectively than their competitors. However, there could be wide variations in what an ERP package can do for the companies that adopt it. Because of the way ERP package are designed, some tailoring is always required to get them up and running, the extent of tailoring varying from one organization to another depending on several factors such as degree of fit (Brehm, Heinzl & Markus 2001). Some companies that selected extensive modifications or building the package option contemplated legally protecting the resource from being obtained by competitors. But, legal protection can prove costly and more undisclosed organization could constrain communication, and so forth (Liebeskind 1996).

Table 4. Generations of ERP (Adapted from Siau 2004).

Particulars	First Generation ERP	Second Generation ERP	Third Generation ERP
Scope	Single company	Single company	Multiple companies
No. of Sites	Single	Multiple	Multiple sites from different companies
Methodology Focus	Streamline business processes	Global integration of enterprise	Integration of supply chain
Technology Focus	Business process efficiency	Interoperability across the globe	Interoperability across platforms
Organization Focus	Business process	Seamless integration across multiple sites	Product/Market channel
Process Focus	Enterprise-wide closed loop	Global enterprise-wide closed loop	E-business, SCM, CRM

The more important aspect was the realization that sustainable value can be created from developing intangible assets, such as skills and knowledge of workforce, information technology that supports the workforce and links the firm to its customers and suppliers, organizational climate that encourages innovation, problem solving and improvement. The quest for excellence in this direction led to tremendous growth of software development centres that continually needed talented specialist staff thus moving the hubs to other countries, particularly India that has today the largest concentration of high quality software development centres in the world as measured by Software Engineering Institute’s capability maturity model (Pralhad, Krishnan & Donker 2004). The financial framework worked well when competitive strategies were based on managing tangible assets (Kaplan & Norton 2001) but describing information age strategies is hazy. Specifically, exploring sustainable competitive advantage through ERP systems could provide clues for the future.

3.4 Pursuits through existing theoretical contexts

Previously, the general theoretical background was reviewed and now exploitation of the existing theoretical contexts will be presented for each research paper consistent with the research outline. The theoretical contexts may not necessarily portray all the objects of study and may even appear restricted suggesting inexplicable conditions as is the case with exploratory research.

Organization Structure. This research draws on organization theory (Robbins 1990; Keen 1991, Monge & Fulk 1999, Ahadi 2004) and change management

theory (Bullock & Batten 1985, Morgan 1986, Nadler & Tushman 1997, Paton & McCalman 2004) to examine the vicissitudes in the organization after ERP implementation. The related contexts signifying ERP influences could be introduced (e.g. Huang & Palvia 2001, Spathis & Constantinides 2003, Jones & Price 2004). The theory of IT and organization structure has been discussed with three components namely complexity, formalization and centralization. According to Keen (1991), with IT, there is shift in emphasis from organizing by labour to organizing by division of knowledge. It is possible to achieve lower complexity by wider span of control, fewer levels, fewer people, easier collaboration and communication. Another aspect is formalization, the degree to which an organization relies on rules and procedures to direct the behaviour of employees. IT would facilitate lower formalization.

The organizational changes with regards to ERP in particular are closer to organizational restructuring dynamics but, the available models are not inclusive of all considerations, human element, management actions, inspiring vision and sustainability. Nadler & Tushman model (1997) is useful from analytical perspective because of its sociotechnical composition. According to this model, the organization is system that draws inputs from both internal and external sources and transforms them into outputs. The components including formal organization, informal organization, work and people are all dependent on each other. The organizations with mechanistic structure have more layers, depriving the members of information except that required to complete the job. ERP implementation favours disperse information, competence and empowerment of employees. Since ERP affects the nature of work, training is an important aspect of implementation process. The applications of new reward schemes that recognize superior performance are also emphasized.

For expressing controlled change and strong restructuring drive, Bullock & Batten (1985) have proposed the planned change model. This model suggests four phases: exploration, planning, action and integration. The phases are essentially linear and irreversible.

Network Development. The theoretical foundation for ERP systems in complex organizations lies on leadership, teamwork, collaboration process, dynamic supply networks and virtual operations (e.g. Rudiger & Galimow 1996, Bal & Gundry 1999, Launonen 1999, Parr & Shanks 2000, Rosenthal 2001, Ptak & Schragenheim 2004, Hameri & Paatela 2005). These, above all, were utilized to explore the elements in multisite ERP implementation.

The global teams in ERP environment are interlinked with or utilize the ERP systems and are increasingly becoming the foundation in accomplishing tasks and as building blocks for global success. Therefore, in multisite ERP implementation, the teamwork among core team members has direct implications for the performance of the whole enterprise. The initial stage involves training of team members depending on the approach for ERP configuration. The approaches could be: total autonomy for business units, minimal headquarters control over local processes, headquarters coordination of transactions between business units and total centralization with headquarters control over local decisions. But, the crucial aspect is to transform the core team to a high performance team. Bal & Gundry (1999) are of the opinion that virtual teaming is the mechanism for examining relationships created across the distributed supply chain with members separated geographically. Parr & Shanks (2000) have developed project phase model suggesting the multiple team formations with organization, leadership and participation as salient features of teamwork. This relates to proposition of more than one dimension in teamwork and development. The dimensions can be considered as associated with individual task, team and organization, or as stages. The core ERP team also has to develop the ability to collaborate effectively. Rosenthal (2001) suggests a collaborative process roadmap based on five key factors namely shared and meaningful purpose, specific and challenging goals, common and collaborative approach, clear roles, and complementary skills. This essentially means that mobilization of core team has to consider the innate drive of members to excel. Also, the purpose has to be understood at the same level by all members including change management policies of the company.

Customization. The increasing pressure to transform businesses to make-to-order production impels information system to become tool for engineering in addition to realistic planning function (Persona *et al.* 2004). The ERP characteristics necessitated in this rapidly changing and turbulent environment formed the literature base (e.g. Yeh 2000, Manetti 2001, Kurtz 2004, Watanabe & Hobo 2004, Vollmann *et al.* 2005).

Barriers in the Systems. Some models of ERP implementation process (e.g. Bancroft 1998, Deloitte 1999) form the persuasive framework for companies to adopt ERP systems. However, the evolution of new capabilities towards ERP II and difficulties in advanced optimization levels (see e.g. Siau 2004, Møller 2005, Kelle & Akbulut 2005, Campbell & Vamsi 2006) lead to new measures. The research moves forward to signify the sustainability of competitive advantage.

The implementation process of ERP system can be conceptualized as a business project rather than the installation of a new software technology. The ERP vendor swaps the software previously used with new ERP package but, that is just the beginning of ERP implementation. Bancroft (1998) presented the model of implementation process that includes five phases: focus, as is, to be, construction and testing and actual implementation while Deloitte (1999) identifies distinct stages as stabilize, synthesize and synergize. Stabilize is familiarizing and sustaining the system's functionality and synergize is achieving value using all the capabilities. The stabilize stage is reached by many organizations but the issues that arise after this stage preclude further advancement and they are typically the post implementation issues.

Agility and Sustainability. The theoretical background in the fifth research paper deals with agile manufacturing, viewing IT as prerequisite. The principles and techniques for agility (e.g. Goldman & Nagel 1992, Yusuf *et al.* 1999, Ismail & Sharifi 2006) builds the context, but, the research explores the elements of agility in practice.

The paradigm of agile manufacturing is concerned with the ability of enterprises to cope with unexpected changes, to survive unprecedented threats from the business environment and to take advantage of changes as opportunities. It is the ability to produce a broad range of cost effective, high quality products with short lead times, in varying lot sizes and built to individual customer specifications as a means of surviving and prospering in the competitive environment of continuous and unpredictable change. The shift is towards proactivity and integration to identify the requirements of customers and acquire capabilities to compete in the turbulence of global market. The key elements are customer enrichment through mass customization, enterprise-wide cooperation for enhanced competitiveness, organizing change through routinely adaptable structures and leveraging the impact of people, information and technology in order to enhance organizational knowledge. Thus, the enablers of agile manufacturing are mass customization, empowerment of employees, manufacturing automation, supply chain networking and technology utilization. Gunasekaran (1999) proposed a research framework for design of agile manufacturing systems that includes four dimensions namely strategy, technology, people and systems. Achieving agility requires flexibility and responsiveness in all four dimensions.

4 Summary of papers

The summaries of the appended papers have been presented here. Also, the logical face that chains the papers together is presented including the contributions and the manner in which the findings fit concomitantly.

Paper I Managing the impact of ERP implementation on organization structure: A case study

This paper deals with the influence of ERP on the organization structure at a steel plant. The case offers a classic example of ERP implementation in mechanistic organization that actually fails to realize the benefits initially but undergoes transformation after the intervention of the top management and then finally turns around to align with the mandates of ERP system. It specifically highlights the factors that provide competitive advantage during implementation phase of ERP systems.

The companies adopted ERP systems in the first generations to capitalize on the benefits and later rushed to optimization without understanding the implications for strategy and structure. All attempts were typically aimed at achieving operational effectiveness precluding visionary developments. However, the competition and uncertainty of the marketplace might justify the management decisions. In the case company S, strong actions by the top management made the difference although the evolutionary change in the beginning seems to be a part of the whole process. The results show that ERP provides only a directive while actual management efforts and organizational initiatives focusing on business, not just technology, are key for sustainable advantage. The organization theory and change management theory has been utilized to understand the transition between structures. The contribution is clear in discussions of ERP implementation phase including the immediate demands made by ERP and specific management actions to be applied, built from reasoning of sociotechnical model and categorized as economic, political, moral, legal and cultural.

Paper II Teamwork in multisite ERP Implementation

This paper extends the work in first publication by considerations of increased complexities, second generation ERP and different industrial environment. The paper is exploratory in nature, uses case study methodology and expresses

elements of teamwork on virtual team's path towards becoming a high performing team. Again, it means that in the stabilization phase also sustainable competitive advantage has been attempted through operational effectiveness. But, the company FS shows inclination to aligning with ERP to provide uniqueness albeit dealing with barriers, sensitivities and questions arising as to the effects at individual and company level. The business strategies are knitted through ERP systems with stated course of providing high degree of integration, responsiveness and reducing costs. It should also be noted that there is a deliberation of multisite implementation converging to virtual teaming.

The inspiration for this paper came from studies of complex competitiveness models and project examples in a major telecommunications company. The approach cited is evolutionary when a case group aims to become high-performing team. The aspects of leadership, capability, commitment and networking have been discussed but no exclusive conclusions or validity beyond explored domain has been claimed.

Paper III Production planning through customized ERP at KPT Nordic

This publication is case of a Nordic company that has strived to create a sustainable differentiation by customizing the applications rather than adopting the standard ERP package. It focuses on production planning intricacies since they pose significant challenges in the environment KPT is operating wherein there is transformation from make-to-forecast operations to short lead time, make-to-order production emphasizing minimal stocks throughout the manufacturing process.

This research was conducted in collaboration with a major log house manufacturing company that utilizes the closed grained northern wood and sophisticated manufacturing technology to satisfy the needs of high quality construction for ecological and healthy living.

The company KPT Nordic could have selected reputed vendor package and met the requirements but, they preferred not to imitate their competitors and favoured the customization decision instead that made the solution more relevant to the company environment. The customized system enables efficient scheduling, realistic delivery promises and increased responsiveness. The configuration tools can model during feasibility and estimation phase and then translate the confirmed orders into releases. However, challenges persist with regards to attracting excellent human resources and making critical decisions.

The process of this case study itself was a substantial learning experience and I claim the results to be based on sound documentation and clear contribution.

Paper IV Developing a perspective on tackling the post implementation issues in ERP systems

Many organizations navigated through implementation stages of ERP system, some stabilized and derived reasonable benefits even reaching ERP II readiness, but then they were stranded by range of post implementation issues some of which threatened to erode the whole competitive advantage. This paper investigates the issues that arise in the post implementation phase of ERP systems, the purpose being to explore the measures that can be taken in advance to successfully tackle the issues and sustain the competitive advantage.

The idea of this paper came from a discussion with a senior manager of an automotive industry supplier firm. However, data collection proved to be difficult and slow process. I chose to apply combination of survey and case strategies with the hope of ameliorating the work to theory development level. I had surmises that this would be an interesting manifestation of how sustainability of advantages can be extremely gruelling.

The implications of the survey have been categorized as personnel, leadership, software vendor support and technical factors. The issues such as retaining ERP trained employees, developing reward schemes, software vendor agreements and new technologies, have been highlighted. I presented the paper at the International Symposium in Athens, Greece.

Paper V Agile manufacturing enablers for finnish steel products network

The manufacturers are forced to develop agile networks or employ agility tools in order to remain competitive in face of changing customer and technological requirements. IT is a requisite for agile manufacturing and ERP systems with supply chain management and customer relationship management capabilities have emerged as major drivers of integration.

The individual components such as mass customization, empowerment of employees, manufacturing automation, supply chain networking and technology utilization have been described in the paper as part of the review process followed by extensive empirical analysis.

The paper presents the results of the study aimed at identifying agile manufacturing enablers of competitive advantage. The intention is to explore whether the key elements of agility exist in practice and whether there is real impact on competitiveness and business performance. The survey research of exploratory type has been used and the analysis includes factor tests and regression. The paper builds on the previous studies conducted during the course of the larger SteelNet II research project.

4.1 Logical chain and contributions

As mentioned earlier in scope (see Fig. 3) and research design, the alternating point of view approach helps deepen understanding thereby revealing new features or effects along with contributions (see Table 5). At the same time, the utilization across periods causes the logical chain influence to move from narrower to wider perspective. This means that the aspects are naturally intertwined with each other although the research efforts for gathering the material are obligated to increased levels. Moreover, discerning the parts of the material in the final analysis towards the objectives of the thesis is demanding.

The exploratory study considered organization structure at inception enabling introduction of the subjects and identification of the different viewpoints. This reflected in the first paper that developed on the notions of technology thrust on structure. The paper revealed new aspects and variations based on operational effectiveness, consequently leading towards studies of more complex implementations. The paper II thus includes a multisite implementation that explores the distinct elements. The ERP field emerged further during this time, incorporating more sophisticated solutions. The organizations increasingly recognized the dynamics of supply networks with emergence of make-to-order production. The paper III contributes these experiences relating customized ERP and sustainable advantage. Research leads to the themes of e-business alliances for SMEs and so on that however cannot be elaborated here since the work in these streams is ongoing or cannot be revealed at this juncture. Moreover, companies are facing several difficulties categorized in the research outline (see Fig. 4) as barriers in the systems. The paper IV attempts to build understanding of post implementation issues. Further, in the uncertain market conditions, companies are aligning with the agile manufacturing philosophy marked as agility and sustainability in the outline. The paper V provides insights into the agile manufacturing practices and aims to identify agility enablers.

The maturity gain is from dealing with not just technology manoeuvre but putting together the information systems strategy with the company strategy. The competitive advantage in the cases from implementation stage bases on operational effectiveness but vindicates in each case the importance of the core strategy. The latter papers draw towards strategic positioning and this chain seems to strengthen as the research progresses. However, this also leads to the micro dynamics of networks, budding forms of collaboration, and so on. Here, I have only made the observation of the differentiation, the aspects remaining limited in the presented cases. Instead, the suggestion is to recognize openings in practicing hubs that have a declared mission of providing services in these spheres. The limitation of the research has been the extent of generalization possible with the results mostly valid for the cases concerned. Again, as in exploratory research the process of accumulating intelligence about the objects is gradual and therefore it is not about having all or exact research questions and definite concepts at the onset. Rather, it can be expressed as a journey in which solving the enigma leads to more questions and replicability is related to applying the case study theory in another set of conditions as discussed later in the reflections on the research process.

Table 5. Summary of research contributions.

#	Research Questions	Contribution	Research Effect
RQ1	How ERP implementation influences the structure of the organization?	<ul style="list-style-type: none"> - Builds understanding about organizational changes after ERP implementation - Projects the demands of ERP and management actions during the change process 	<ul style="list-style-type: none"> - Steers examination of more complex implementations - Factors affecting competitiveness
RQ2	How to control the evolving aspects in complex ERP implementation?	<ul style="list-style-type: none"> - Insights into the elements of multisite implementation - Experiences of team on path towards high performance 	<ul style="list-style-type: none"> - Generated questions about optimization practices for multiple sites with virtual teams - Aspects of competence based reward schemes, shared leadership and outsourcing
RQ3	How customized system can be preferential?	<ul style="list-style-type: none"> - Provides deeper understanding about customized system as a means for sustainable advantage - Experiences of ERP in the emerging MTO environment 	<ul style="list-style-type: none"> - Highlights the issue of ERP selection for SMEs - Themes of e-business alliances for SMEs and integrating RFID technologies and ERP systems
RQ4	How to deal with post implementation issues?	<ul style="list-style-type: none"> - Builds understanding of the post implementation problems - Experiences on measures taken in advance in ERP venture 	<ul style="list-style-type: none"> - Leads to questions on post implementation vision and factors of people focus and advanced networks - Competitive advantage by unique integration with business processes
RQ5	How agility elements impact competitiveness?	<ul style="list-style-type: none"> - Insights into agile manufacturing practices 	<ul style="list-style-type: none"> - Leads to questions about deploying enablers and innovative applications

5 Evaluation and discussion

This dissertation pursued the research objectives with exploratory research methodology aiming to develop significant insights about sustainable competitive advantage through ERP systems. The characteristics of this research lean towards generating more questions or new avenues although I have also regarded some theory development or rather descriptive exploration from my work.

Literature reviews were conducted and empirical research made feasible by collaboration with industries and interactions with researchers, managers and technology consultants. Both qualitative and quantitative aspects were considered and data collection accomplished through interviews, observations, manuals and so on. Case study and survey research practices were mainly applied with particular stress on credible documentation. Again, the intention was to appreciate the knowledge acquired through the studies rather than drawing rigid extensive conclusions. This would be maintaining the critical balance while eluding the critic about simply applying 'approved' methods ignoring the subjectivity (Gummesson 2000).

The outcome of this research traces the factors of competitive advantage in different stages of ERP and different industrial environments, shedding light on managing ERP as sustainable competitive resource. During the entire period of the study, ERP systems seem to provide competitive advantage or continued trend thereof, thus rejecting notions of commoditization and long-term dilution. The results in the appended papers indicate that ERP imparts either direct advantage or directive, depending on industry structure and levels. However, the basis of seeking the advantage or more appropriately the sustainability factors have shifted from operational effectiveness to differentiation to both, from ERP to e-business-e-strategy to strategy, from internal processes to zero-sum game to positive-sum game of supply chain partners for overall profitability, from data to visibility to improved decision-support in macro processes and from functional working success to synergistic knowledge-based management environment and innovation.

Here, I am expressing my reflections on findings, possible implications of the research work and finally some suggestions for the future.

5.1 Theoretical implications and discussion of the results

In the 21st century, the business environment is changing with organizations facing new extreme competition, new markets, changing technologies, demanding customers, loss of traditional leadership styles, uncertainty and unprecedented threats. There is tremendous pressure on manufacturers to provide better service to customers, greater variety, reliable delivery dates, short throughput time, efficient global coordination and lower total costs in the complete supply chain.

ERP systems have been a major information technology used by businesses today in hopes of gaining competitive advantage. After the initial ERP applications, some authors are claiming competitive convergence (see e.g. Carr 2003, Davenport *et al.* 2004) while others believe in the potential of ERP to build and sustain competitive advantage over time (Kalling 2003), with today's companies transforming to ERP II (Møller 2005) or building agile supply chains (see e.g. Hofman & Cecere 2005, Ismail & Sharifi 2006). Previous studies have focused on 'success' factors in ERP implementation, design, project phases or IT strategy while this thesis portrays the ERP in industry over time to explore sustainable competitive advantage and respond to the anxiety over the actual competitive value delivered by the ERP systems. Early in the research, I identified gaps between theory and practice that would enable academic contribution and acceptance of the academic community.

Paper I set out to elaborately investigate the impact of ERP on structure when many companies were not reaping the benefits of ERP as expected. On the basis of the case study alone, it is difficult to be certain about all factors affecting competitiveness however, there are subtle signs that competitive advantage through ERP system stems from directives of ERP rather than ERP in isolation. This means that at the time when ERP implementation was the basic step forward, companies were seeking operational effectiveness as the tool to trounce the rivals. The case shows that the ERP places demands on management for rewarding competence, empowering employees, training, etc and neither the flat structure emerges immediately nor the explicit steps to optimize the system result in particular advantages. The Nadler & Tushman model (1997) would have predicted leading a slow development process while some other theories denote radical enhancement. So, there is theoretical implication by the case analysis proposing tactic of evolutionary change followed by planned change. In the process industry and repetitive manufacturing sectors, the choice of vendor, technology, mindset of people about work, organization and strategy, and user

friendliness, all play an important role in building sustainable advantage. The top management vision and involvement is also significant for business context of the venture. The consolidation of this industry has implications for first-movers since the system provides competitive advantage based on the company integrating the system with its own processes to make it unique, the cost and time offset by benefits.

Many companies are becoming global and the multi-site ERP implementations offer specific challenges particularly with respect to teamwork, communications, decentralized units, commitment of site management, and so on. This is rendered in paper II wherein the stress is again on operational effectiveness although several other issues surface. The outsourcing of work to other countries raise questions about coordination, conflict of interests, interpersonal sensitivities, trust, data integrity and policy matters. In multi-site context, the local managers have to be knowledgeable and committed to the system. The sustaining of advantage may require decisions on redundant personnel, changing work processes and control. The suggestions of Markus, Tanis & Fenema (2000) and Aladwani (2001) in this regard are inclined to absolute leadership for ERP efforts but the study has indicated another alternative as shared leadership form with facilitator or mentor role for senior management. Moreover, the implication is that the companies have to look beyond ERP solution in order to build sustainable competitive advantage and this concurs with findings of paper IV that typifies post implementation hurdles. The study laments the lack of post implementation vision leading to difficulties in providing unique value proposition, upgradation and prioritization. So, reiterating that competitive advantage comes from the way the company implements the system and exploits the resulting data. The competitors will have ERP but it is useless if it is not integrated with the company's business processes as every business is unique and like any tool it is essential to know how to utilize it for it to be an asset.

Still, the competition with ERP systems is defined in terms of operational effectiveness. Porter (2001) pinpoints the importance of strategic positioning as it becomes harder to sustain solely on operational advantages. Packaged applications forced the companies to adapt, following arguments for conformance to best practices, but speeding competitive convergence. Therefore, sustainability could be ascribed to building integrated and customized system that reinforce fit among activities, tailoring deployment to particular strategies, as in the KPT Nordic case of paper III. Although a single case study cannot provide a whole basis, the findings demonstrate that customizing of applications remains difficult

but that difficulty of task itself could contribute to sustainability of competitive advantage. The extreme competition put pressure on managements to follow the market and in fact some companies implemented ERP just because their competitors had done so. But, it is essential to gain solid understanding of the ERP systems and benefits in relation to business expectations. This requires lot of efforts, allocation of resources, hiring consultants and substantial costs. Calori & Ardisson (1988) have moreover highlighted the total advantage approach for some sectors for example, process industries. Another aspect brought forward by the study is the transformation towards MTO environment with ERP vendors tuned to MTS conditions and further interesting developments in RFID technologies. This finding has to be taken into cognizance considering that the strategy level analysis and competitiveness investigations of MTO types has been relatively obscure more so with ERP and emerging labels of versatile or project based manufacturing (see e.g. Hayes & Wheelwright 1984, Amaro, Hendry & Kingsman 1999, Donselaar *et al.* 2001). So, for the present time, this research has voiced both operational effectiveness and strategic positioning together.

Organizations are increasingly recognizing agile manufacturing as necessary condition for competitiveness and development of agile networks is a progression. The advanced ERP solutions are essential components or indeed requisites in agility principles (see e.g. Song & Nagi 1997, Kehoe & Boughton 2001). The study in Paper V offers a broader extension aiming to identify agile manufacturing enablers of competitive advantage. The exploration in research environment of heavy engineering and steel product companies positively found the elements of agility but the practices had yet to impact at higher levels of business performance. However, with the limitation of sample size and external validity in this study may imply exigency to build on differentiation or face aggressive takeovers.

5.2 Managerial implications

For the industrial managers the implications of this research are two fold: to capitalize on the potential of ERP and comprehend the trends or profound impact of technological change on competitive advantages. In most industries ERP or advanced ERP II complements the companies' activities and ways of competing rather than overturning all critical corporate assets. So, the managers have to understand the business improvement opportunities and engage knowledgeable people to ensure strategic fit. Also, ERP systems can act as enabler of business

process innovation by the potential for enhanced knowledge capabilities. This however requires recognition of the opportunities as well as constraints (see e.g. Barki & Pinsonneault 2005, Jansen *et al.* 2005, Srivardhana & Pawlowski 2007). The argument is that the output and productivity impacts of new technologies can be long-delayed. Consequently, the buildup in knowledge is investment in intangible capital and that the productivity growth comes from effective utilization of the technology among other things. According to Baily (2004), the productivity is driven by innovation which may be strongly related to IT use. It is possible that the on-going digitalization and outsourcing of business processes may result in restructuring of white-collar work at the global level bringing in a new wave of productivity growth. Jalava & Pohjola (2007) suggest that the intelligent use of information is a source of increased productivity just as natural resources were in the twentieth century with the difference that the natural resources were tied to a certain place whereas information has no such restrictions and can be produced just as well in India, Russia, Estonia, as in Finland.

Table 6. Summary of implications.

#	Research Questions	Theoretical Implications	Managerial Implications
RQ1	How ERP implementation influences the structure of the organization?	- Proposition on tactic of evolutionary change followed by planned change	- Displacement of earlier skills and mindsets - Working in new organization structures with different political flavours and incentives.
RQ2	How to control the evolving aspects in complex ERP implementation?	- Need to encapsulate the combination of team characteristics and dimensions model. - Challenges of multiple sites with virtual teaming	- Engaging knowledgeable people who are committed to the system - Shared leadership form with facilitator or mentor role for top management
RQ3	How customized system can be preferential?	- Furthers strategy level analysis and developments in ERP for MTO environment - Tailoring applications to achieve sustainability	- Understanding of business improvement opportunities - Long term investment
RQ4	How to deal with post implementation issues?	- Strengthens idea of conceptualizing ERP implementation process as business project than installation of new software technology - Mechanism for moving through the ERP phases	- Post implementation vision - Comprehend the uniqueness and know-how for utilization of the system
RQ5	How agility elements impact competitiveness?	- Need for further research in additional settings to find out feasibility of other agility enablers and impact on business performance	- ERP as enablers of business process innovation

The case studies show that the integration has to meet the business needs and custom-built systems have to be created for the business processes. This would involve both leadership and significant investment. Managers have to prepare for working in new organization structures with different political flavours, incentives and controls. The older employees are likely to be affected since such changes displace earlier skills and mindsets. As the analysis suggests, it has become necessary to strive for not only operational effectiveness but also differentiation and therefore, uniqueness has to be delivered by the system. The

idea is not to imitate competitors but to tailor applications to the company’s overall strategy so as to extend competitive advantages and achieve sustainability. The technological strength lies in enhancing service, responsiveness and leveraging existing strengths. The table 6 summarizes the implications.

5.3 Reflections on the research process

The quality of research is often discussed on the basis of reliability and validity. These criteria are founded in the quantitative tradition although used for qualitative research as well.

The criticism targeting researchers who conduct case studies in operations management is about the rigor in research. But, the requisites namely controlled observations, controlled deductions, replicability, and generalizability, are simply means to obtaining rigor in research that cases studies achieve through different means (see Table 7).

Table 7. Methods to meet the requirements of rigor (Meredith 1998).

Type	Controlled observation	Controlled deduction	Replicability	Generalizability
Rationalism	Laboratory or statistics	Mathematics	Results	Assumptive
Case	Natural	Logic	Theory	Theoretic

According to Meredith (1998), the case/field focus on understanding is preferable for new theory development in operations management because eventually, the explanation of quantitative findings and the construction of theory based on those findings will ultimately have to be based on qualitative understanding. Yin (2003) presents the traditional criteria for judging the quality of research that he extends for case study research (see Table 8).

Reliability refers to the consistency of results obtained in the research. The goal of reliability is to minimize the errors and biases in a study. The prerequisite is documentation by protocols and established databases. However, Meredith (1998) claims that for case studies, because exactly the same case conditions never can be fully duplicated, replicability is attained by applying the resulting case study theory to a somewhat different set of conditions, which might very well result in a different prediction.

Internal validity refers to whether or not what is identified as the causes or stimuli actually produce what have been interpreted as effects or responses. So, it is more of concern for causal or explanatory studies. For exploratory studies it could be cited as part of a hypothesis generating process but the goal being not to conclude a study but to develop ideas for further study (Glaser & Strauss 1967). In case study analysis, the pattern-matching logic might prove more relevant, for example, if patterns coincide, the results can help strengthen its internal validity (Yin 2003).

External validity refers to the extent to which any research finding can be generalized or extrapolated beyond the immediate research sample or setting in which the research took place (Gill & Johnson 1997). The generalization approach could be statistical or analytical.

In the appended paper IV, analytic type drives inferences from the survey and case study findings to theory development. But, in paper V, it is difficult to judge the extent of generalization and the limitation of the study is lack of external validity. To claim that the results of the study are representative for all organizations would not be scientific.

Table 8. Evaluation criteria for case study research (Adapted from Yin 2003).

Element	Test	Case Study Tactic	Phase of research in which tactic occurs
Construct Validity	Establishing correct operational measures for the concepts being studied	- Use of multiple sources of evidence - Establishing chain of evidence	Data Collection
Internal Validity	Establishing causal relationship, whereby certain conditions are shown to lead to other conditions	- Pattern-matching - Explanation-building - Address rival explanations	Data Analysis
External Validity	Establishing the domain to which a study's finding can be generalized	- Use of theory in single-case studies - Use of replication logic in multiple-case studies	Research Design
Reliability	Demonstrating that operations of a study can be repeated, with the same results	- Documentation	Data Collection

Concerning the initial qualitative studies during this research, I have myself collected all the data and I believe that the results are interesting for both practitioners and academics.

The appended paper I has utilized pattern-matching as mode of analysis and high internal validity can be claimed. Also, multiple sources of evidence tactic have enhanced construct validity. The paper II is purely exploratory in nature proposing further work in the area of virtual networks while establishing a framework relevant to increasing competitiveness in progressive phases of ERP implementation.

5.4 Future research

The findings and limitations of this research suggest several areas for additional research. The drawback of sample size or necessity of more settings could be overcome to claim replication and serve as vehicle for theory generation. For instance, the Nordic company in paper III has certain inherent benefits that might be denied in other cases, resulting in inconsistencies and further evidence would be justified. Since the sustainable advantage lies in focusing on supply chain management macro processes, new prospect in research can consider improvement of decision making in these macro processes enabled by ERP systems. According to Chopra & Meindl (2007), the supply chain macro processes can be divided into supplier relationship management, internal supply and customer relationship management with all three having potential to drive the evolution of enterprise software. Also in order to bridge the information gap, two effective solutions of service oriented architecture (SOA) and business process management (BPM) tools have been introduced (Fingar 2006). With SOA, one premise is to build web access into each application to provide information on an enterprise level. This signifies an important step towards fully digital factory of the future. The key however is to develop company's competitive advantage through strategic ERP resources by absorbing the system in a unique manner without eroding the vital lead.

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