

Sami Jantunen

MAKING SENSE OF SOFTWARE PRODUCT REQUIREMENTS

Thesis for the degree of Doctor of Science (Technology) to be presented with due permission for public examination and criticism in the Auditorium of the Student Union House at Lappeenranta University of Technology, Lappeenranta, Finland on the 6th of June, 2012, at noon.

Acta Universitatis
Lappeenrantaensis 470

- Advisor Donald C. Gause
Research Professor, Bioengineering Department
Professor Emeritus, Systems Science and Industrial Engineering
Department
Thomas J. Watson School of Engineering and Applied Science
State University of New York at Binghamton, Binghamton, New York
13902, USA
- Supervisor Kari Smolander
Professor, Laboratory of Information Processing
Department of Information Technology
Lappeenranta University of Technology, Finland
- Reviewers Björn Regnell
Professor in Software Engineering
Department of Computer Science
Lund University
SE-221 00 LUND, Sweden
- Marjo Kauppinen
Professor (pro tem)
Software Business and Engineering Institute
Aalto University, Finland
- Opponent Alan M. Davis
Professor of Business Strategy and Entrepreneurship
University of Colorado at Colorado Springs
College of Business
Colorado Springs, CO 80918 USA

ISBN 978-952-265-217-1

ISBN 978-952-265-218-8 (PDF)

ISSN 1456-4491

Lappeenrannan teknillinen yliopisto

Digipaino 2012

Abstract

Sami Jantunen

Making Sense of Software Product Requirements

Lappeenranta, 2012

182 pages, 2 Appendixes

Acta Universitatis Lappeenrantaensis 470

Diss. Lappeenranta University of Technology

ISBN 978-952-265-217-1, ISBN 978-952-265-218-8 (PDF)

ISSN 1456-4491

One of the most crucial tasks for a company offering a software product is to decide what new features should be implemented in the product's forthcoming versions. Yet, existing studies show that this is also a task with which many companies are struggling. This problem has been claimed to be ambiguous and changing. There are better or worse solutions to the problem, but no optimal one. Furthermore, the criteria determining the success of the solution keeps changing due to continuously changing competition, technologies and market needs.

This thesis seeks to gain a deeper understanding of the challenges that companies have reportedly faced in determining the requirements for their forthcoming product versions. To this end, product management related activities are explored in seven companies. Following grounded theory approach, the thesis conducts four iterations of data analysis, where each of the iterations goes beyond the previous one. The thesis results in a theory proposal intended to 1) describe the essential characteristics of organizations' product management challenges, 2) explain the origins of the perceived challenges and 3) suggest strategies to alleviate the perceived challenges.

The thesis concludes that current product management approaches are becoming inadequate to deal with challenges that have multiple and conflicting interpretations, different value orientations, unclear goals, contradictions and paradoxes. This inadequacy continues to increase until current beliefs and assumptions about the product management challenges are questioned and a new paradigm for dealing with the challenges is adopted.

Keywords: market-driven requirements engineering, grounded theory, product management, wicked problems, sensemaking.

UDC 004.415:004.416.6:65.011.8:658.624:658.8

Acknowledgements

While working in industry, I faced challenges for which I could not find explanations. When I saw an emerging possibility to understand my past experiences better, I grasped the opportunity with no hesitation. It took me a while to complete the thesis, but I am now nearly there. One of the few tasks remaining is the pleasure to thank all of those who have helped me on the way.

The opportunity that initially made this thesis possible was the establishment of the Global Network Management (GNM) project. The research was then later continued in conjunction with the Product Internationalization with Firm-Hosted Online Communities (PROFCOM) project. I thank TEKES (Finnish Funding Agency for Technology and Innovation) for funding these two research projects. I also thank the industrial partners of these projects for their valuable participation. I am particularly indebted to people at Tekla, with whom I have had the privilege to collaborate closely throughout the entire thesis research.

I sincerely thank all members of the GNM project. Thank you Mika Ruokonen, Jussi Hätönen and Jani Lindqvist for being my nearest colleagues in conducting GNM project's research activities. Together we gathered a rich and extensive set of empirical data that was more than enough for the purposes of this thesis. I thank professors Sami Saarenketo, Niina Nummela and Olli Kuivalainen for their solid leadership during the GNM project.

I thank the members of the PROFCOM project for the three years of collaboration, during which I have had the possibility to learn about the challenges and opportunities of utilizing social media. You have helped me to understand better the steps I need to take when taking the results of this thesis towards more practical solutions.

I am forever grateful to Professor Donald C. Gause for his invaluable work as the thesis advisor. You have been truly a great source of insights and perfect for supporting the process of discovery. I wholeheartedly thank Professor Rex Dumdum, Raymond Barnes (Ph.D.), Associate Professor Eileen Way and Gil Regev (Ph.D.) for taking part in advising the thesis. I have truly enjoyed the dialogue with all of you in an atmosphere that has been filled with curiosity and mutual respect.

I thank the preliminary examiners of this thesis, Professors Björn Regnell and Marjo Kauppinen, for their valuable suggestions for improvement.

I express my gratitude to Professor Kari Smolander for all the help he has given as the thesis supervisor.

I thank Tiina Väisänen for revising the language of the thesis.

I gratefully acknowledge the financial support from Liikesivistysrahasto.

Finally, I want to express my gratitude to my family and friends, including my wife Terhi, our children Joel, Jalmari and Saara, my parents Taisto and Maija-Liisa, and my parents-in-law Timo and Ritva. Thank you all for being there for me through good times and bad.

Lappeenranta, April 2012

Sami Jantunen

Symbols and abbreviations

ADP	Automatic Data Processing
BSP	Basic Social Process
CPS	Creative Problem Solving Process
GNM	Global Network Management. The research project under which this research has been carried out.
IS	Information Systems
MDRE	Market-Driven Requirements Engineering
MIS	Management Information Systems
R&D	Research and Development
RE	Requirements Engineering
Tekes	Finnish Funding Agency for Technology and Innovation
RSS	Really Simple Syndication

List of publications that the thesis is partly based on

1. Jantunen, S & Smolander, K 2006, 'Towards Global Market-Driven Software Development Processes: An Industrial Case Study', paper presented to 28th International Conference on Software Engineering & Co-Located Workshops. The first International Workshop on Global Software Development for the Practitioner (GSD 2006), Shanghai, China, 23 May, 2006.
2. Jantunen, S & Smolander, K 2006, 'Challenges of Knowledge and Collaboration in Roadmapping', paper presented to International Workshop on Software Product Management (IWSPM'06 - RE'06 Workshop), Minneapolis/St.Paul, USA.
3. Jantunen, S 2010, 'Exploring Software Engineering Practices in Small and Medium-Sized Organization', paper presented to ACM/IEEE 32nd International Conference on Software Engineering. Cooperative and Human Aspects of Software Engineering Workshop (CHASE2010), Cape Town, South Africa.
4. Jantunen, S 2010, 'The Benefit of Being Small: Exploring Market-Driven Requirements Engineering Practices in Five Organizations', paper presented to 16th International Working Conference on Requirements Engineering: Foundation for Software Quality. RE in Small Companies Workshop (RESC), Essen, Germany, June 29th, 2010.
5. Jantunen, S, Smolander, K & Gause, DC 2007, 'How Internationalization of a Product Changes Requirements Engineering Activities: An Exploratory Study', paper presented to 15th IEEE International Requirements Engineering Conference (RE 2007), New Delhi, India, October 15-19th, 2007.
6. Jantunen, S & Saarenketo, S 2007, 'Exploring the Modes of Foreign Entry from the Product Development Viewpoint', paper presented to The R&D Management Conference, Bremen, Germany, 4-6 July, 2007.
7. Jantunen, S, Gause, DC & Wessman, R 2010, 'Making Sense of Product Requirements', paper presented to 18th IEEE International Requirements Engineering Conference (RE'10), Sydney, Australia, September 27th, 2010.
8. Jantunen, S, Lehtola, L, Gause, DC, Dum Dum, UR & Barnes, RJ 2011, 'The Challenge of Release Planning: Visible But Not Seen?' paper presented to 5th International Workshop on Software Product Management (IWSPM 2011) in conjunction with 19th IEEE International Requirements Engineering Conference 2011, Trento, Italy, August 30th, 2011.

I have been the primary author, having an overall responsibility, of all of the publications above.

Contents

PREFACE	11
INTRODUCTION.....	12
PART I: SETTING THE SCENE	16
1 The research area and its shaping	17
1.1 My professional background	17
1.2 The research project	19
1.3 Determining the research area.....	20
2 Approaching the research design	22
2.1 Research paradigms and perspectives	23
2.2 My position within the sociological paradigms.....	26
2.3 Research strategies	27
2.4 Methods of data collection and analysis	29
3 Focusing and bounding the collection of data.....	32
3.1 Development of research questions.....	32
3.2 Development of interview questions.....	34
3.3 Conducting interviews	35
3.4 Data management	37
4 Concluding remarks of PART I.....	39
4.1 Writing grounded theory	39
4.2 Summary	44

PART II: DATA ANALYSIS AND DISPLAY	45
5 Developing an initial understanding	46
5.1 Findings from an early case study	47
5.2 Conceptualizing the initial understanding	51
5.2.1 Sensing the market	51
5.2.2 Making sense of the market	53
5.2.3 Acting upon knowledge	54
5.3 Comparisons to the literature	56
5.4 Conclusions	63
6 Exploring the research area.....	65
6.1 Research process.....	66
6.2 Results.....	71
6.3 Characteristics of indigenous designer organization	73
6.4 Discussion.....	75
6.5 Conclusions	78
7 How internationalization of a product changes requirements engineering activities?	79
7.1 Research process.....	80
7.2 Results.....	82
7.2.1 Sensing the market	83
7.2.2 Making sense of the market	85
7.2.3 Acting upon knowledge	87
7.3 Discussion.....	87
7.4 Comparison to the literature.....	90
7.5 Conclusions	92
8 Making sense of software product requirements.....	93
8.1 Research process.....	93
8.2 Forty years of Tekla software.....	97
8.2.1 Phase 1: From punch cards to software products	98
8.2.2 Phase 2: Software product development.....	100
8.2.3 Phase 3: Towards collaborative product development	102
8.3 Towards a theory.....	103
PART III: CONCLUSIONS.....	111
9 Summary of the results.....	113
10 Integrating the literature	118
10.1 Release planning: state of the art.....	119

10.2	Reported challenges of release planning.....	122
10.3	The challenge of release planning: visible but not seen?	124
10.4	MDRE and the wisdom of the organization	127
10.4.1	Sensing the market	129
10.4.2	Making sense of the market	130
10.4.3	Acting upon knowledge	131
10.4.4	Conclusions	131
10.5	Towards supporting organizational cognition in RE	132
11	Assessing the proposed theory	139
11.1	What is a theory and how to evaluate it?	139
11.1.1	Fit.....	143
11.1.2	Understandability.....	144
11.1.3	Generality	144
11.1.4	Control	145
11.2	Evaluating trustworthiness.....	145
11.3	Assessing relevance.....	149
12	Research contribution and implications	151
12.1	Implications for further research.....	154
12.2	Implications for practice	156
	EPILOGUE.....	161
	REFERENCES	165

PREFACE

This thesis seeks to understand better the increasingly challenging design problem that many software product organizations face – the challenge of determining what new features should be implemented in the product’s forthcoming version. This challenge, primarily dealt with an activity of release planning, is often affected by complexities caused by social, cultural and organizational factors.

I have decided to approach the research area of release planning from a social perspective. I explore software product companies in order to understand how they plan for their product’s future and what challenges they experience. I have chosen an inductive research strategy, where the scope of the thesis and the understanding of what is the related literature, has evolved cautiously with each round of data analysis. Only in the final round of analysis have I been able to define what I believe this study is about and how the essence of the explored research area may be conceptually described. The data analysis has eventually resulted in a theory proposal, which has guided me to integrate it with an unanticipated range of literature.

Due to the inductive nature of the study, I have chosen to organize this report in a format that readily matches the order in which my discoveries have come together. While this research, as does all research, involves many critical decisions on the path to discovery and presentation, including the selection of voice, writing style, format and organization, all of which must be made explicit, I have delayed these discussions until section 4.1, after the research setting has been portrayed.

INTRODUCTION

One of the most crucial tasks for a company offering a software product is to decide what new features should be implemented in the product's forthcoming versions (Carlshamre 2002; Damian, D. E. & Zowghi 2003). This task is usually considered as the concern of requirements engineering (RE). RE as a field of study offers a multitude of methods, process models, and techniques that enable software development organizations to approach and execute requirements elicitation, specification, and management (Kotonya & Sommerville 2000). The main objective of the requirements engineering processes is to provide a model of what is needed in a clear, consistent, precise and unambiguous statement of the problem to be solved (Kotonya & Sommerville 1996). In essence, RE aims to transfer potentially incomplete, inconsistent and conflicting stakeholder goals into a complete set of high quality requirements (Aurum & Wohlin 2005).

Most RE research to date is devoted to handling requirements at the project level (Aurum & Wohlin 2005), where customers and users are regarded as informants and sources of requirements. Ideally, in RE, requirements are collected from these informants in negotiations and sessions for which RE offers a variety of requirements elicitation methods (Sommerville & Sawyer 1997). The elicited requirements are then analyzed, and a specification is produced and accepted by the customer. During the software development process, the requirements are managed in order to be able to show that the system or the software meets the specified requirements. Unfortunately, this idealized view of RE does not hold in practice. Even in the development of a single system, requirements engineering activities are a common source of failure (Bergman, King & Lyytinen 2002). The requirements, including their objectives, constraints, features, functions and priorities, are perhaps not agreed upon.

Furthermore, organizations may be incapable of agreeing politically about feasible requirements (e.g. Drummond 1998).

The traditional view of RE is somewhat limiting when considering software product development for markets (Aurum & Wohlin 2005). Supporting RE in software product development is considered as the primary concern of market-driven requirements engineering (MDRE) (Regnell & Brinkkemper 2005), which adds the marketing perspective to RE (Carlshamre 2002). In general, the MDRE processes can be seen as approaches to synchronize the continuous flow of candidate requirements and the work with the discrete release events (Regnell & Brinkkemper 2005; van de Weerd et al. 2006). Continuously incoming requirements are stored into a requirements repository that is dynamically evolving with past and recent data of varying types and levels of abstraction (Regnell & Brinkkemper 2005). The software is then developed in a series of releases as a result of product evolution, where new features are added and existing features are improved according to the advancement of the targeted market (Regnell & Brinkkemper 2005). Central activities in organizing the discrete release events are roadmapping and release planning. Roadmapping involves long term planning from diverse viewpoints, providing a layout of the product releases to come over a time frame of three to five years (Regnell & Brinkkemper 2005). The release planning is the activity of determining a feasible combination of dates, features, and resourcing for the next release of a software product (Penny 2002).

One of the keys in making the right decisions during the release planning activity is to prioritize between different alternatives (Berander & Andrews 2005). A multitude of requirements prioritization techniques have been developed for helping to identify the most valuable requirements by distinguishing the critical few from the trivial many (Berander & Andrews 2005). Yet, existing studies show that this is also a task with which many companies offering a software product are struggling. It has been claimed (Damian, D. E. & Zowghi 2003) that the prioritization and negotiation of customer requirements for a particular release is the most significant challenge of a global organization. Similar findings have also been presented by Lehtola et al. (2006) with a statement that “prioritization methods may have limited ability to support decision-making in a complex area like requirements prioritization in market-driven product development”.

Companies have become increasingly overwhelmed with the complexity of their design problem aiming at determining the best possible selection of features for the product's future releases. This problem has been claimed to resemble the characteristics of a wicked problem (Carlshamre 2002; Rittel & Weber 1973). There are better or worse solutions to the problem, but no optimal one (Carlshamre 2002). The criteria determining the success of the solution keep changing due to continuously changing competition, technologies and market needs. To make matters worse, the

complexity of the problem tends to increase over time. New customers may introduce new requests that may conflict with the needs of previous customers. Furthermore, in order to build a holistic basis for decision making, the customer's requirements need to be examined from different angles such as strategy, vision and competition. This complicates requirements prioritization even further.

Scope of the study

This thesis seeks to gain a deeper understanding of the challenges that companies have reportedly faced (Carlshamre 2002; Damian, D. E. & Zowghi 2003; Karlsson, Lena et al. 2007; Lehtola & Kauppinen 2006) in determining the requirements for their forthcoming product versions. To this end, product management related activities are explored in seven companies. The purpose of this thesis is to 1) describe the essential characteristics of organizations' product management challenges, 2) explain the origins of the perceived challenges and 3) suggest strategies to alleviate the perceived challenges.

This thesis concentrates on the cognitive aspects of moments when the organization is forming an understanding of the requested requirements and their potential value in order to decide which of the requirements shall be implemented to the forthcoming product versions. This problem area is explored with grounded theory research approach, which is oriented towards the inductive generation of theory from systematically gathered data. As the research has proceeded, the scope of the thesis has evolved from the *study of human aspects in software product companies' requirements engineering activities* into a study of *organizations' effort to adjust their problem-solving approaches to the changing design problem in order to make sense of what new product requirements are to be implemented*. Activities that occur after the release decisions are excluded from this thesis. Although related to the topic of this thesis, activities such as software configuration management and software design are thus out of scope.

Organization of the thesis

This is a qualitative study of exploratory nature. It does not start with a conceptual framework, but rather aims to end up with one (Miles & Huberman 1994, p. 298). It does not start with a ready set of research questions, but attempts to hasten slowly to understand what it is that I am trying to find out (Punch 1998, p. 38). It is a study where the literature coverage is deliberately delayed until directions emerge from the early analysis of data (Punch 1998, p. 43). So, how to begin reporting this study? It would surely be possible to follow the conventional structure that has long been familiar to quantitative researchers (something similar to: 1. *Statement of the problem*; 2. *Conceptual framework*; 3. *Research questions*; 4. *Methodology*; 5. *Data analysis*; 6. *Conclusions*; 7. *Discussion*). However, such a structure would, in this case, result in a report that is procrustean and forced (Miles & Huberman 1994, p. 298). As there are no

fixed formats to report a qualitative study (Miles & Huberman 1994, p. 299; Robson 2002, p. 507), I have been left with a number of choices including the voice, writing style, format and organization of the thesis (Miles & Huberman 1994, p. 300). While it is necessary to make these choices explicit, justifications for them cannot yet be presented. I will discuss the choices I have made in greater detail in section 4.1 after the research setting has been portrayed.

The thesis is divided into three parts. The first part (PART I: SETTING THE SCENE) describes how this research came into being. Part I is composed of four chapters. Chapter 1 describes factors that have affected the choice of study, discusses their role in shaping the research problem and, finally, determines the research area for this study. In chapter 2, the study is focused further by discussing how the research setting has been designed for this particular research area. Chapter 3 documents the substantive start of the research by discussing how the data collection has been focused, bounded and set up in practice. Finally, chapter 4 discusses first how the decisions on the research design have affected the documentation of this thesis and then summarizes PART I.

The second part (PART II: DATA ANALYSIS AND DISPLAY) describes the details of the data analysis phase by phase. Each phase constantly deepens the understanding beyond the previous analysis (Glaser, B. G. 1978, p. 6). Part II is composed of four chapters. Chapters 5 to 8 each illustrate one round of data analysis. The data analysis begins in chapter 5 by creating an initial understanding of the research area by exploring product management activities within one company. The data analysis is then taken into a larger scale in chapter 6. A total of 37 transcribed interviews from seven organizations are analyzed line by line. The similarities and differences between the organizations are then analyzed, leading to the identification of conceptual categories. Guided by the results of chapter 6, the data analysis then focuses on a particular topic of how product development challenges change when an organization begins to offer its product in a global marketplace (chapter 7). Finally, chapter 8 conceptualizes the findings further and proceeds to propose a theory.

The final part of this thesis (PART III: CONCLUSIONS) consists of four chapters. Chapter 9 summarizes the results. Chapter 10 integrates the results with existing literature. Chapter 11 assesses the credibility of this study. Finally, chapter 12 articulates the research contribution of this study and discusses their implications.

PART I: SETTING THE SCENE

"Not that the story need be long, but it will take a long while to make it short."
Henry David Thoreau, 1817 - 1862

1 The research area and its shaping

This chapter describes factors that have affected the choice of study, discusses their role in shaping the research problem, and finally, determines the research area for this study.

If I had to single out the most significant factor motivating this study, I would say that it is my past professional experience. For this reason, I begin this chapter by revealing portions of my history (section 1.1). This is not only important because it provides an introduction to the research topic. It is also the starting point to address my prejudices in developing the research results, a difficult issue that is further expanded in section 4.1.

Research becomes a reality only after the motivation meets the opportunity. Therefore, I will continue this chapter by describing the research project, Global Network Management (GNM), which not only made this thesis possible, but also set boundaries to it (section 1.2). Finally, I will end this chapter by shaping the research area and summarizing the key properties of this study that are likely to affect the research design (section 1.3).

1.1 My professional background

I consider myself to be a software engineer. My professional history began in 1996 when I joined a small software development company, Acta Systems. I was hired to be a subcontractor developing software to a much larger company, Valmet Automation. I took part in a multi-project software development effort attempting to build a new

generation automation and information platform for large process industry plants. Being located in Helsinki, I was physically separated from most of my colleagues. Valmet Automation was based in Tampere and most of Acta Systems' employees were located in Oulu. Collaboration occurred largely by e-mail, telephone, written specifications and occasional face-to-face meetings. I did not find such a distributed setting problematic. I always felt that I was part of the team and that communication was not an issue.

I was initially trained to follow a software development process, adopting its ideas from object-oriented development with OMT++ (Aalto & Jaaksi 1994) and the waterfall model (Royce 1970). At that time, I firmly believed that following such a process was the proper and professional way of developing software. However, my opinions with respect to software development have shifted since then.

My responsibilities changed significantly in January 1999. I stayed in Acta Systems but moved to China to head a newly founded software development unit in Beijing. Our task was to develop software according to the requirements originating from the Acta Systems headquarters in Finland. Even though the software development processes did not change significantly, I started to meet challenges that were new to me. I soon found myself to be a moderator between us-the developers and them-the customers. This was an indication that there are much more human nuances in software development that I had thought there to be.

In summer 2001, I joined Comptel Communications and moved to Kuala Lumpur, Malaysia. My new assignment was in many ways similar to my previous one. I was still heading a software development unit, working for Finnish-based headquarters. Furthermore, both of the companies had a similar systematic approach to software development. Perhaps the most notable change was that my new employer was developing software products to be sold worldwide. This change in the software development environment was significant enough to open my eyes. I remember often wondering why so many important product-related design decisions were left to be made by the software developers. To me, this was rather odd because the software developers almost never visited the customers and thus did not know the intended use of the product well. It appeared to me that in the quest of being efficient, the organization actually systematically ignored most of the knowledge it possessed. I gradually started to believe that sometimes the way we develop software fits very poorly with the design challenge. We seem to have a tendency to take software development processes for granted and accept it to be 'the professional way' without much criticism.

These moments in my past tell a short tale of how I have turned from a person firmly believing in the efficiency of the software development processes into a one that is critical and doubtful. This is also a story sufficient enough to introduce the

phenomenon I am motivated to understand better at a broad level. I want to gain a deeper understanding of why current software development approaches do not seem to work well in certain situations. At this point, it is not desirable to focus my research interest any further. Emerging research opportunities and early research results will guide me to do that when the moment comes.

I joined Lappeenranta University of Technology in autumn 2003. I became a member of a two-year research project studying more than 80 software development companies in South-east Finland (Katapultti project 2005). While this research project gave me a broad overview of software development practices across a large number of companies, the research results did not change my beliefs.

Then, finally, the research opportunity for this thesis emerged.

1.2 The research project

In 2005, I joined the Global Network Management (GNM) research project. The GNM project was organized in cooperation with Lappeenranta University of Technology and Turku School of Economics and funded by the Finnish Funding Agency for Technology and Innovation (TEKES) and twelve industrial partners. The three-year project lasted from May 2005 to February 2008. The objectives for the GNM project were 1) to investigate how a company can create and maintain successful business in a global environment that is based on technology, knowledge and partnerships and 2) to increase possibilities for successful business by transferring the research results to the companies in the form of best practices (GNM project 2006).

I saw the GNM project as the opportunity I had been looking for. After working for many years in relatively isolated development units, I was delighted to join a research project that was multidisciplinary. As I was looking for a more holistic understanding of how companies organize their activities, I now had the possibility to broaden my understanding towards the topics of marketing, partnerships, strategies and outsourcing. Furthermore, the GNM project focused on studying companies that had recently internationalized their business activities or were on their verge of internationalization. Working in the past within such companies has had the most significant impact on my beliefs towards software development. Therefore, I believed that the companies taking part in the GNM project were a very fruitful place to start my research.

Being part of the GNM research project, I have been bounded and guided by the project-level objectives. From the GNM project's four research themes, my focus has been on research & development (R&D) and product management while investigating

their relation to partner network management and business (Figure 1). These responsibilities in the GNM project fit well with my motivation to understand why current software development approaches do not seem to work well in certain situations.

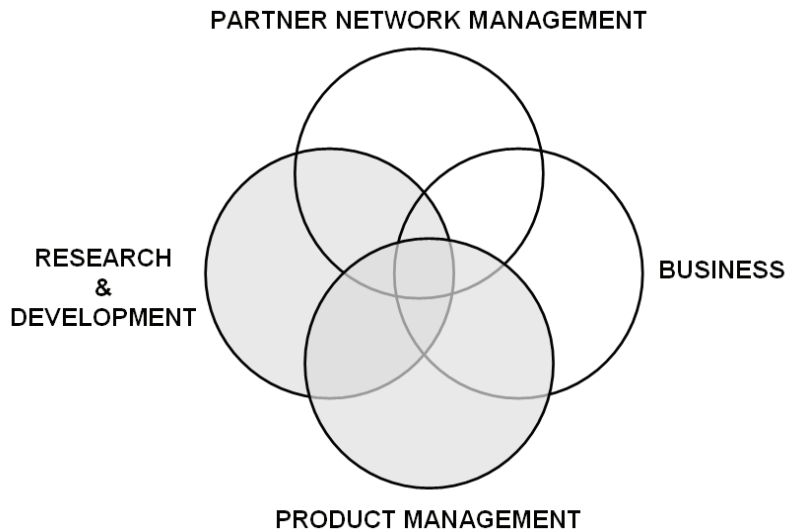


Figure 1. My research focus in the GNM project (grayed)

1.3 Determining the research area

Both my background and the research opportunity have played a significant part in determining the research area of this study.

The GNM project has guided me to focus on the topics of R&D and product management. This situates this study within the discipline of requirements engineering (RE), which operates at different levels, including the organizational, product and project levels, and is concerned with the critical problem of designing the right software for the customer (Aurum & Wohlin 2005).

As my past professional experiences have made me critical and doubtful of the efficiency of existing software development approaches, I have started to believe that there are much more human nuances in software development than are currently acknowledged. This is why I have decided to focus on human behavior in software development. Consequently, I decided to draw upon the social sciences research tradition when designing this study. Relying on the methods of social sciences when dealing with RE research has recently been strongly advocated (Gause 2004).

Taking into account the factors affecting this study, the research area is now determined to be:

human aspects in software product companies' requirements engineering activities.

Framing this study in terms of research questions still depends on how the actual research setting is designed. This will be discussed in greater detail in the following chapter.

2 Approaching the research design

Research design is about finding an appropriate fit between the components of a research effort, such as the paradigm, the research questions, the study design, the data collection procedures and the data analysis procedures (Easterbrook et al. 2007; Edmondson & McManus 2007; Lincoln & Guba 2000; Punch 1998, p. 22). Therefore, in order to make the assessment of this research effort possible, I need to reveal a far broader landscape of the research context than just the practicalities of the research setting. Denzin and Lincoln (2000) have suggested five phases for defining a research process:

1. *The researcher's position within the research tradition.*
2. *Research paradigms and perspectives.*
3. *Research strategies.*
4. *Methods of data collection and analysis.*
5. *Interpretation and presentation of findings.*

I will address each of the phases as follows. I will first provide an overview of research paradigms and perspectives (section 2.1) in order to define my position within the research tradition (section 2.2). Next, I will discuss how my choice of research paradigm has affected the choice of research strategy for this study (section 2.3). I will continue by describing what methods of data collection and analysis the chosen research strategy implies (section 2.4). The interpretation and presentation of findings will be discussed later in section 4.1.

2.1 Research paradigms and perspectives

Beliefs limit what people see and how they inquire (Weick 1986). All scientists approach their subject via explicit or implicit assumptions about the nature of the world and the way in which it may be investigated (Burrell & Morgan 1979). The most fundamental set of assumptions adopted by a professional community that allows its members to share similar perceptions and engage in commonly shared practices is called a 'paradigm'. Typically, a paradigm consists of assumptions about knowledge and how to acquire it, and about the physical and social world (Hirschheim, R. & Klein 1989).

Existing literature (e.g. Burrell & Morgan 1979; Creswell 1998; Deetz 1996; Lincoln & Guba 2000) recognizes numerous ways of distinguishing and labeling paradigms. I have chosen to approach this topic with Burrell and Morgan's framework (1979) because it focuses on social science and is intended to map one's own personal frame of reference with regard to social theory. Burrell and Morgan (1979) claim that it is convenient to map paradigms along two dimensions: *subjective-objective* and *regulation-radical change*. The authors have further decomposed the subjective-objective dimension into debates of ontology, epistemology, human nature and methodology as follows (Figure 2):

The subjective-objective dimension

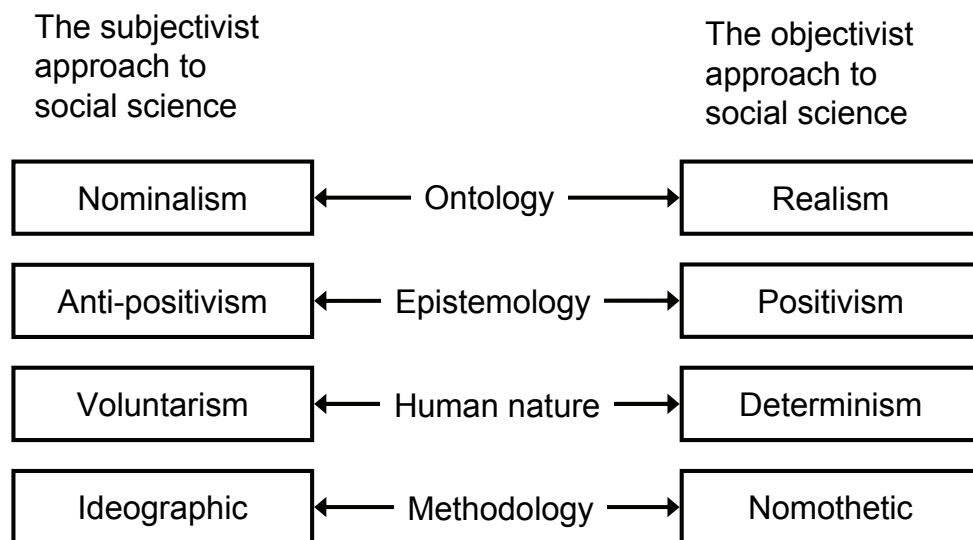


Figure 2. A scheme for analyzing assumptions about the nature of social science (Burrell & Morgan 1979)

The ontological debate revolves around the issue of what the nature of reality is. At one extreme, the *nominalist* position assumes that the social world external to individual cognition is made up of nothing more than names, concepts and labels which are used to structure reality. *Realism*, on the other hand, postulates that the social world external to individual cognition is a real world made up of hard, tangible and relatively immutable structures. For the realist, the social world has an existence which is as hard and concrete as the natural world (Burrell & Morgan 1979).

The epistemological debate focuses on the relationship between the researcher and that being researched. *Positivists* seek to explain and predict what happens in the social world by searching for regularities and causal relationships between its constituent elements. Positivist epistemology is in essence based upon the traditional approaches which dominate the natural sciences. The growth of knowledge is essentially a cumulative process in which new insights are added to the existing stock of knowledge and false hypotheses eliminated. For the *anti-positivist*, the social world is relativistic and can only be understood from the point of view of the individuals who are directly involved in the activities which are to be studied. From the anti-positivist point of view, social science is seen as essentially a subjective rather than an objective enterprise (Burrell & Morgan 1979).

The human nature debate relates to discussions of what model of man is reflected in any given social-scientific theory. At one extreme, we can identify a *determinist* view which regards man and his activities as being completely determined by the situation or 'environment' in which he is located. At the other extreme, we can identify the *voluntarist* view that man is completely autonomous and free-willed (Burrell & Morgan 1979).

The methodological debate has important consequences for the way in which one attempts to investigate and obtain 'knowledge' about the social world. Different ontologies, epistemologies and models of human nature are likely to incline social scientists towards different methodologies. The possible range of choice is indeed so large that what is regarded as science by the traditional 'natural scientist' covers but a small range of options. In this debate, the *ideographic approach* is based on the view that one can only understand the social world by obtaining first-hand knowledge of the subject under investigation. It thus places considerable stress upon getting close to one's subject and exploring its detailed background and life history. The ideographic method stresses the importance of letting one's subject unfold its nature and characteristics during the process of investigation. The *nomothetic approach* to social science lays emphasis on the importance of basing research upon a systematic protocol and technique. It is epitomized in the approach and methods employed in

the natural sciences, which focus upon the process of testing hypotheses in accordance with the canons of scientific rigor (Burrell & Morgan 1979).

The *regulation-radical change* dimension in Burrell and Morgan's (1979) framework relates to assumptions about the nature of society. The *sociology of regulation* is essentially concerned with the need for regulation in human affairs; the basic questions which it asks tend to focus upon the need to understand why society is maintained as an entity. The *sociology of radical change* stands in stark contrast to the sociology of regulation in that its basic concern is to find explanations to the radical change, deep-seated structural conflict, modes of domination and structural contradiction which its theorists see as characterizing modern society. It is a sociology which is essentially concerned with man's emancipation from the structures which limit and stunt his potential for development. The basic questions which it asks focus upon the deprivation of man, both material and psychological. The distinction between these two sociologies can perhaps be best illustrated in schematic form (Table 1).

Table 1. The regulation-radical change dimension (Burrell & Morgan 1979).

<i>The sociology of REGULATION is concerned with:</i>	<i>The sociology of RADICAL CHANGE is concerned with:</i>
a) The status quo	a) Radical change
b) Social order	b) Structural conflict
c) Consensus	c) Modes of domination
d) Social integration and cohesion	d) Contradiction
e) Solidarity	e) Emancipation
f) Need satisfaction	f) Deprivation
g) Actuality	g) Potentiality

The subjective-objective and regulation-radical change dimensions define four distinct sociological paradigms: *radical humanist*, *interpretive*, *radical structuralist* and *functionalist* (Figure 3).

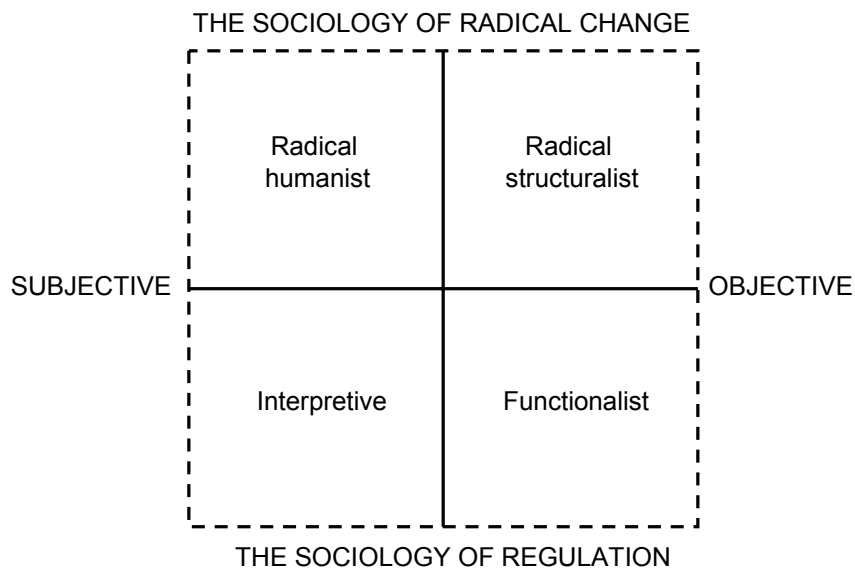


Figure 3. Four sociological paradigms (Burrell & Morgan 1979)

These paradigms define fundamentally different perspectives for the analysis of social phenomena. They approach this endeavor from contrasting standpoints and generate quite different concepts and analytical tools.

This overview of Burrell and Morgan’s work (1979) will be utilized in the following section to locate my position within the research tradition.

2.2 My position within the sociological paradigms

I am not dogmatic in the choice of a paradigm. Instead, I believe that the choice of paradigm is closely dependent of the research problem. As the research area in this thesis is to gain a deeper understanding of human aspects in software product companies’ requirements engineering activities, it is relatively easy to situate myself along the subjective-objective dimension. In this research effort, I am inclined towards the subjective end of the spectrum. In other words, I see the research area to be situated in a social world that tends to be *nominalist*, *anti-positivist*, *voluntarist* and *ideographic*. The regulation-radical change dimension is slightly more difficult for me. Even though I found interpretivists’ desire to understand the essence of the everyday world appealing, I see many things unnatural in current software development approaches. Therefore, I situate myself, with hesitation, within the *radical humanist paradigm*, which has an interest to be released from the constraints which existing

social arrangements place upon human development and to provide critique of the status quo (Burrell & Morgan 1979).

2.3 Research strategies

The choice of a research paradigm has an effect on what type of research approach is suitable for a particular research effort. As I situate myself within the radical humanist paradigm, I have a tendency to favor the subjectivist approach to social sciences. Furthermore, as a radical humanist, I tend to believe that existing theories do not provide a sufficient explanation to the phenomenon I want to study. When comparing my choice of a research paradigm with Järvinen's (2008) classification of research approaches, this research effort can be defined as one that attempts to understand what is reality with a theory-developing and empirical approach (Figure 4). Such a research approach fits with the research area defined earlier as *the human aspects in software product companies' requirements engineering activities*.

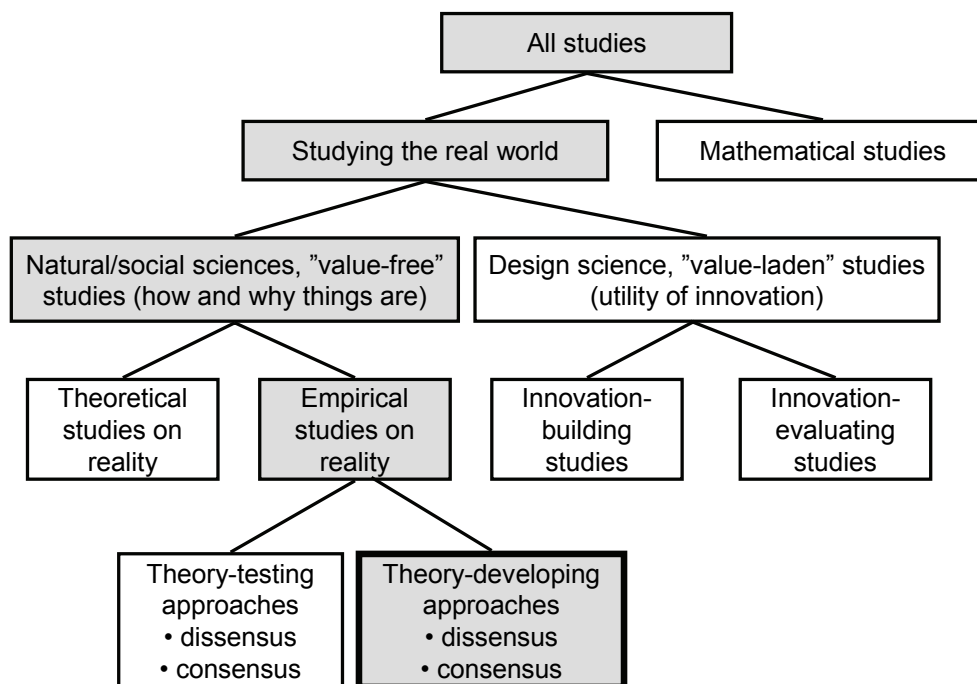


Figure 4. Järvinen's classes of research approaches (Järvinen 2008). Selected approach for this study grayed.

The choice of theory-creating approaches typically suggests qualitative research (Punch 1998, p. 16). The principal advantage of using qualitative methods is that they force the researcher to delve into the complexity of the problem rather than abstract it away. Thus, the results are richer and more informative (Seaman 1999). However, even though the choice for my research approach is now considerably narrowed down, I am still left with a number of approaches to choose from: the ethnographic method, grounded theory, phenomenography, contextualism and discourse analysis, to name a few (Järvinen 1999).

I have decided to choose grounded theory as the research approach for this study because it fits with the nature of the research problem and my background. Grounded theory approach has been claimed to be an effective and appropriate way of researching emerging phenomena in their own organizational and human context (Locke 2001, p. 95; Orlikowski 1993), valuing the professional experience of the researcher (Locke 2001, p. 95; Strauss & Corbin 1990, p. 46). Choosing grounded theory as a research approach comes with risks. Potential problems in following grounded theory approach have been reported to be (Robson 2002, p. 192; Seldén 2005): 1) the impossibility to avoid pre-existing theoretical ideas and assumptions, 2) tensions between the evolving and inductive style of a flexible study and the systematic approach of grounded theory, 3) difficulties in practice to decide when categories are 'saturated' or when the theory is sufficiently developed, 4) existing prescribed categories of the theory which may not appear appropriate for a particular study, and 5) the break from context during the early steps of analysis.

Grounded theory approach was developed in the early 1960s by Barney Glaser and Anselm Strauss. Glaser and Strauss came together at a time when they had in common a strong dissatisfaction with the nature of theorizing that prevailed in sociology. Glaser and Strauss also shared a conviction that theory needed to be intimately connected to rich observational data (Locke 2001, p. 29). The development of grounded theory approach was their reaction against the exclusive insistence on theory verification research, especially in the American sociology of the 1950s (Punch 1998, p. 166).

A formal description of grounded theory approach, *The Discovery of Grounded Theory* (Glaser, B. & Strauss 1967), was published in 1967. As originally stated, Glaser and Strauss characterized this research approach as one oriented towards the inductive generation of theory from data that has been systematically obtained and analyzed (Glaser, B. & Strauss 1967, p. 1). The research process they articulated provided the means to achieve the development of more empirically grounded theories of everyday action in context (Locke 2001, p. 30).

Grounded theory's distinctive feature is its commitment to research and 'discovery' through direct contact with the social world studied coupled with a rejection of *a priori*

theorizing (Locke 2001, p. 34). The rejection of pre-conceived theories is argued vehemently by the originators in the original monograph specifically because, as Glaser and Strauss claim, such theories have the effect of obstructing the development of theory by coming between researchers and the subjects of their study. When this eschewal of pre-existing theories is combined with an emphasis on research and 'discovery', it results in a conception of knowledge as *emergent*. Knowledge is composed by researchers in the context of investigative practices that afford them intimate contact with the subjects and phenomena under study (Locke 2001, p. 34).

2.4 Methods of data collection and analysis

Grounded theory is both a strategy for research and a way of analysing data (Punch 1998, p. 163; Robson 2002, p. 191). This section deals with the basic ideas of following grounded theory procedures for collecting and analysing data. The details on how these basic ideas have been followed in practice are documented in Part II.

The basic process of grounded theory approach is depicted in Figure 5 (Wagner, Lukassen & Mahlendorf 2010). Grounded theory approach is built upon two key concepts: *constant comparison*, in which data are collected and analyzed simultaneously, and *theoretical sampling*, in which decisions about which data should be collected next are determined by the theory that is being constructed (Glaser, B. & Strauss 1967, p. 45). Both concepts violate longstanding positivist assumptions about how the research process should work. Constant comparison contradicts the myth of a clean separation between data collection and analysis. Theoretical sampling violates the ideal of hypothesis testing in that the direction of new data collection is determined, not by a priori hypotheses, but by ongoing interpretation of data and emerging conceptual categories (Suddaby 2006).

The contradicting characteristics of grounded theory approach against what has dominantly been considered as the conduct of good science does not mean that grounded theory approach lacks rigor. Grounded theory sets down a stringent regime of rigorous steps for the interpretation and presentation of findings (Fernández, Lehman & Underwood 2002; Glaser, B. G. 1978, p. 2).

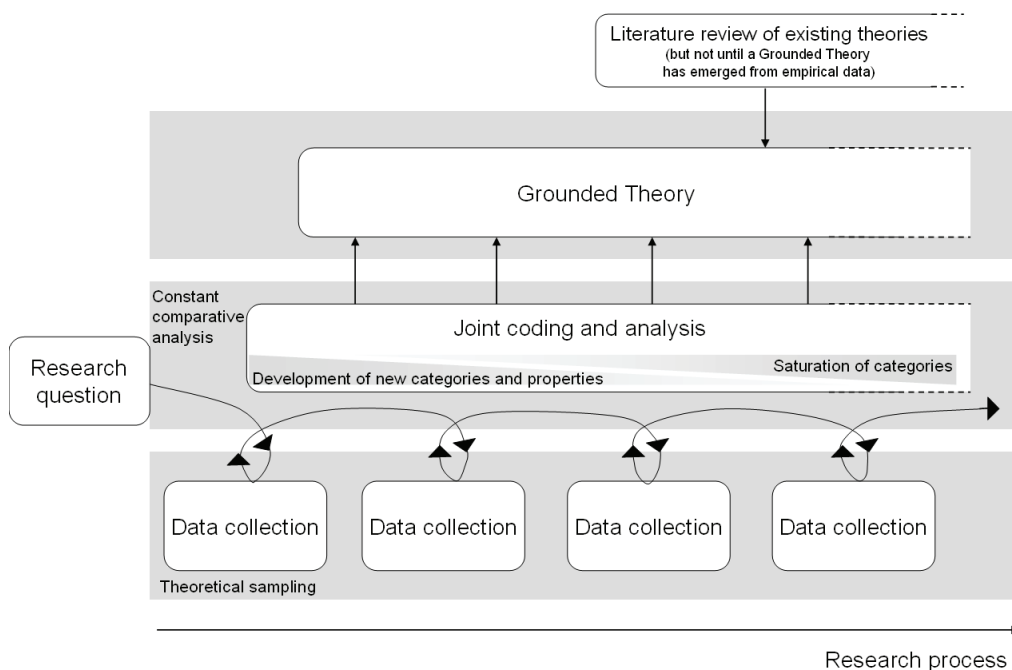


Figure 5. Basic process of grounded theory approach (Wagner, Lukassen & Mahlendorf 2010)

A grounded theory study involves going out into the ‘field’ and collecting data (Robson 2002, p. 191). Interviews are the most common data collection method. However, other methods such as observation and the analysis of documents can be and have been used together with grounded theory analysis (Robson 2002, p. 191). The set of research practices that comprise grounded theory style of research are designed to help researchers make the move from gathered data to composing conceptual categories and to delineating the ways in which the categories relate to each other (Locke 2001, p. 37). The language that Glaser and Strauss use to describe theoretical accomplishments includes the terms, ‘categories,’ ‘core categories,’ ‘properties,’ and ‘generalized relations’ or ‘hypotheses.’ From their perspective, a grounded theory is made up of a number of conceptual categories that are organized in terms of their relationship to each other (Locke 2001, p. 39).

Central to grounded theory analysis are two basic operations, *coding* and *memoing*. Coding is an operation by which data are broken down, conceptualized, and put back together in new ways (Strauss & Corbin 1990, p. 57). While coding is considered as a way of analyzing, at a concrete level it can be defined as the process of putting tags, names or labels against pieces of the data (Robson 2002, p. 493). The second basic operation, memoing, links coding with the development of propositions (Punch 1998,

p. 207). A memo is the theorizing write-up of ideas about codes and their relationships as they strike the analyst while coding, constantly comparing, coding and analyzing (Glaser, B. G. 1992, p. 108). Memoing is essential, for without it the researcher would have no written record of his or her analysis (Glaser, B. G. 1978, p. 89).

The essential idea in discovering a grounded theory is to find a core category, at a high level of abstraction but grounded in the data, which accounts for what is central in the data (Punch 1998, p. 210). This is done in three stages (Robson 2002, p. 493):

1. *find conceptual categories in the data;*
2. *find relationships between these categories;*
3. *conceptualize and account for these relationships through finding core categories.*

Interestingly, at this point in time, just what constitutes grounded theory is by no means an unequivocal or an uncontested issue (Locke 2001, p. 2). Grounded theory has evolved and adapted as its research practices have been further articulated and extended by its originators, their students, and other methodologists who have taken up this style of inquiry (Locke 2001, p. 2). However, these subsequent texts (Glaser, B. G. 1978, 1992; Strauss & Corbin 1990) also express key differences in the authors' styles of processing grounded theory approach. Generally speaking, Glaser's interpretation of the necessary operational practices tends towards more openness, flexibility, and more parsimony in the elaboration of necessary analytic steps. Strauss' interpretation of the approach, on the other hand, tends towards increased prescription and formal elaboration of operational procedures (Locke 2001, p. 64). It has been claimed that every researcher who chooses to use grounded theory as a research methodology should investigate this divergence between the founders of grounded theory critically (Goede & de Villiers 2003; Smit 1999). My stance to such divergence is similar to that of Goede and de Villiers (2003): While the methods of Strauss and Corbin can be very helpful in organizing one's data and strengthening the scientific value of the emerging theory, coding procedures should not overshadow the influence of creativity of the original grounded theory concept. For this reason, I have deliberately chosen to avoid labeling the steps of analysis for this study according to the widely popular coding procedures proposed by Strauss and Corbin (1990):

1. *open coding* to find the categories;
2. *axial coding* to interconnect them; and
3. *selective coding* to establish the core category or categories.

Even though I have sought advice from Strauss and Corbin (1990) whenever applicable, I feel that using their terminology would diminish Glaser's point of view (1992) and give the false impression that I have explicitly chosen to follow the approach proposed by Strauss and Corbin.

3 Focusing and bounding the collection of data

Even though there is merit in open-mindedness and willingness to enter a research setting looking for questions as well as answers, it is impossible to embark upon research without some idea of what one is looking for and foolish not to make that quest explicit (Wolcott 1982, p. 157). This chapter documents the substantial start of the research effort.

I begin this chapter by drafting an initial set of research questions (section 3.1). As almost all data for this thesis has been collected as part of the GNM project (section 1.2), I then continue by describing how the objectives of this thesis have been aligned with the project-level objectives in terms of interview questions (section 3.2) and case selection (section 3.3). Finally, section 3.4 describes how the gathered data has been managed in practice.

3.1 Development of research questions

The role of the research problem and research questions has been a source of debate between the originators of grounded theory approach. Strauss and Corbin (1990, p. 34) advise to begin the grounded theory study by defining a research problem. However, Glaser argues that the grounded theory researcher moves into an area of interest with *no* problem. He or she moves in with the abstract wonderment of what is going on that is an issue and how it is handled (Glaser, B. G. 1992, p. 22). The underlying principle in grounded theory which leads to a researchable problem with a high yield and relevance is that the research problem and its delimitation are discovered or

emergent as the open coding begins in the first interviews and observations (Glaser, B. G. 1992, p. 21).

The debate on the role of the research question takes a similar course. According to Strauss and Corbin (1990, p. 38), the research question in a grounded theory study is a statement that identifies the phenomenon to be studied, telling what you specifically want to focus on and what you want to know about this subject. Glaser argues that: "the research question in a grounded theory study is *not* a statement that identifies the phenomenon to be studied. The problem emerges and questions regarding the problem emerge by which to guide theoretical sampling. Out of open coding, collection by theoretical sampling, and analyzing by constant comparison emerge a focus for the research" (Glaser, B. G. 1992, p. 25). There is benefit to 'hastening slowly'. Since research questions do not usually come out right the first time, several iterations are often required, and we only reach an answer to the question 'what are we trying to find out?' after careful thought (Punch 1998, p. 38).

Even though I have chosen a highly inductive research strategy, I have taken the advice by Miles and Huberman (1994, p. 25) to start with some general research questions. General research questions allow making it clear what is, generally speaking, of most interest. They make the implicit explicit without necessarily freezing or limiting my vision (Miles & Huberman 1994, p. 25). Defining initial research questions at this phase was particularly important due to the fact that the data for this thesis was gathered as part of the GNM project. It was hence necessary to align the data gathering activities with the other researchers of the GNM project.

I begin the formulation of research questions with the research area that was defined in section 1.3 as *human aspects in software product companies' requirements engineering activities*. In my quest of deriving research questions from the research area statement, I have focused on three constraints originating from the research area definition:

First, the research area statement implies that I am working with companies offering a *software product*. This suggests that I need to understand mechanisms of how companies gather information about the markets and how they utilize the gathered information in their product development.

Second, the emphasis on *human aspects* suggests focusing on human interaction in order to understand how collaboration occurs in the companies and how information is shared with different parties.

Third, *requirements engineering activities* leads me to investigate companies' current requirements engineering practices and the challenges of following them.

Taking these considerations into account, my initial set of research questions have been defined as:

1. How can the role of human interaction be described in organizations' attempt to position their software product in the marketplace?
 - a. How do software product development organizations develop understanding regarding the market?
 - b. How do software product development organizations utilize the understanding regarding the market in their product development?
 - c. What are the challenges faced by the software product development organizations?
2. How can organizations' attempt to position their software product in the marketplace be supported?

3.2 Development of interview questions

It was decided within the GNM project that data is primarily gathered with semi-structured interviews. A semi-structured interview has predetermined questions, but the order can be modified based upon the interviewer's perception of what seems most appropriate. Question wording can be changed and explanations given; particular questions which seem inappropriate with a particular interviewee can be omitted, or additional ones included (Robson 2002, p. 270). This decision fit well with the objectives of this thesis because semi-structured interviews have been found to be particularly suitable in situations where a study focuses on the meaning of particular phenomena to the participants and where individual perceptions of processes within a social unit – such as a work-group, department or whole organization – are to be studied prospectively, using a series of interviews (Robson 2002, p. 271). In addition to the interviews, documents relevant to the interview topic were gathered. In the case of this thesis, such secondary data included organizational charts, product development related memos, process descriptions and design artefacts.

The companies taking part in the GNM project were explored from several perspectives. A set of interview questions was developed on the topics of business, internationalization, juridical issues and partnerships. Such a holistic exploration of each company has helped in building a rich understanding of the context in which the phenomenon under study has been situated. The questions relevant to the research questions of this thesis were added to the interviews concerning partnerships in practice (Appendix 1). These questions explored, in particular, collaboration and

sharing of information both within the organization and between the company and partners.

3.3 Conducting interviews

The primary source of data has been the twelve companies that participated in the GNM project (Table 2). A common denominator for all twelve companies was the fact that they operated in the software business and had a strong interest in strengthening their global activities.

In order to gain a holistic understanding of the companies, several interviews were conducted from different perspectives in each of the companies (Table 2). Typical interviewees included management-level representatives responsible for business, marketing, partnerships, legal issues or product development. The interviews were, in most cases, conducted in the company's premises by two out of the four GNM project's researchers. Almost all of the interviews were conducted in Finnish. Almost all interviews were audio taped and transcribed. The interviews were always transcribed by one individual. Some of the interviews were transcribed by the researchers and some were transcribed by a professional third party. The transcriptions have focused on capturing the spoken meaning of the interviews. Gestures and facial expressions have often been left undocumented. In total, 71 interviews were conducted within the companies participating in the GNM project. On an average, the interviews lasted roughly 1.5 hours.

This study has analyzed a subset of GNM project's data, consisting of 37 interviews from 7 companies (Table 2).

Table 2. Companies that participated in the GNM project. Companies analyzed in this study grayed.

Company	Number of interviews	Company's offering
Abako	3	Customer specific web-based solutions utilizing Abako's own content management system
CADi	5	2D and 3D CAD design and data management solutions
Conmio	5	Mobile content management and publishing solution
Idesco	7	RFID-based identification solutions
Informa	10	Solution for managing resources and material flows
Meridea	4	Mobile banking software
Omnitele	7	Strategic advisory services to business and technology players within the wireless industry
Solid	8	Relational in-memory database
Stinghorn	3	Firewall for small and medium-sized companies
SysopenDigia	6	Integration services and applications for SymbianOS-based smartphones.
Tekla	6	Model-based software product for building and construction
Vertex Systems	7	Engineering and data management software

The great majority of the interviews were conducted during late 2005 and early 2006 (Figure 6). The project-level decision to gather large amounts of data at the very beginning of the GNM project contradicts to a certain extent with the concept of *theoretical sampling*. However, according to Glaser and Strauss (1967, p. 71), theoretical sampling can also be performed with previously collected research data. Nevertheless,

this effort requires a large mass of data to draw on in order to develop a theory of some density of categories and properties. This has been the case in the data analysis of this thesis. As the GNM project has produced vast amounts of rich data, it has been possible to go back to the transcribed interviews and re-analyze the data in light of the improved understanding of the phenomenon under study.

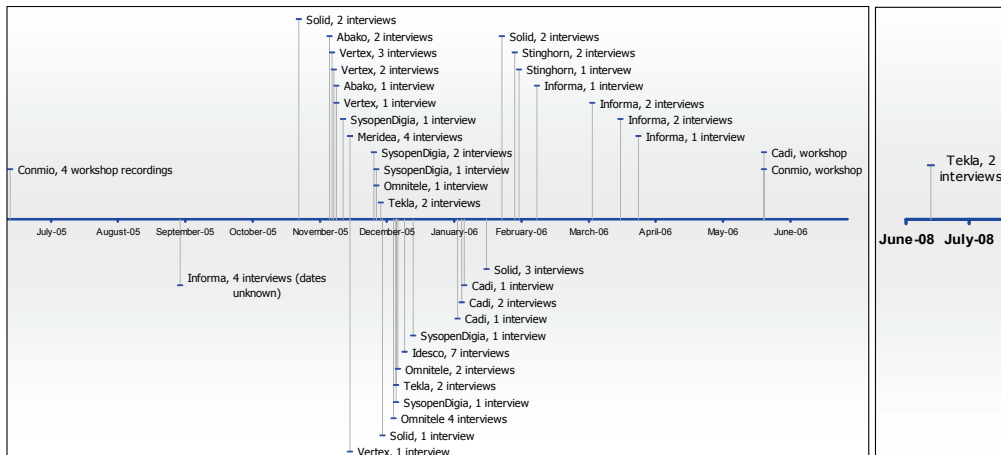


Figure 6. Approximate timeline of the conducted interviews.

3.4 Data management

Since the data collection was a group effort by four of the GNM project’s researchers, it was necessary to manage the data collection at the project level. For such a purpose, a set of spreadsheet pages was set up in order to gather details on the data collection activities within each company and to provide a summary of the data gathering activities. These spreadsheet pages kept track of the following details related to each interview:

1. Date and time of the interview
2. Name(s) of the interviewee(s)
3. Name(s) of the interviewer(s)
4. Location of the interview
5. Topic of the interview
6. Status of transcription (ready/under progress/not assigned yet)
7. Person responsible for transcription

8. Format of the audio file

For the purposes of this thesis, I extended the data management practices further by keeping track of the length of the interviews and by writing *contact summary forms*, as suggested by Miles and Huberman (1994, p. 51) (Appendix 2). The contact summary forms can be used in several ways (Miles & Huberman 1994, p. 52): a) to guide planning for the next contact, b) to suggest new or revised codes, c) to help with coordination when more than one field-worker is involved in the study, d) to reorient yourself to the contact when returning to the write-up, and e) to help with further data analysis. I then further organized the gathered data by creating a *data accounting sheet* to keep track of to what extent each interview provided data to my research questions (Miles & Huberman 1994, p. 80).

The data management has been most active in the early part of the research. Although I see value in the efforts to manage the data, these practices have eventually faded as the analysis advanced further and became more independent from the project-level activities.

4 Concluding remarks of PART I

In this chapter, I look back at PART I. I begin this task in section 4.1 by discussing how the characteristics of grounded theory approach (section 2.3) have affected the documentation of this thesis. The choices I have made pertaining reporting this study are made explicit, rationalized and then illustrated by revisiting the writings of PART I and by providing a layout for the remaining part of the thesis (PART II: DATA ANALYSIS AND DISPLAY). Finally, section 4.2 summarizes PART I of this thesis.

4.1 Writing grounded theory

Suddaby (2006) has captured the essential challenge of writing grounded theory with the following statement:

“In pure form, grounded theory research would be presented as a jumble of literature consultation, data collection, and analysis conducted in ongoing iterations that produce many relatively fuzzy categories that, over time, reduce to fewer, clearer conceptual structures. Theory would be presented last. Presenting grounded theory in this pure form, however, would be neither efficient nor comprehensible to the majority of researchers who work in the positivist paradigm.”

The objective in grounded theory studies is to explain phenomena in light of the theoretical framework that evolves during the research itself. Thus, it is not wanted to be constrained by having to adhere to a previously developed theory that may or may not apply to the area under investigation (Strauss & Corbin 1990, p. 49). It makes no sense to start with “received” theories or variables (categories) because these are likely to inhibit or impeded the development of new theoretical formulations (Strauss & Corbin 1990, p. 50). Presenting a conceptual framework for a grounded theory

study at the beginning of the report is unnatural because the understanding about the phenomenon to be researched emerges throughout the study. Thus the conceptual framework would be the end-result of the research. Furthermore, with the emergence of the analysis, the understanding about research questions and related literature also evolves. This affects the way the research problem and research questions are presented.

My stance towards the debate on the research problem and research question (section 3.1) is closer to Glaser's point of view. For this reason, this thesis began with only a vague description of the context of the study (chapter 1). The research area was then, little by little, shaped in chapter 1 by first addressing my professional background motivating the study (section 1.1) and then by discussing how the research project has set boundaries to this study (section 1.2). The research area in its initial form was then finally stated in section 1.3. The initial set of research questions has been derived from the definition of the research area in section 3.1. The way the research area and research questions have further evolved will be documented together with the analysis in PART II.

Due to the emergent nature of grounded theory research, there is no need to review all of the literature beforehand, as is frequently done by researchers trained in other approaches (Strauss & Corbin 1990, p. 50). Grounded theory is for the discovery of concepts and hypotheses, not for testing or replicating them. Thus the license and mandate of grounded theory is to be free to discover in every way possible. It must be free from the claims of related literature and its findings and assumptions in order to render the data conceptually with the best fit (Glaser, B. G. 1992, p. 32). Researchers may not even know which literature is relevant until the analysis is well advanced (Glaser, B. G. 1992, p. 32). However, this stance is part of the methodology only in the beginning. When the theory seems sufficiently grounded in a core variable and in an emerging integration of categories and properties, then the researcher may begin to review the literature in the substantive field and relate the literature to his or her own work in many ways (Glaser, B. G. 1992, p. 32). Slowly, as the grounded theory emerges with strength and formulation the researcher can start to switch at a commensurate pace to the related literature (Glaser, B. G. 1992, p. 36).

I have taken the advice of the originators of grounded theory approach and avoided extensive review of related literature at the beginning of the thesis. Throughout the study, my understanding of what the related research is has kept evolving. Following again Glaser's way of thinking, the literature is reviewed once I have developed a vivid enough understanding of the theoretical development. For this reason, relevant literature is reviewed in a constant dialogue with emerging results in PART II and PART III.

A qualitative study can be evaluated accurately only if its procedures are sufficiently explicit for readers of the resulting publication to be able to assess their appropriateness (Strauss & Corbin 1990, p. 249). Contradicting prevalent ideals of scientific detachment from context, the constant comparative method implies an intimate and enduring relationship between researcher and site. Because of this close and longstanding connection, the personality, experience, and character of the researcher become important components of the research process and should be made an explicit part of the analysis (Suddaby 2006). Therefore, in grounded theory, researchers must account for their positions in the research process. That is, they must engage in ongoing self-reflection to ensure that they take personal biases, world-views, and assumptions into account while collecting, interpreting, and analyzing data (Suddaby 2006).

I have provided an overview of research paradigms and perspectives (section 2.1), after which I have stated my position with sociological paradigms (section 2.2). The chosen paradigm is then taken into account when deriving the research strategy for this study (section 2.3). Furthermore, I have revealed details of my professional background in section 1.1, illustrating how my past has affected the beliefs I currently have with respect to the research area.

Although it is still necessary to write extensively about research design related to grounded theory in order to ensure the proper evaluation of the study, some (e.g. Locke 2001, p. 128) have begun to wish for less writings to heighten reader's understanding of the approach and to demonstrate that good scientific practice has been followed. For this reason, the description of how the research is set up is separated from the actual data analysis and display. PART I: SETTING THE SCENE reports the research setting, whereas PART II reports the data analysis and the emerging results.

Up to this point, I have provided reasons for the structure of PART I. Now, I will focus on discussing the writing of PART II.

Grounded theory approach resembles what we normally do in everyday life when we encounter a puzzling situation. It models the way humans have always learned (Punch 1998, p. 167). Learning when conducting grounded theory study follows the cognition process proposed by Neisser (1976, p. 112) (Figure 7). The information in any real situation is indefinitely rich. There is always more to see than anyone sees, and more to know than anyone knows (Neisser 1976, p. 79). Perception depends on the skill and experience of the perceiver and what he or she knows in advance (Neisser 1976, p. 13). Information pickup is crude and inefficient at first. Only through perceptual learning do we become able to perceive progressively more subtle aspects of the environment (Neisser 1976, p. 62). At each moment, the perceiver is constructing anticipations of certain kinds of information that enable him or her to

accept it as it becomes available. Neisser (1976, p. 20) claims that these explorations are directed by the anticipatory *schemata*, which are plans for perceptual actions as well as readiness for particular kinds of structures. The outcome of the explorations – the information picked up – modifies the original schema. Thus modified, it directs further exploration and becomes ready for more information (Neisser 1976, pp. 20-21).

In order to document the learning process, Part II follows a theory-generating writing structure that serves to support the theoretical case that is being made (Punch 1998). Each succeeding section establishes a further part of, or link in, the argument in order for the totality to provide a convincing case for a particular theoretical formulation. Following the coding schema as suggested by grounded theory approach, the research is reported in four iterations. These iterations are documented in their own chapters (chapters 5 to 8).

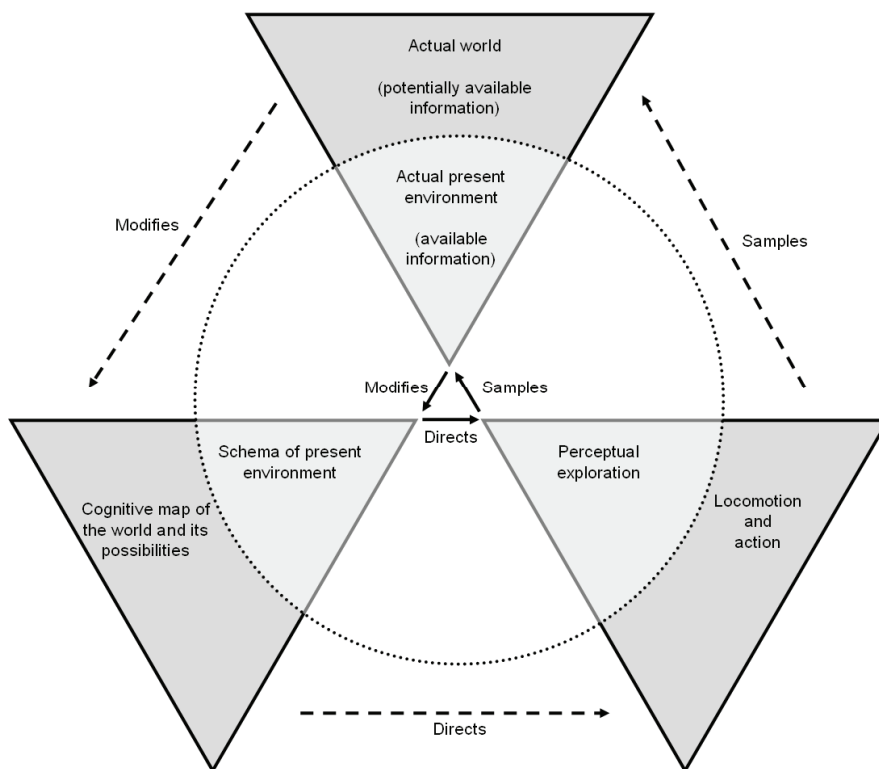


Figure 7. Schemata as embedded in cognitive maps (Neisser 1976, p. 112)

Documenting the study with a theory-generating structure demands considerable powers of exposition and analytic grasp if it is not only to be theoretically convincing but also to demonstrate a rigorous approach to data analysis and interpretation (Punch 1998). While it is certainly necessary to explicate the developed theoretical framework, it is also vital to persuade the audience of its plausibility and its relevance (Golden-Biddle and Locke, 1997). Miles and Huberman (1994, p. 304) have offered general guidelines for reporting a qualitative study:

1. The report should tell us what the study was about or came to be about.
2. It should communicate a clear sense of the social and historical context of the setting(s) where data were collected.
3. It should provide us the “natural history of the inquiry,” so we see clearly what was done, by whom, and how. More deeply than in a sheer “methods” account, we should see how key concepts emerged over time; which variables appeared and disappeared; which codes led into important insights.
4. A good report should provide basic data, preferably in focused form (vignettes, organized narrative, photographs, or our data displays) so that reader can, in parallel with the researcher, draw warranted conclusions. (Conclusions without data are a sort of oxymoron.)
5. Finally, researchers should articulate their conclusions, and describe their broader meaning of the worlds of ideas and action they affect.

The challenge to authors, then, appears to be illustrating data and linking them to the theoretical points. Typically, this is accomplished through a style of presentation that moves back and forth between extensive theoretical presentation and illustrative ‘live’ excerpts from the setting. It alternates between ‘telling’ and ‘showing’ (Locke 2001, p. 116). The process of data analysis, including coding techniques and category creation, should be made apparent to the reader (Suddaby 2006). Furthermore, it is necessary to document how the analysis proceeded in the course of time. The objective is to produce a thorough report of a carefully reasoned set of consistent choices, after consideration of the alternatives. In the written report, the writer is, among other things, telling the reader about the decision path taken through the research, and taking the reader down that path (Punch 1998, p. 278).

Taking such advice into account, I have decided to document the rounds of analysis in independent chapters. Each of the chapters includes its own research methodology section, reports results that go beyond the previous results and discusses the results with related literature relevant to that particular round of analysis.

4.2 Summary

The purpose of PART I has been to demonstrate an appropriate fit between the components of a research effort, such as a paradigm, the research questions, the study design, the data collection procedures and the data analysis procedures. Following Glaser's (1992, p. 22) advice, the research topic has been approached with caution. The research area has emerged gradually first by addressing my background motivating the study (section 1.1) and then by addressing the boundaries set by the research opportunity, the GNM project (section 1.2). Finally, the initial statement of the research area has been defined in section 1.3 as *human aspects in software product companies' requirements engineering activities*.

In chapter 2, the research design has been built for the research area. I first provided an overview of research paradigms and perspectives (section 2.1) in order to define my position within the research tradition (section 2.2). I then continued to discuss how my choice of research paradigm has affected the choice of research strategy for this study (section 2.3). I described what methods of data collection and analysis the chosen research strategy implies (section 2.4). Chapter 3 began with an initial definition of research questions (section 3.1):

1. How can the role of human interaction be described in organizations' attempt to position their software product in the marketplace?
 - a. How do software product development organizations develop understanding regarding the market?
 - b. How do software product development organizations utilize the understanding regarding the market in their product development?
 - c. What are the challenges faced by the software product development organizations?
2. How can the organizations' attempt to position their software product in the marketplace be supported?

I have then continued chapter 3 by describing how the objectives of this thesis have been aligned with the project-level objectives in terms of interview questions (section 3.2) and case selection (section 3.3). Section 3.4 described how the gathered data was managed in practice. Finally, chapter 4 provided the concluding remarks of PART I by first discussing how the characteristics of grounded theory approach (section 2.3) have affected the documentation of this thesis (section 4.1) and then by summarizing PART I of this thesis (section 4.2).

PART II: DATA ANALYSIS AND DISPLAY

"How can I tell what I think till I see what I say?"

E. M. Forster's "Aspects of the Novel" (1927)

"The researcher must have patience and not force the data out of anxiety and impatience while waiting for the emergent. He must trust that emergence will occur and it does."

Barney Glaser (1992, p. 4)

5 Developing an initial understanding¹

“An effective strategy is, at first, literally to ignore the literature of theory and fact on the area under study, in order to assure that the emergence of categories will not be contaminated by concepts more suited to different areas” (Glaser, B. & Strauss 1967, p. 37).

This chapter reports the first of four consecutive iterations of data analysis. The analysis begins with an open mind with the objective to develop an initial understanding of the research area. For such a purpose, the research area (*human aspects of requirements engineering*) was explored within one company. The findings of this early case study are presented in section 5.1 and conceptualized in section 5.2. The cautious search for relevant literature has then begun in section 5.3. Based on the findings and comparison to literature, conclusions are drawn in section 5.4, providing guidance for the deeper analysis of all gathered data.

¹ Substantial sections of this chapter have been earlier published in:

1. Jantunen, S & Smolander, K 2006b, 'Towards Global Market-Driven Software Development Processes: An Industrial Case Study', paper presented to 28th International Conference on Software Engineering & Co-Located Workshops. The first International Workshop on Global Software Development for the Practitioner (GSD 2006), Shanghai, China, 23 May, 2006. and
2. Jantunen, S & Smolander, K 2006a, 'Challenges of Knowledge and Collaboration in Roadmapping', paper presented to International Workshop on Software Product Management (IWSPM'06 - RE'06 Workshop), Minneapolis/St.Paul, USA.

5.1 Findings from an early case study

Following the commonly given advice to analyze early (Glaser, B. G. 1978; Miles & Huberman 1994, p. 50; Strauss & Corbin 1990), the data analysis began with a study of a single *revelatory* case (Yin 1994). The target of the study, Tekla, develops software solutions, products and services for customers' core business processes in building and construction and infrastructure management and energy distribution (Tekla 2009b). Tekla had in recent times grown to a strong position in the global marketplace for engineering software. Tekla's model-based software products are currently used in more than 80 countries (Tekla 2009b). Due to Tekla's focus on product business and the global presence of Tekla's product in diverse market areas, it was believed that the case study was likely to provide rich data that addresses the research questions particularly well.

Nine persons were interviewed in Tekla during December 2005. The interviewees represented different functions within the organization, including product management, marketing management, product development, and general management. All interviews were tape-recorded and transcribed. The total amount of recordings added up to 10 hours 32 minutes. In addition, documents relevant to the research area were gathered from Tekla. These documents included presentation slides, product development process descriptions, organization charts and design artifacts.

The gathered data were analyzed in order to find answers to the initial research questions (section 3.1). In answering research question 1: *How can the role of human interaction be described in an organizations' attempt to position their software product in the marketplace?*, the focus was first put on sub-question 1 a): *How do software product development organizations develop understanding regarding the market?* The case study (Jantunen & Smolander 2006b) revealed numerous sources through which Tekla gathered information about the product's market:

"Some of the sources through which we receive market information, in one way or another, are: the existing customers, the ongoing sales cases and all sorts of ideas we get at the exhibitions while looking at what competitors have accomplished. We also follow, to some extent, what is happening in the adjacent customer segments." (Tekla's product management, December 2005)

Information related to the product and its market was continuously collected and stored into a database:

"The product- and market-related information is largely gathered and stored into the database by our product management team." (Tekla's product management, December 2005)

The gathered data was then processed further at regular intervals in order to plan what functionality shall be implemented in the product's forthcoming releases. A central document in such planning activity was a roadmap:

"The roadmap is our three year vision of what type of features will be implemented into the forthcoming product versions" (Tekla's product management, December 2005)

During the roadmapping, the most important requirements were tentatively planned to be implemented in one of the many forthcoming product versions (often also referred as *product releases*). Roadmapping proved to be a complex activity for which business objectives and diverse viewpoints from different customer segments and geographical market areas needed to be taken into account. Based on the gathered data, Tekla managed such complexities with both organizational measures and processes.

The updated roadmap was considered to represent Tekla's latest understanding of what the market needs were and how Tekla should react to them. Hence, in addressing the sub-question of 1 b): *How do software product development organizations utilize the understanding regarding the market in their product development?*, the focus was put on activities that occurred after the product's roadmap was updated.

A roadmap was utilized in Tekla as a long-term plan, according which the new product releases were developed one at a time. The development of a new product version was carried out as a product release project. Preparations for a release project required more concrete and detailed planning. According to Tekla's product development process descriptions, the product management team first composed a *requirements specification* that described in an explicit manner those requirements that were decided to be implemented in the next product release. Based on the requirements specification, the product management team then described the planned functionality further in a *functional specification* and made an initial estimate on the workload needed to implement the functionality. The requirements specification and functional specification were then delivered to the software production organization, which was largely responsible for further product design and implementation.

In addressing the research question 1 c) *What are the challenges faced by the software product development organizations?*, the case study revealed challenges in the nature of the gathered information. Although customers were found to be a valuable source of product- and market-related information, there were also limitations to the information gathered from them:

"The customers typically give ...especially if they are end-users as well... information only about the current situation (such as: this is not working, that is not working). It is very difficult to get visionary views related to the product from the customer. On the other hand, customers typically don't even have the technical competence to see what would be possible with existing technology." (Tekla's business management, December 2005)

Consequently, it has become Tekla's role to understand the product's business domain and the possibilities of technology in order to determine what new product features would be most beneficial for the customers:

"One of our product management team's responsibilities is to develop an understanding of what features would be technologically viable and desirable for the customers. The product management team need to see beyond the customer wishes and think of functionality that the customers are not yet able to request." (Tekla's business management, December 2005)

Gathering the information about the market needs did not appear to be a problem in Tekla. The company had plenty of gathered market information – perhaps even more than the organization was able to digest. Instead, the challenge appeared to be to understand what the gathered information really meant. The gathered information needed first to be developed further into explicit product requirements. It was then necessary to develop an understanding of how important the product requirements were in terms of the product business. Without such understanding it was difficult to determine which of the requirements should be implemented in the product's forthcoming versions:

"We receive large amounts of market information, but the typical problem we are facing is that the business value behind the customer need is often missing. In such a case, we have difficulties in prioritization. We might not be able to see that focusing on other request would actually benefit us much more. We have a horn of plenty in receiving market information, but understanding the priority of the information often gets lost in the abundance of technical details." (Tekla's business management, December 2005)

The roadmapping was further complicated due to the fact that the product's stakeholders had conflicting needs:

"It is quite a challenge for our resources and processes that we need to serve pragmatic existing customers while searching for new businesses and being a forerunner and a visionary." (Tekla's business management, December 2005)

In addition, the product requirements were often dependent on each other.

"On many occasions, a product feature that has been implemented for one customer segment has benefited the other customer segments, as well." (Tekla's business management, December 2005)

Thus, the case study suggested that building an understanding of the gathered information is a complex challenge, which can be alleviated with experience and tacit knowledge:

"There does not exist any equation that can determine the priorities of market needs correctly. It takes a certain touch, hunch and experience to understand the priorities. This knowledge has just been built into the organization. [...] The more we have made business, the more we have gained this tacit knowledge." (Tekla's business management, December 2005)

"It is a huge challenge to set up the organization to support the product-related decision making. It is difficult to determine the criteria according which the requested features are decided to be implemented. We have recently put much effort in finding ways to organize the decision making in a

business oriented manner.” (Tekla’s business management, December 2005)

“Who is to say what the right interpretation is of the data we have gathered? This is the challenge that we have been tackling all the time. The more we have done business the more experience we have gained [on understanding the customers]” (Tekla’s business management, December 2005)

Although such statements were identified already during the early case study, the significance of these statements has increased throughout the entire research effort.

In addition to the challenge related to understanding and decision making, the case study revealed another clearly identifiable challenge. There appeared to be communication blockages between the product management team and the rest of the organization:

“We have detected challenges on how to share the information between the customer segment teams and the product management team. In addition, we have identified another communication barrier between the product management team and the development team. If we can solve these two Gordian knots then everyone’s work will be easier.” (Tekla’s business management, December 2005)

The challenges caused by the communication blockages were experienced differently depending on the abstraction level of the shared information:

“It is the sharing of the high-level information that is difficult. Sharing information about the low-level details is much more under control.” (Tekla’s product management, December 2005)

Not knowing the full picture of product-related decisions has occasionally led to challenges in the organization:

“In many cases, knowing the plans for the future versions would have an impact on the design decisions. If we knew that a certain requirement is actually laying a foundation to something forthcoming, we would implement the requirement differently.” (Tekla’s product development, December 2005)

“We have had challenges in informing the customers about the practical meaning of new product features. We have listed what features the new product version has, but the true practical meaning has not been understood.” (Tekla’s product management, December 2005)

“Our marketing department has not been able to write anything related to the new product until the product has been implemented.” (Tekla’s product management, December 2005)

“The R&D department has only been able to see a planning window of one third of a year. Because of this, they do not know what features are to be implemented in the next version.” (Tekla’s product management, December 2005)

“The country managers have had to rely on product managers’ communication skills in creating an understanding of what is new in the product’s forthcoming versions.” (Tekla’s product management, December 2005)

In addressing the research question 2: *How can organizations’ attempt to position their software product in the marketplace be supported?*, the case study focused on the actions that Tekla has taken to alleviate the perceived challenges. Such actions tended to cope

with the complexity of the design problem by pushing the decision-making towards the origin of requirements:

“We try to guide the product-related decision making from the customer segment point of view.”
(Tekla’s business management, December 2005)

One effective method in managing vast numbers of requirements was to ask each market area to maintain a top 10 list of the most needed features:

“When we provide [the dedicated product management resources in the market areas] a long list of requirements we ask the local managers to pick the ten most important requirements from the list. After they have picked the ten we ask them to narrow it down to three. It is evident that product management in each market area needs to make tough choices. In this way, we can quickly focus on what the most important features are and what the choices within the selected features are. With these activities, you finally find those gems that are possible to implement with the resources we have.” (Tekla’s business management, December 2005)

While helping to narrow down vast amounts of requirements, comparing the top 10 lists across the market areas have also helped all stakeholders to understand the complexity of the problem as a whole. It was then more likely that they were willing to make compromises and understand better the decisions that have to be made in finding the optimal combination of features for the next release to be implemented.

5.2 Conceptualizing the initial understanding

Extended, unreduced text alone is a weak and cumbersome form of display (Miles & Huberman 1994, p. 91). Hence, in this section, the data that was presented in the previous section is developed further and displayed in terms of identified concepts and relationships. While conceptualizing the findings, existing literature is reflected upon with caution. The role of the literature is to sharpen the initial understanding by identifying better fitting ideas from the literature rather to be shaken by it (Glaser, B. G. 1992, p. 33).

The gathered data suggested three distinct sets of activities in the organization’s effort to determine what functionality shall be implemented in the product’s forthcoming versions: 1) *sensing the market*, 2) *making sense of the market*, and 3) *acting upon knowledge*. These categories are discussed in greater detail as follows.

5.2.1 Sensing the market

One category of activities was related to gathering information about the emerging trends, customers’ needs as well as transmitting the gathered information to people responsible for managing the product. This category was labeled as *sensing the market*, as suggested by Day (1999, p. 85). In Tekla’s case, information was gathered from

many sources, including ongoing sales cases, exhibitions, adjacent customer segments and existing customers. This suggested that the activity of sensing the market may be further decomposed into activities of 1) *listening to the staff in the front line* and 2) *listening to the periphery* (Figure 8).

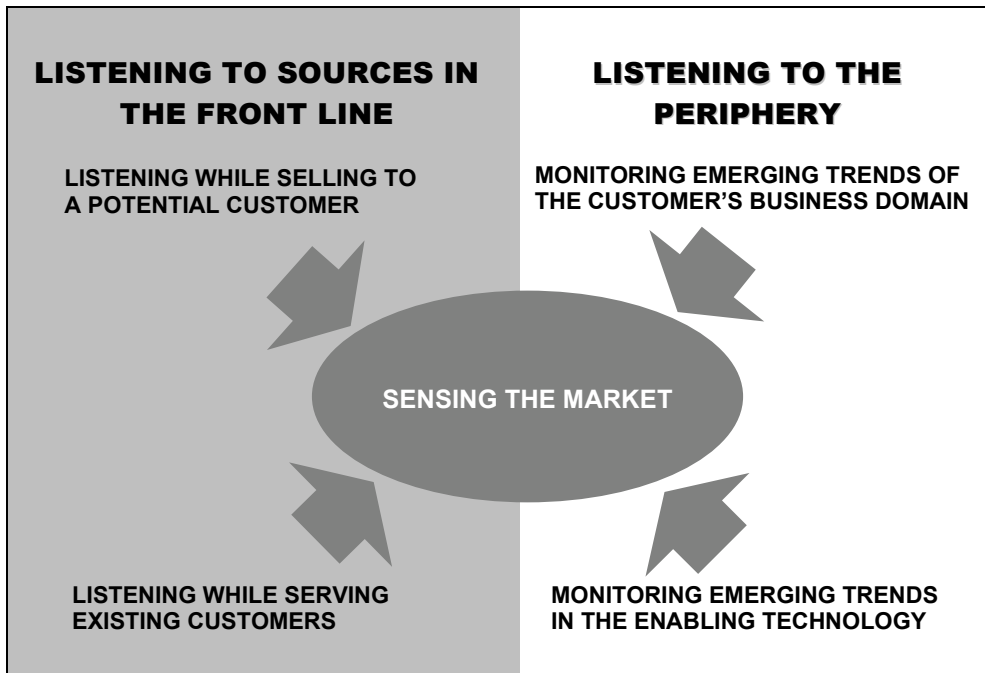


Figure 8. Classification for market sensing activities

When an organization is *listening to the staff in the front line* (Day 1999, p. 88), it is harnessing its employees to gather market information while interacting with a customer. The interaction occurs either *while selling* a product to a potential customer or *while serving* the existing customers with activities such as technical support or training.

Due to the limitations in the information that customers provide, it is evident that more market information is needed to be able to make better-founded decisions. Many of the potential information sources can be categorized as being part of the *periphery*. This type of information is typically general in nature, describing matters such as what is happening in the customer segment, what the competitors are doing and how the enabling technology is changing.

5.2.2 Making sense of the market

The second category of activities was related to sorting the gathered needs, resolving conflicts and inconsistencies, determining the requirements, prioritizing the requirements and planning for the implementation. This category was labeled as *making sense of the market*, as adopted from Day (1999, p. 93). In terms of requirements engineering activities, making sense of the market relates to roadmapping, release planning and requirements prioritization. Following such activities appeared to be a source of challenges in Tekla. The gathered data suggested that the needs of the market were often made sense of based on tacit knowledge. Hence, further focus was put on conceptualizing the nature of available information (Figure 9).

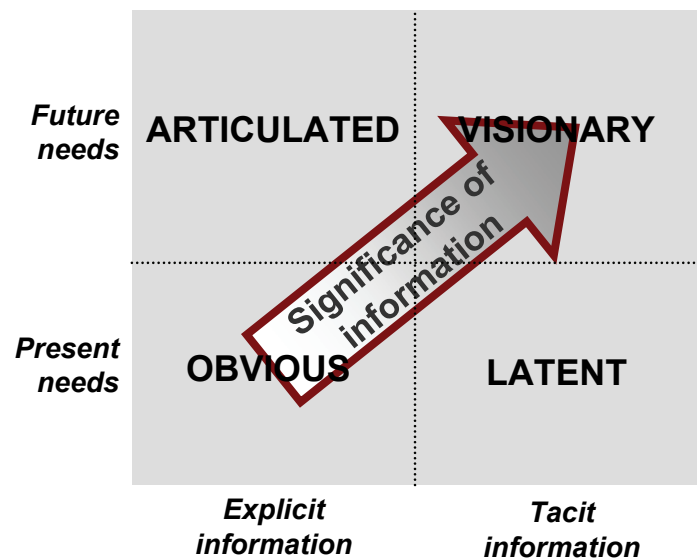


Figure 9. Types of market information

The gathered data suggested that the product's users often provided information related to what they experienced with the current version they were using. Such explicitly definable information that was related to current needs was labeled as *obvious* information. Some of the customers had the capability to express their future needs. Such explicit and future oriented information was labeled as *articulated* information. In many cases, the gathered information was not readily suitable to be expressed as a product requirement. This type of gathered information was rather a seed for further knowledge creation than an explicit requirement itself. This was one of the reasons why Tekla has established a product management team. The information that was considered as a component for understanding customers'

current needs was labeled as *latent*. Tacit information that suggested needs for the future was labeled as *visionary*.

The analysis suggested that the greatest potential in terms of a product's success lies in understanding the customer's unspoken needs. However, such an objective was also the most difficult to achieve. The tools and processes at Tekla appeared to be better suited to deal with explicit rather than tacit information.

5.2.3 Acting upon knowledge

The third category of activities was related to communicating the future plans to relevant stakeholders and determining the reasonableness, consistency, completeness, suitability, and lack of defects in a set of requirements. This category was labeled as *acting upon knowledge*.

Since communication was identified as one of the central challenges, the data was examined in terms of how information was shared within Tekla. The gathered data suggested that organizational units have different needs in terms of consuming knowledge that has been created while making sense of the market needs and deciding on the product's future versions (Figure 10). The *first line knowledge consumers* depend heavily on the created knowledge, as this largely defines their activities. The failure of disseminating the knowledge appeared to leave the organization's employees *ignorant* or *misinformed*. The teams that appeared to suffer the most from the insufficient communication with the product management team were *marketing* and *product development*. The *second line knowledge consumers* are less dependent on the richness of knowledge created while making sense of the market. Their need for information can therefore be satisfied, in most cases, with documents. As with the first line knowledge consumers, the determination of second line knowledge consumers varies, to a certain extent, from one organization to another. Some of the second line knowledge consumers identified in this particular case study were customers, partners, sales and technical support.

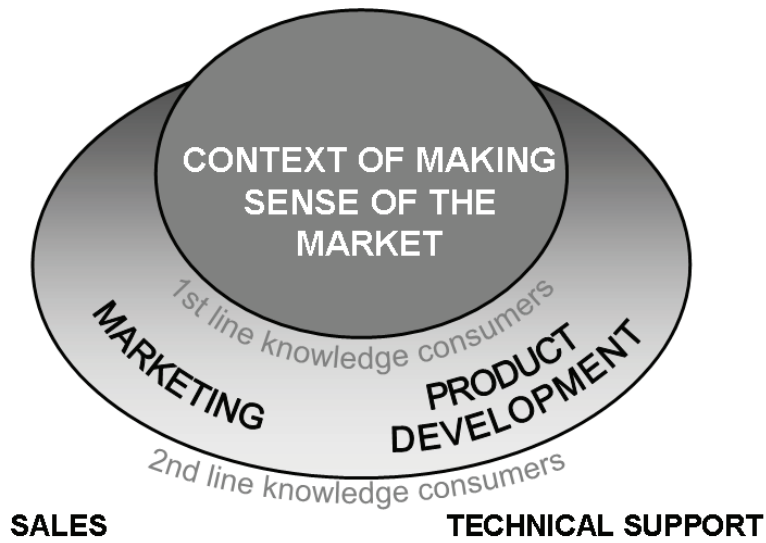
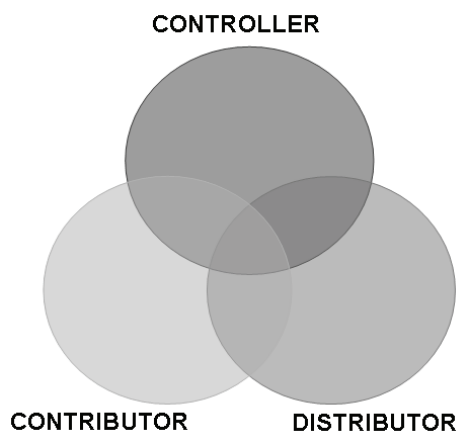


Figure 10. Different functional units within your organization may have differing needs for accessing the knowledge you create

The current ways of sharing product-related information largely with documents appeared to be insufficient. This suggests that more focus needs to be put on understanding and organizing human collaboration within the organization. The perceived challenges in understanding the needs of a product's market and in transferring the decisions made to the remaining part of the organization suggested that, when the needs of the market are being made sense of, three types of roles must be present:



- 1) *Contributors*, who bring valuable information to a roadmapping context,
- 2) *Controller(s)*, who ensure that the roadmapping is being performed in a systematic manner,
- 3) *Distributors*, who absorb information in the roadmapping context and disseminate it to those who will need to act upon it.

5.3 Comparisons to the literature

The search for relevant literature began by comparing the gathered data with the literature within the substantive discipline of this study, requirements engineering (RE). A majority of RE research is devoted to managing requirements in the context of *bespoke* software development, where a software system is delivered to a well known customer using a requirements specification as a contract (Aurum & Wohlin 2005; Carlshamre 2001, p. 57). This line of literature did not fit well with the gathered data which suggested that requirements engineering for developing software products differs in many ways from bespoke software development. Such differences in the development context began to receive attention from academia during the 1990s and early 2000s (Carlshamre 2001; Carmel & Sawyer 1998; Keil & Carmel 1995; Lubars, Potts & Richter 1993; Sawyer, S. 2000, 2001). These studies concluded that developing software products for an anticipated market places numerous and fundamentally different demands on RE activities (Carlshamre 2001, p. 57). An overview of such key differences is presented in Table 3, as compiled by Carlshamre (2001, p. 59).

Table 3. RE-related differences between bespoke development and product development (Compiled by Carlshamre (2001, p. 59) from (Kamsties, Hörmann & Schlich 1998; Keil & Carmel 1995; Lubars, Potts & Richter 1993; Novorita & Grube 1996; Potts 1995; Yeh 1992)).

Aspect	Bespoke development	Product development
Primary goal	Compliance to the specification.	<i>Time-to-market. Requirements are jettisoned rather than allowing delay of release.</i>
Measure of success	Satisfaction, acceptance.	<i>Sales, market share, product reviews.</i>
Life-cycle	One release, then maintenance.	<i>Several releases, as long as there is a market for the product.</i>
Requirements conception	Elicited, analyzed, validated.	<i>Invented. Either the market (marketing department) permits a feature, or technology does.</i>
Requirements specification	Used as a contract between customer and supplier.	<i>Rarely exists in orthodox RE terms, if so, they are much less formal. Requirements are communicated verbally.</i>
Users	Known or identifiable. Termed <i>user, end user</i> .	<i>Unknown, may not exist until the first product is on the market. Termed customer.</i>
Physical distance to users	Usually small.	<i>Usually large.</i>
Main stakeholder	Customer organization.	<i>Developing organization.</i>
Specific RE issues	Elicitation, modeling, validation, conflict resolution.	<i>Managing a steady stream of new requirements. Prioritizing, cost-estimating, release planning.</i>
Developer's association with the software	Short-term (until end of project).	<i>Long-term, promoting e.g. investment in maintainability.</i>
Validation	Ongoing process.	<i>Very late, e.g. at trade fairs.</i>
Use of RE standards and explicit methods	More common.	<i>Rare.</i>
Use of iterative techniques	Less common.	<i>More common.</i>
Domain expertise available on the development team	More common.	<i>Less common (product development often breaks new ground).</i>

The literature describing the characteristics of product development closely resembled the findings discovered in Tekla. In product development, it is more difficult to form a mental image of who the customer really is (Lubars, Potts & Richter 1993). At product conception, there will be only potential customers. Hence, for newly packaged software, requirements are invented, not elicited (Potts 1995; Sawyer, P., Sommerville & Kotonya 1999). Once the product has entered the market, the further needs of the stakeholders have to be interpreted from existing and potential customers (Keil & Carmel 1995; Lubars, Potts & Richter 1993). Existing products lead to a steady stream of new requirements, which may have interdependencies (Carlshamre et al. 2001) and conflicts (Lubars, Potts & Richter 1993) with other requirements. This steady stream of new requirements calls for processes beyond the scope of a single software development project (Ebert, Cristof 2005).

The studies describing the unique characteristics of software product development have laid the foundation for the evolution of requirements engineering processes for software product development, market-driven requirements engineering (MDRE). The gathered data revealed that Tekla's way of developing software products closely resembled the MDRE process presented in Figure 11 (van de Weerd et al. 2006; www.softwareproductmanagement.org 2010). Characteristic to the MDRE process is the approach to synchronize the continuous flow of candidate requirements and the work with discrete release events (Regnell & Brinkkemper 2005). The continuously incoming requirements are stored into a *requirements repository* that is dynamically evolving with past and recent data of varying types and levels of abstraction. The product is then developed in a series of releases as a result of product evolution, where new features are added and existing features are improved according to the advancement of the targeted market (Regnell & Brinkkemper 2005). Central activities in organizing the discrete release events are *roadmapping* and *release planning*. Roadmapping involves long term planning from diverse viewpoints, providing a layout of the upcoming product releases over a time frame of three to five years (Regnell & Brinkkemper 2005). The release planning is the activity of determining a feasible combination of dates, features, and resourcing for the next release of a software product (Penny 2002).

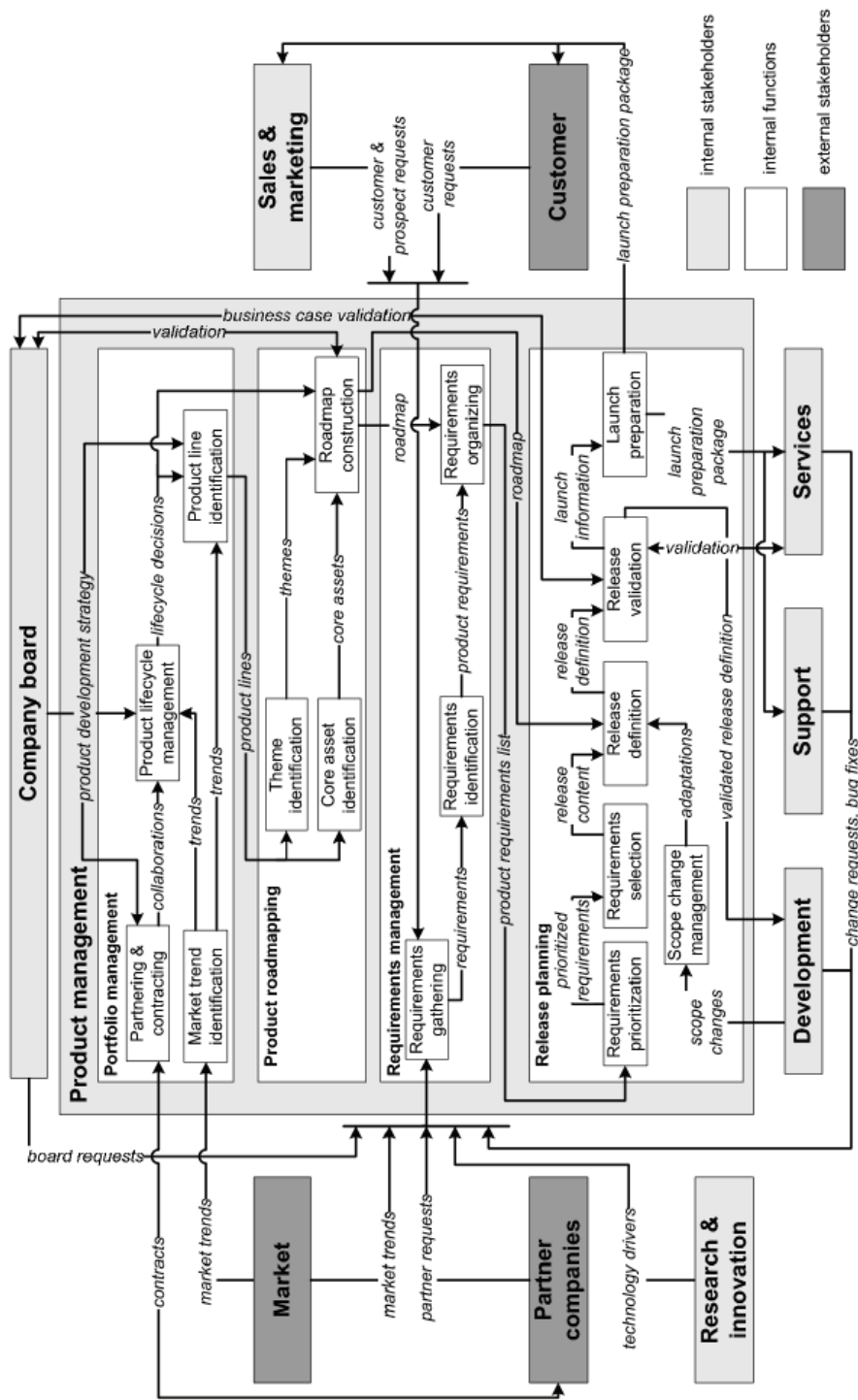


Figure 11. Reference framework for software product management (van de Weerd et al. 2006; www.softwareproductmanagement.org 2010)

MDRE-related literature fit well with the gathered data in terms of describing the RE-related challenges that were characteristic to Tekla. Furthermore, MDRE-related literature closely described the process Tekla has adopted to manage its product development activities. However, MDRE-related literature did not appear to address what I now believed to be central in the data – the challenge of knowledge creation and communication. The gathered data suggested that, in the end, product-related decisions are largely based on knowledge that can only be gained with experience, but cannot be communicated with ease. Based on the gathered data, such *tacit* knowledge (Polanyi 1966) was required in building the understanding of what the requirements really are and how important they are for the business. These findings appeared to contradict, to a certain extent, with MDRE-related literature. A majority of MDRE-related studies are based on the assumption that requirements are to be elicited and processed, not interpreted. Furthermore, although prioritization was considered as a key element of decision making in MDRE (Regnell & Brinkkemper 2005), the gathered data suggested that the determination of requirements' priorities was difficult, if not impossible. Studies reporting this challenge do exist. For example, Damian and Zowghi (2003) have argued that the prioritization and negotiation of customer requirements for a particular release is the most significant challenge of a global organization. Similar findings have also been presented by Lehtola and Kauppinen (2006) with the statement that “prioritization methods may have limited ability to support decision-making in a complex area like requirements prioritization in market-driven product development”. Yet, there still seems to be a lack of studies making an effort to understand the origins of such challenges or offering strategies to alleviate them.

Another contradiction between the gathered data and existing MDRE literature was related to communication. Existing MDRE literature highlights the importance of the product manager as a decision-maker. The product manager is considered as a “mini CEO” who is, among other things, largely responsible for planning and prioritizing requirements into roadmaps, releases and projects (Ebert, Christof 2007). However, the gathered data suggests that emphasizing the role of the product manager leads to communicational blockages within the organization. A lack of communication between the product management team and the rest of the organization was considered as a significant source of challenges in Tekla.

Since the analysis identified misfits between existing MDRE literature and the gathered data, the literature review was extended to other related fields. The focus was first placed on the marketing concept and the related construct of *market orientation*, which have been important components of marketing studies and practice for several decades (Lafferty & Hult 1999). Over the years, market orientation has been widely researched from various perspectives, resulting in several definitions. In their work on finding a synthesis from the most cited market orientation definitions,

Jaworski and Kohli (1996) proposed a definition of their own: “the organization wide generation of market intelligence pertaining to customers, competitors, and forces affecting them, internal dissemination of the intelligence, and reactive as well as proactive responsiveness to the intelligence”. In a similar vain of finding a synthesis for the market orientation literature, Lafferty and Hult (1999) have identified five distinct approaches to the concept of market orientation:

- 1) the decision-making perspective;
- 2) the market intelligence perspective;
- 3) the culturally based behavioral perspective;
- 4) the strategic perspective;
- 5) the customer orientation perspective.

While Lafferty and Hult (1999) identified inherent differences among the five perspectives, they also identified several similarities that reflect a general agreement as to what constitutes the basic foundation of market orientation. These included:

- 1) an emphasis on customers;
- 2) the importance of shared knowledge (information);
- 3) interfunctional coordination of marketing activities and relationships;
- 4) being responsive to market activities by taking appropriate action.

Such identified foundations of market orientation fit with the gathered data in terms of describing what has been found to be important in positioning the product in the marketplace. However, despite the growing interest in this marketing concept, research on how organizations become more market oriented is surprisingly limited. Much research on market orientation has focused on developing measures of a firm’s orientation and identifying antecedents and consequences of a greater market orientation (Gebhardt, Carpenter & Sherry 2006). Thus, market orientation literature has proven to be useful in identifying important aspects for the problem under study, but offers little practical guidance on what to do with the gathered information related to the product and its market.

Another source of related literature was identified to be the discipline of Research and Development (R&D) Management. The evolution of R&D generations, as illustrated in Figure 12 (Miller 2001), appeared to be suitable in situating Tekla’s approach for managing its product.

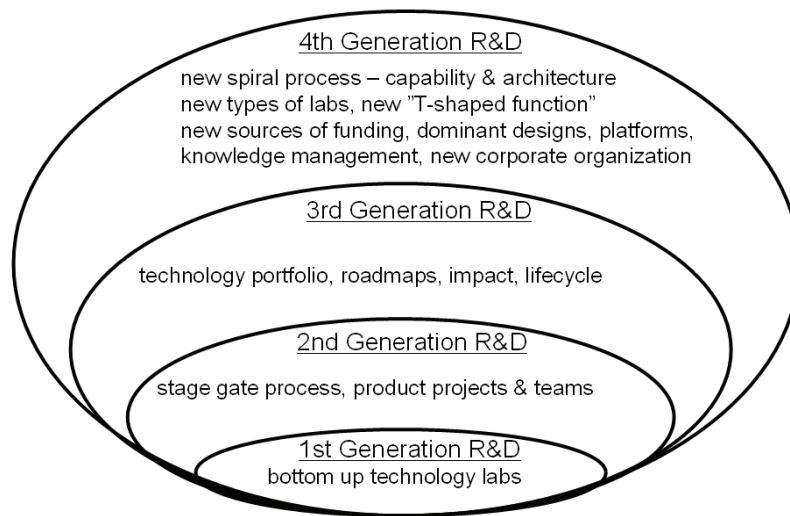


Figure 12. The Four Generations of R&D (Miller 2001)

The gathered data suggested that Tekla’s approach to R&D development had, at the moment of analysis, evolved from the second generation towards the third generation of R&D. Characteristic to second generation R&D, Tekla followed a stage gate process (Cooper 1990), which has been defined as a blueprint for managing the product process to improve effectiveness and efficiency (Cooper 1990). The stage gate process consists of a predetermined set of stages. Each stage includes related, concurrent activities involving different organizational functions. The entrance to each stage is a gate, in which the deliverables produced in the previous stage are evaluated in order to make a Go/Kill/Hold/Recycle decision for the project (Cooper 1990). Characteristic to third generation R&D, Tekla had begun to take a long-term approach to its product management by establishing a product management unit and by introducing product management related activities such as roadmapping and release planning. Furthermore, Tekla had already recognized some of the challenges that have been related with third generation R&D. One such challenge has been reported to be the emergence of the knowing-doing gap that prevents marketing and R&D from learning effectively with customers about what is possible and mutually valued in the product (Miller 2001). Hence, the gathered data suggested that Tekla was already on its way towards fourth generation R&D.

A particular challenge that fourth generation R&D addresses is the discovery of 1) what customers need but are unable to articulate and 2) what is possible with the product, but has not yet been developed (Figure 13) (Miller 2001).

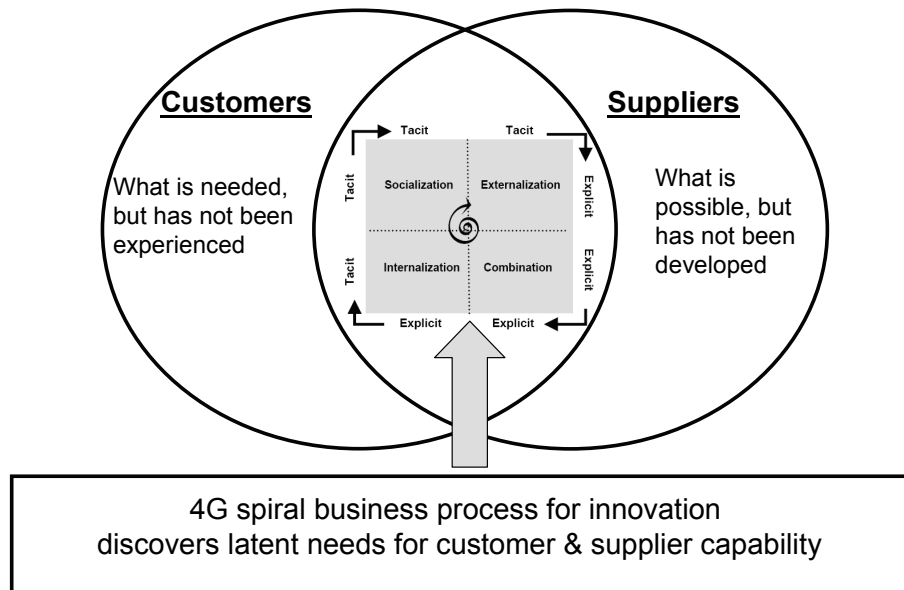


Figure 13. The fourth generation (4G) of innovation management (Miller 2001)

The central process in fourth generation R&D for unveiling customers' latent needs and suppliers' capabilities is a four-step spiral process that is based on the application of knowledge management principles discovered by Ikujiro Nonaka and the principles of behavioral psychology and learning discovered by Chris Argyris (Miller 2001). Such a line of thinking appeared to explain and describe the essential role of tacit knowledge when Tekla was making sense of its product's future direction.

5.4 Conclusions

An initial understanding of the research area was developed by exploring human aspects of requirements engineering within one company. The gathered data suggested three distinct sets of activities in the organization's effort to determine what functionality shall be implemented in the product's forthcoming versions: 1) *sensing the market*, 2) *making sense of the market*, and 3) *acting upon knowledge*. These three activities form a basis for more detailed data analysis of all of the gathered data, as will be seen in the forthcoming chapter.

The challenge that is continually faced in grounded theory is: what is the best pace for reading and using the related professional literature in the substantive area under study? We are all used to the normal, extensive literature review to ascertain gaps to fill in, hypotheses to test, and ideas to contribute to, in descriptive and verificational

studies (Glaser, B. G. 1992, p. 31). In contrast, in grounded theory, there is a need *not* to review any of the literature in the substantive area under study (Glaser, B. G. 1992, p. 31). Despite such advice, the initial findings were compared with what was considered to be the substantive area of this study, requirements engineering (RE). Reviewing RE-related literature at such an early phase of analysis was not considered harmful because my exposure to RE practices in the past had already resulted in beliefs that were more doubtful than assuring (section 1.1). Thus, I was not searching for preconceived concepts, but rather wanted to understand how the findings from Tekla fit with existing RE literature.

An examination of RE-related literature revealed that Tekla's approach to manage its product-related requirements closely resembled the process of market-driven requirements engineering (MDRE). However, MDRE-related literature did not appear to address the challenges that were found most essential within Tekla – the challenge of knowledge creation and communication. This finding has raised questions whether RE literature actually is the substantive line of literature on which to draw. While RE and market orientation literature seemed largely to ignore the role of tacit knowledge in positioning the product in the marketplace, the fourth generation of R&D management did address such a topic by adopting ideas from knowledge management and behavioral psychology. The dynamic theory of organizational knowledge creation (Nonaka 1994) appeared to be particularly relevant to the findings. However, further analysis of knowledge management and behavioral psychology literature was refrained from at such an early point of analysis, as "the data analysis must be free from the claims of related literature and its finding and assumptions in order to render the data conceptually with the best fit" (Glaser, B. G. 1992, p. 32).

The results of the early case study have improved the understanding of what is essential in the gathered data. The initial conceptual understanding of the research area, gained in this chapter, has created a stronger foundation for the full-scale data analysis of the 37 transcribed interviews from 7 organizations. This will be reported in the forthcoming chapter.

6 Exploring the research area²

"[The analysis of qualitative data] is sometimes boring, often tedious, and always more time-consuming than expected. However, the alternative to data analysis (which, unfortunately, is sometimes practiced even in published work) is to simply write down all the researcher's beliefs and impressions based on the time they have spent in the field collecting data. This alternative pseudoanalysis method is attractive because it is certainly easier than rigorous analysis, and most researchers feel that they "know" a great deal about the setting they have studied. But it is neither scientific nor reliable, and this practice is largely responsible for the skepticism about qualitative methods that is so prevalent in our field." (Seaman 1999)

This chapter reports the beginning of the actual grounded theory data analysis. Results from chapter 5 are utilized in order to establish more rigorous analysis practices for a larger set of transcribed interviews. The analysis now focuses on 37 interviews from seven organizations. The analysis seeks to identify categories that are salient to the research area (*human aspects in software product companies' requirements engineering activities*) and to gain an understanding of how the categories may be related to each other. Section 6.1 describes the research process of this phase. The

² Substantial sections of this chapter have earlier been published in:

1. Jantunen, S 2010b, 'Exploring Software Engineering Practices in Small and Medium-Sized Organization', paper presented to ACM/IEEE 32nd International Conference on Software Engineering. Cooperative and Human Aspects of Software Engineering Workshop (CHASE2010), Cape Town, South Africa.
2. Jantunen, S 2010a, 'The Benefit of Being Small: Exploring Market-Driven Requirements Engineering Practices in Five Organizations', paper presented to 16th International Working Conference on Requirements Engineering: Foundation for Software Quality. RE in Small Companies Workshop (RESC), Essen, Germany, June 29th, 2010.

initial conceptualization of the findings is presented in section 6.2. Section 6.3 illustrates some of these findings with empirical data before further conceptualization in section 6.4. Section 6.5 concludes this chapter and outlines the next round of data analysis.

6.1 Research process

The essential relationship between data and theory is a conceptual code (Glaser, B. G. 1978, p. 55). Coding moves the analysts away from the empirical level by fracturing the data, then conceptually grouping it into codes that then become the theory which explains what is happening in the data (Glaser, B. G. 1978, p. 55). The analyst begins the conceptualization with open coding, which is the part of analysis that pertains specifically to the naming and categorizing of phenomena through the close examination of data (Strauss & Corbin 1990, p. 62). The basic analytic procedures by which this is accomplished are the asking of questions about data and the making of comparisons for similarities and differences between each incident, event, and other instances of phenomena (Strauss & Corbin 1990, p. 74).

Glaser (1978, p. 58) has advised to analyze the data line by line, constantly coding each sentence. The line by line approach forces the analyst to verify and saturate categories, minimizes the possibility of missing an important category, produces a dense rich theory and gives the feeling that nothing has been left out (Glaser, B. G. 1978, p. 58). Furthermore, focusing on small portions of the data at a time helps to ensure that none of the analyst's "pet themes" will be incorporated into the theory unless they have an emergent fit with the data (Glaser, B. G. 1978, p. 58).

The mandate of open coding is that the analyst starts with conceptual nothing – no concepts (Glaser, B. G. 1978, p. 39). When researchers begin the process of naming data incidents, their aim is to open up the data fragments to a wide range of possible interpretations – to be creative and comprehensive in articulating the different ways in which the data might be understood. Thus, when researchers are urged initially to label or code a data incident in more than one way, creating multiple categories to hold it, they are constrained to think in terms of multiple possible interpretations (Locke 2001, p. 69).

The data analysis has been conducted by using Atlas.ti (Scientific Software Development, 2004), which is a software specifically intended for qualitative data. Although we have gathered the data as a project activity, I have conducted the analysis for this thesis alone. I began open coding by scanning the data line by line and assigning labels to those sections of data that I found relevant to the research area. I looked for multiple meanings assigning each interpretation with its own code name.

Even though both originators of grounded theory approach have explicitly warned against creating and trying to work with too many codes (Locke 2001, p. 73), I began open coding with no attempt to limit the number of codes. My primary concern was that, in an attempt to limit the amount of codes, I would be forced to move to an abstract level too soon. I feared that giving abstract codes to portions of the data would, in fact, lead to a loss of important contextual information. I first wanted to reduce the data (Miles & Huberman 1994, p. 10) while still capturing enough information into the code names to be self-descriptive. Thus, I started the analysis by just labeling an act, which, in fact, is not a method in grounded theory (Glaser, B. G. 1978, p. 42). It is merely an early step for conceptualizing a pattern among many incidents (Glaser, B. G. 1978, p. 42). The use of Atlas.ti has provided me means to cope with a large amount of codes. I have further improved the possibilities to manage the codes by adopting a hierarchical coding scheme, according to which the assigned label begins with one of the three primary activities as identified in the initial case study (*sensing the market, making sense of the market and acting upon knowledge*).

Based on the richness of the product development-related empirical data available, seven out of the twelve companies participating in the research project were selected for further analysis (Table 2 in section 3.3), reducing the number of transcripts to be analyzed to 37 interviews. Companies that were excluded from further data analysis either: 1) did not focus primarily on the product business, or 2) the gathered data did not focus on product development related issues.

The following shows a translated excerpt of a transcript after labeling incidents using Atlas.ti:

Q: From which sources do you receive information that is likely to have an effect on the product's future versions?

A: We have a dedicated system for collecting the feature requests. The requests are gathered by a product management team that has resources in our offices all around the world. This team knows well the requests originating from the customers particularly because many of them have a background in providing technical support to the customers.

Q: So, the product management team largely consists of technical engineers?

A: Actually, in some offices, we also have resources whose background is closer to marketing. Their responsibility is to collect requirements on everything they see and hear. Not just what originates from the existing customers. Some of the ideas originate from sales cases. In addition, they may attend exhibitions and follow what competitors have done. We also follow, to a certain extent, what is happening in adjacent segments.

Sensing the market: A dedicated system is being used for gathering market needs.

Sensing the market: The product management team is responsible for gathering the needs regarding the future product.

Sensing the market: Helpdesk experience is considered good in building an understanding of customer's needs.

Sensing the market: There is a need to be sensitive to the surrounding environment (not just customer needs).

Sensing the market: Source: Existing customers.

Sensing the market: Source: Potential customers.

Sensing the market: How: Attending exhibitions.

Sensing the market: How: Analyzing competitors.

Sensing the market: How: Monitoring adjacent segments.

After the essential sections of gathered data were assigned with codes, the analysis proceeded to the next phase in which the relationships between the identified codes were in focus. The purpose of this phase was to move the analysis to a more abstract level while maintaining the link to the gathered data. In grounded theory, such an objective is achieved largely through the process of *memoing*. Memos are the theorizing write-up of ideas about codes and their relationships as they strike the

analyst while coding. Memoing and diagramming are important elements of analysis and should *never* be omitted, regardless of how pressed the analyst might be for time (Strauss & Corbin 1990, p. 198). If the analysts skips this stage by going directly from coding to sorting or to writing, he is *not* doing grounded theory (Glaser, B. G. 1978, p. 83).

Regardless of the detailed advice on memoing (Glaser, B. G. 1978, pp. 90-91; Strauss & Corbin 1990, pp. 199-203), both founders of grounded theory approach also say that each analyst must develop his or her own style for memoing and diagramming. Strauss and Corbin (1990, p. 200) claim that “the method you choose is not important, as long as it works for you. What is salient, however, is that your memos and diagrams remain orderly, progressive, systematic, and easily retrievable for sorting and cross-referencing”. In a similar vain, Glaser (1978, p. 91) states that “always be flexible with memoing techniques. The analyst’s techniques should serve him, not hinder or enslave him. Each analyst has a personal recipe for memoing, and this is always emerging and forcing to change techniques”.

My way of memoing has been considerably different compared to the advice given (Glaser, B. G. 1978, pp. 90-91; Strauss & Corbin 1990, pp. 199-203). Even though it is recommended (Glaser, B. G. 1978, p. 90; Strauss & Corbin 1990, p. 201) to stop all other activities and write a memo as soon as an important idea occurs, insights about the data do not appear to come to me as sudden flashes. Furthermore, I tend to think in visual terms. Hence, instead of writing memos in verbal form, I have advanced my thinking on the codes and their relations by creating visual diagrams. Often such diagrams have resulted in independent research papers (Jantunen 2010a, 2010b; Jantunen & Saarenketo 2007; Jantunen & Smolander 2006a, 2006b; Jantunen, Smolander & Gause 2007). These papers can be considered as written memos on the larger research effort. I don’t consider the fact that I am memoing in a different way harmful for this study. I still obtain mid-level results that bind the data and theory together.

The analysis focusing on the relationships between codes was also conducted with Atlas.ti (2004). The codes from all interviews of a particular organization were exported to one organization-specific network diagram, where each of the codes was represented as individual boxes. The analysis proceeded from there by visually organizing and connecting codes until the organization-specific network diagrams formed maps of clearly definable interconnected clusters with similar codes next to each other (see Figure 14 for an example). Hence, based on my interpretation, associations were added between codes and similar codes were moved closer to each other. Such network diagrams can be considered as knowledge maps, a visual display of captured information and relationships (Vail 1999). A knowledge map can serve as

an inventory. It is a 'picture' of what exists in an organization or a 'network' of where it is located (Egbu & Suresh 2008).

Knowledge maps have been reported to be an excellent way to capture and share explicit knowledge in organizational contexts (Wexler 2001), helping to support cognitive processing by reducing cognitive load and enhancing the representation of relationships among complex constructs (O'Donnell, Danserau & Hall 2002). Each way that one organizes information can create new knowledge and understanding. This new understanding results from the organizational context that knowledge maps can provide (Eppler 2001).

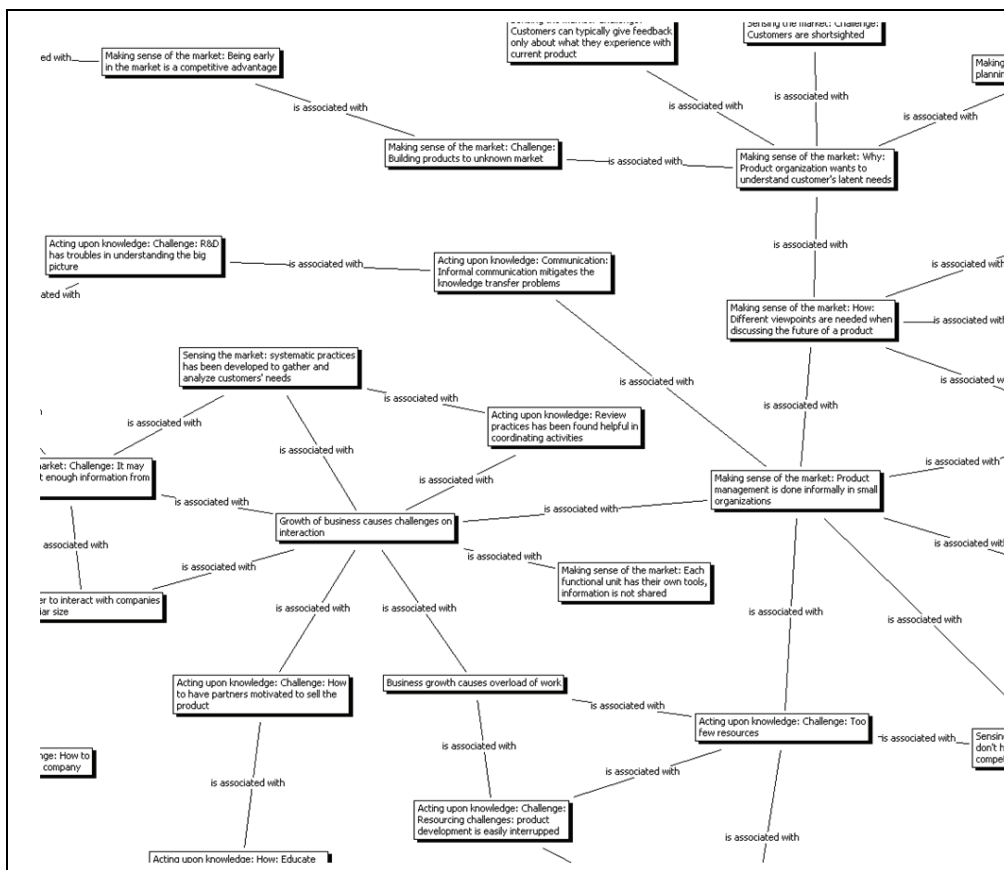


Figure 14. Partial example of an organization-specific network diagram created with Atlas.ti

These organization-specific diagrams have then been compared with three types of questions. The most general question, "What is this data a study of?", continually

reminded the researcher that the original intents of what the analyst thought he was going to study just might not be, and usually is not (Glaser, B. G. 1978, p. 57). The next vital question, “*What category does this incident indicate?*” forces coding that earns its way into the theory by its grounding in the data (Glaser, B. G. 1978, p. 57). Lastly, the analyst asks continually: “*What is actually happening in the data?*” keeping the substantive directions in tractable focus, as they force the generation of a *core* category (Glaser, B. G. 1978, p. 57).

6.2 Results

Due to the qualitative nature of the gathered data, efforts to describe the data conceptually are always subject to interpretation. The results cannot be described with high precision.

My effort to describe the gathered data at a higher level of abstraction is largely based on the comparison of the organization-specific maps. This analysis revealed two primary dimensions according which each company could be differentiated:

1. The *perceived challenge* of developing software appeared to vary notably between the two extremes. Some companies faced the challenge of deciding whether a new functionality should be implemented only for a particular customer or as a new general product feature. Product development in such companies was often hampered by the fact that customer delivery projects took higher priority. These companies thus faced the *challenge of executing* the plans. At the other extreme, the challenge appeared to be one of *comprehension and communication*. Such challenges have been reported in detail in chapter 5.
2. The *software development style* also appeared to have clearly distinguishable extremes. Some companies had agreed on only a few shared software development related rules and practices. These companies were labeled to have a *flexible* software development style in contrast to the *systematic* style of software development with clearly defined processes.

In addition, company-specific interviews, gathered documents and company facts were revisited with an attempt to distill a set of characteristics for each analyzed company consisting of 1) the number of employees working with the product, 2) the degree of tailoring that appeared to be necessary for satisfying customers’ needs with the product, and 3) the geographical scope of the business. The geographical scope was considered to be domestic if the primary market area for the product had not extended beyond Finland and the neighboring countries.

The two dimensions have then been used as coordinates according to which I have situated the analyzed companies with their corresponding characteristics (Figure 15).

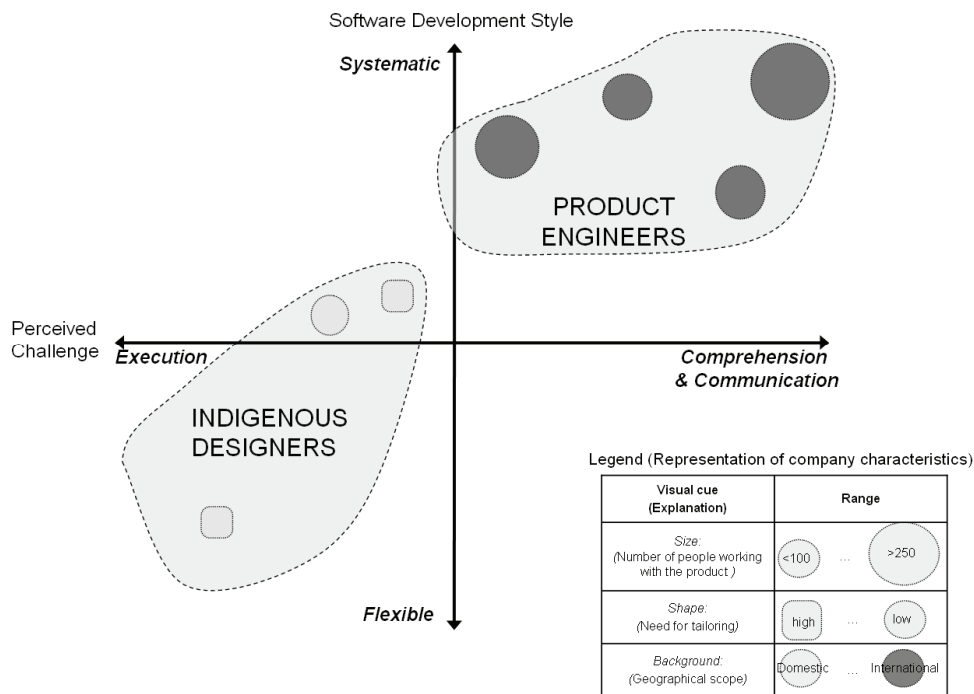


Figure 15. Description of similarities and differences in companies' software development context.

Although the placement of companies in Figure 15 cannot be claimed to be highly accurate, the figure nevertheless illustrates vividly the emergence of two distinct clusters. Four of the seven analyzed organizations showed similar characteristics in their product development practices and challenges compared with the results of the early case study (section 5.2). Due to their attempt to organize their product-related activities with systematic processes, this category of companies was labeled as *product engineers*. These organizations tended to 1) emphasize product development over tailored development, 2) seek a systematic style of developing software, 3) face challenges of comprehension and communication and 4) conduct global product business with diverse and complex network of stakeholders.

The essential characteristics of the other three companies were distinctively different. Although these companies were all relatively small in size, the number of employees is not the only factor to explain the perceived differences. Other factors affecting the software development style have been reported to be the type of the customers, the background and skills of the developers, the preferences of the company's founders,

the nature of the business environment, and the spatial layout and geographical distance of the offices (Aranda, Easterbrook & Wilson 2007). Hence, I decided not to create labels based on the organization's headcount. Instead, this group of companies was labeled as *indigenous designers*. These organizations tended to 1) emphasize tailored development, 2) favor the flexible software development style, 3) face challenges in executing the plans, and 4) deal with a rather small network of stakeholders.

The challenges and practices of *product engineer* organizations have already been described in section 5.2. The following section focuses on presenting data describing an *indigenous designer organization*. A further analysis of the similarities and differences of these two types of organizations are then presented in section 6.4.

6.3 Characteristics of indigenous designer organization

All indigenous designer organizations had only a handful of people working with the product. Characteristic to such an organization is that there are no clear roles. Everyone conducts many different types of tasks:

"The benefit of working in a small company is that when you wear a tie instead of a t-shirt, you know that you are currently doing sales work."

-Software developer in an indigenous designer organization

As long as the organization is small enough, work is carried out rather informally, relying heavily on collaboration:

"The two of us hold a face-to-face meeting in which we go through what we need to do for the next product version. Then, we present the roadmap to our management who ask reasons for our decisions.

We have such a light organization. We can sort things out while having a cigarette."

-Two workers responsible for a product in an indigenous designer organization

Relying largely on human collaboration is typically positively experienced:

"I don't necessarily long for a fancy organization that produces loads of documents. I'd rather do real work."

-Software developer in an indigenous designer organization

The fact that everyone has a wide range of responsibilities appears to be beneficial in determining what functionality needs to be implemented in the forthcoming product versions. However, informal work practices may also have unwanted consequences. The absence of formal work practices may lead to individualism:

"We all have long traditions of working in our own individual ways. If you try to have all of us work in a uniform way, you will fail."

-Software developer in an indigenous designer organization

“He has his own way of thinking about certain matters and he implements his thoughts without discussing it with others. When others disagree, there may be some shouting in the hallways. There are quite many propel heads here with strong personalities.”

-Project manager in an indigenous designer organization

Informality and individualism also introduce risks:

“If I get hit by a tram on my way home, that’s about it. The product-related knowledge would be pretty much lost.”

-Software developer in an indigenous designer organization

Strong personalities tend to dominate decision making in small organizations. In some companies, the product development decisions were made by the developers:

“If the sales guys had even the slightest clue of what we are playing around with, they would immediately call to the customers and use the information to sell a feature before we had decided to implement it. That’s why we are very cautious of revealing information to the sales guys.”

-Software developers in an indigenous designer organization

In other companies, decisions were made by sales:

“I’d say that 80 percent of the decisions to implement a new feature have actually been made by selling the non-existent functionality to a customer.”

-Salesman in an indigenous designer organization

Furthermore, informal work practices work only up to certain point. As the organization begins to grow, the need for more formal work practices increases:

“At the moment I do all of the coding. If we hired even one more person, things would get ten times more complicated. We would need to start synchronizing and agreeing on everything and start assigning responsibilities.”

-Software developer in an indigenous designer organization

The first symptoms of the need for more formal work practices appear to be coordination problems:

“We have too many competing versions that we have implemented in different customer projects. Other projects may start from scratch, implementing a solution that we have already implemented in another project. The developer may not have heard about the existing solution or he prefers to develop the solution himself rather than develop further an existing solution.”

-Project manager in an indigenous designer organization

Another symptom is version control problems:

“Occasionally, someone comes to notify me that he has just saved a new version of a source file I was also working on. The fact that my recent work was lost makes me often annoyed enough to overwrite his work by saving my version of the file.”

-Project manager in an indigenous designer organization

6.4 Discussion

This section continues to compare the organization-specific network diagrams in order to analyze the similarities and differences between the organizations at a higher conceptual level.

The further conceptualization begins with the recognition of tacit knowledge as an important factor affecting the product related decision making. Since tacit knowledge is deeply rooted in action, commitment, and involvement in a specific context (Nonaka 1994), the data analysis first identified three contexts in which people participate when determining what functionality shall be implemented in the product's forthcoming versions. These contexts are the same as the three distinct sets of activities already identified and described in the initial case study (section 5.2): 1) *sensing the market*, 2) *making sense of the market*, and 3) *acting upon knowledge*.

The people participating within these three contexts appeared to go through similar activities in all of the analyzed organizations. These identified phases suggested seven categories (Figure 16).



Figure 16. Three contexts and seven phases of determining what will be implemented in forthcoming product versions.

The first activity, *listening*, relates to gathering information about product-related needs. This activity was already conceptualized in Figure 8 (Page 52). The data analysis identified a notable difference between product engineers and indigenous designers in their way of listening to a product's stakeholders. While product engineer

organizations typically had specialized workers listening to the product-related needs, listening was just one of the many responsibilities of workers within an indigenous designer organization.

The second activity, *sharing*, relates to making the gathered product-related needs available to others. Again, the data analysis identified a notable difference between the two types of organizations. Sharing in indigenous designer organizations was often unsystematic and spontaneous (section 6.3), whereas product engineer organizations typically had established processes and systems to store the gathered product-related needs (section 5.1).

The third activity, *determining*, relates to describing what the actual requirement is. This activity has been identified to be challenging due to the fact that customers often are unable to articulate their real needs (section 5.1).

The fourth activity, *knowing*, relates to understanding the impact of the proposed requirement. This activity includes building the understanding of the requirement's value from different viewpoints and determining the requirement's conflicts and dependencies with other requirements. This activity was identified in section 5.1 as a significant and complex challenge, which can be alleviated with experience and tacit knowledge.

The fifth activity, *deciding*, relates to choosing which of the requirements shall be implemented. In a product engineer organization, the primary process supporting this activity is requirements prioritization. Deciding is often performed in a less formal way in an indigenous designer organization.

The sixth activity, *communicating*, relates to informing the decision made to the ones responsible for acting on them. This appeared to be a source of challenges in product engineer organizations, where workers were occasionally left with insufficient levels of information on the decisions made (section 5.1).

The seventh activity, *implementing*, relates to making the decisions real.

The three contexts people are involved in and the seven activities of determining what shall be implemented in a product's forthcoming versions create a framework that illustrates the differences between indigenous designer and product engineer organizations (Figure 17).

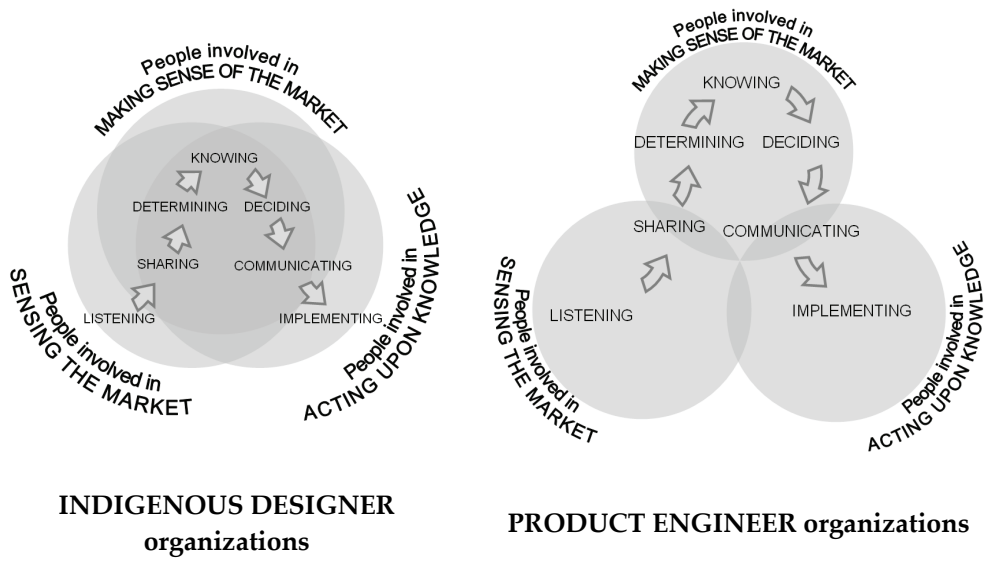


Figure 17. Conceptualized differences between indigenous designer and product engineer organizations.

The workers in indigenous organizations perform diverse sets of tasks. This enables them to utilize efficiently tacit knowledge they have gained in their day-to-day social interaction. Since tacit knowledge is difficult to formalize and often time- and space-specific, tacit knowledge can be acquired only through shared direct experience, such as spending time together or living in the same environment (Nonaka & Toyama 2003). Furthermore, continuous face-to-face connections allow the workers to share information in a richer format than with documents.

When the organization grows, it begins to face coordination challenges. The analysis of the interviews revealed that organizations typically alleviate such challenges with increasingly systematic work practices by introducing processes. With these processes, workers begin to specialize and information begins to be shared more in an explicit and documented form. Paradoxically, with the efforts to increase coordination, organizations appear to lose the benefits of human collaboration. A growing organization may soon find itself in the middle of communication challenges where workers need to work with partial information. With the reduced human collaboration, growing organizations lose advantages that once helped them to perform well.

6.5 Conclusions

This chapter reported the data analysis of seven organizations. A total of 37 transcribed interviews were analyzed line by line, constantly coding each sentence, and by looking for multiple meanings. The data analysis has resulted in organization-specific network diagrams providing a visual display of the captured information and relationships within each of the analyzed companies.

The comparison of the organization-specific network diagrams suggested that the analyzed companies can be claimed to belong to one of two distinct groups: 1) *indigenous designers*, who follow a flexible style of developing software but often face challenges in executing plans, or 2) *product engineers* who seek to develop software in a systematic way, but often face challenges of comprehension and communication.

Further conceptual analysis of the organization-specific network diagrams resulted in three contexts and seven phases describing how organizations determine what shall be implemented in forthcoming product versions. These categories have then been utilized in describing further the similarities and differences between *indigenous designers* and *product engineers*.

The findings presented in this chapter suggest that changes in an organization's product development context create challenges for the product development activities. Organizations tended to rely on human collaboration as long as the number of product development related workers remained in a manageable scale. Once the organization grew larger, it was forced to introduce processes in order to increase coordination. However, such a change in the product development approach created new challenges. With processes, workers tended to specialize and share information increasingly and explicitly. The specialization of the workers has led to diminishing opportunities to utilize tacit knowledge, which has, in turn, created challenges particularly when making sense of the market needs.

In addition to the organization's growth, the data analysis revealed another potentially significant change causing new challenges in the organization's product development activities. Two of the analyzed organizations showed particularly similar challenges with existing literature describing MDRE practices and the related challenges. One common denominator with the two companies was the fact that both of them had already extended their business into a global marketplace. This is the lead I have taken in focusing my study in the following chapter. I will focus on a particular change in the organization's business environment and understand better how it has altered the challenge of managing their software product. To be more precise, I want to gain a deeper understanding of how the challenge of managing a software product changes when the product is offered in a global marketplace.

7 How internationalization of a product changes requirements engineering activities?³

Imagine that you are a manager in a small software firm with a successful product. The product has already reached its potential in its home market and there is no more sales growth in sight. What shall you do in order to ensure the viability of your company? Emphasize bespoke software development? Expand your product portfolio? Offer your existing product in new customer segments? Such actions may ensure the stability of your company, but they may also result in a loss of focus. If you truly believe in your product, finding new market areas for it may provide your organization an opportunity to grow while allowing your workers to build their competence in a clearly defined scope. What, then, does it take for a software firm to move into international markets with a product? What are the product development related challenges the firms face and how could a firm anticipate such challenges? These questions outline the purpose of this chapter.

³ Substantial sections of this chapter have earlier been published in:

1. Jantunen, S, Smolander, K & Gause, DC 2007, 'How Internationalization of a Product Changes Requirements Engineering Activities: An Exploratory Study', paper presented to 15th IEEE International Requirements Engineering Conference (RE 2007), New Delhi , India, October 15-19th, 2007.
2. Jantunen, S & Saarenketo, S 2007, 'Exploring the Modes of Foreign Entry from the Product Development Viewpoint', paper presented to The R&D Management Conference, Bremen, Germany, 4-6 July, 2007.

This chapter focuses on a lead that emerged from the data analysis in chapter 6. Those organizations that had already moved into the global market place showed similar unique characteristics in their product management practices and challenges. While the internationalization of a product causes challenges in the adaptation of the software to non-native environments, the topic of making software portable to other locales is excluded from this study. The focus in this chapter is to explore the impact of internationalization on companies' RE practices.

In this chapter, I advance further in grounded theory coding procedures. I continue to understand how the identified codes are related to each other in two particular organizations that are already conducting product business worldwide.

The remaining part of this chapter is organized as follows: section 7.1 describes the research process for this phase of analysis. The results of the analysis are presented in section 7.2 and discussed in section 7.3. The results are compared with literature in section 7.4 and, finally, conclusions are drawn in section 7.5

7.1 Research process

Both originators of grounded theory approach (Glaser, B. G. 1978, 1992; Strauss & Corbin 1990) describe coding as an essential aspect of transforming raw data into theoretical constructions. However, as mentioned in section 2.4, Glaser and Strauss have differences in their coding procedures. Glaser distinguished two types of coding processes, substantive (open) and theoretical. Strauss and Corbin (1990) described three: open, axial, and selective. The approaches to open coding are similar, although Glaser places more emphasis on the importance of allowing codes and a theoretical understanding of the data to emerge than Strauss and Corbin do (Kendall 1999).

The main controversy involves Strauss and Corbin's addition of an intermediary set of coding procedures called axial coding (Kendall 1999). Axial coding is defined by Strauss and Corbin (1990, p. 96) as "a set of procedures whereby data are put back together in new ways after open coding, by making connections between categories. This is done by using a coding paradigm involving conditions, context, action/interactional strategies, and consequences". Glaser (1992, p. 123) noted that "if you torture data enough, it will give up!". Glaser insists that the codes used and, in fact, the actual labels placed on the codes should be driven by conceptual interests that have emerged from the data and not "forced" into any particular scheme, such as the paradigm model (Kendall 1999).

Glaser's approach may be seen as risky and unfocused by many who are reluctant to give themselves up to the data and wallow in the creative process. Strauss and Corbin,

on the other hand have been accused of stifling creativity by making the methodology overly mechanistic, highly formulistic and inflexible. Consequently, it is important to recognize the differences in order to avoid confusion over terminology and procedures (Goulding 2001).

The data analysis of this thesis follows Glaser's approach. Hence, I have not conceptualized the data in terms of causal conditions, phenomenon, context, intervening conditions, action/interactional strategies, and consequences, as suggested by Strauss and Corbin (1990, p. 99). Rather, I have followed the lead of the data suggesting that moving into a global marketplace notably changes the organization's challenges of developing a software product.

The purpose of this round of analysis is thus to understand better how the move into a global marketplace changes the challenges when people are *sensing the market, making sense of the market* and *acting upon knowledge*. When articulating the purpose of this chapter in terms of the research area statement (chapter 1.3) the question becomes:

How do human aspects in software product companies' requirements engineering activities change when the company begins to offer its product in a global marketplace?

Through theoretical sampling (Glaser, B. G. 1978, p. 37), the analysis now focuses on two companies that had demonstrated similarities with each other and with existing MDRE literature. A common property for both of the companies was the fact that the major part of their business was based on software products that assist modeling and design activities within various engineering domains. Furthermore, both companies had in recent years extended their product offering outside of their home market. One of the companies, Tekla, was already introduced in chapter 5. Tekla's model-based software products were at the time of analysis used in more than 80 countries (Tekla 2009b). The other company, Vertex, develops products for technical design and data management. Compared to Tekla, its internationalization history is shorter, but it has already started the process, especially in Europe and North America. Their products were at the point of analysis being sold in 31 countries.

The data analysis was conducted by analyzing Tekla- and Vertex-specific network diagrams that were created in the previous phase of analysis and by revisiting a total of 11 interviews involving a total of 16 interviewees (Table 4). The average length of the interviews was approximately two hours. Altogether, the 11 interviews lasted more than 20 hours and produced more than 130,000 words of transcribed text. The interviewees in both companies represented various functions in their organizations, including product management, marketing management, product development, and general management. In addition to the interviews, data were also collected from

documents given by Tekla and Vertex, revealing details of the companies, their products and the processes they followed.

Table 4 . Demographics of analyzed interviews.

(Interviews in which I have been present are represented in a gray background)

Date	Interviewee information		Researchers	Theme of interview	Length of interview	Transcribed words
	Persons	Roles				
VERTEX:						
9.11.2005	1	Business Management	2	Internationalization	2:06:29	13009
9.11.2005	1	Marketing Management	2	Partnerships	1:41:54	8979
9.11.2005	1	Product & Partnering Management	2	Collaboration with partners, R&D	1:03:28	6932
10.11.2005	1	Management of Foreign Office	2	Core competence, internationalization	1:46:48	11092
10.11.2005	1	R&D Management	2	Juridical issues	2:06:28	11659
11.11.2005	1	Management of Foreign Office	1	International partnerships	1:21:30	7539
17.11.2005	1	Management of Foreign Office	1	International partnerships	unknown	5243
TEKLA:						
1.12.2005	2	Business Management, Partnering Management	2	Business and Internationalization	2:11:47	14804
1.12.2005	2	Partnering Management, Legal Issues	2	Partnerships and Juridical Issues	3:10:45	20326
8.12.2005	5	Business Management, 3* Product Management, Software Development	1	Product development processes	2:17:05	14875
8.12.2005	6	3* Product Management, Business Management, Partnering Management	1	Relation Between Business and Development	2:53:05	14593

7.2 Results

If a company chooses to expand its product offering to new market areas, it will need to make a decision regarding the mode of the foreign entry. Such a decision is often distilled into two distinct options: entering new market areas 1) with the company's own workers or 2) with partners. What, then, are the benefits and drawbacks of different market-entry modes? One variable in this equation to solve is the easiness of market entry and the investments needed:

"The benefit of using partnerships as a market-entry mode is that there is a low threshold to enter the market and low investments involved. Given that the partner already has sales competence and knows the domain of the product, they can start selling the product quickly. By letting the partner keep a certain percentage of the sales price we can enter the new market with very little effort."
(Vertex's partner management, November 2005)

On some occasions, partnering may not be an option at all. For a product to be partner capable, it must meet certain criteria. The product needs to be flexible, easy to learn and easy to use. Low usability may easily lead to difficulties in finding a partner that is willing to sell the product:

“The product may be efficient for a customer after he or she has gone through the pain of learning the product. However, the partners may not be willing to step into such a difficult environment. Some resellers don’t have the luxury of investing so many man-years to learn the product in order to start to sell it. They rather pick an easier product.” (Vertex’s management of foreign office, November 2005)

The flexibility of a product is important in order to be able to build localized and customized versions that meet the unique needs of a certain market. If the product is flexible, the product development company has the option of deciding who will be responsible for its alteration and to what extent. Allowing the partner to customize the product or to integrate it to other solutions may lead to more efficient use of the product organization’s workers and even increased commitment by the partner.

“Due to the possibility to take part in our product’s customization for a specific market area, our partners have been able to feel a sense of pride and ownership for the product.” (Vertex’s partner management, November 2005)

If the product has low usability and flexibility, or a committed partner is difficult to find, it may be wise for the company to stop considering partnering and enter the market with its own workers.

Regardless of the chosen market-entry mode, the decision to move into a global marketplace will affect the challenge of developing their software product. This section describes in closer detail how such a decision affects the three contexts of: 1) *sensing the market*, 2) *making sense of the market*, and 3) *acting upon knowledge*.

7.2.1 Sensing the market

The analysis revealed that the internationalization of a product causes challenges for sensing the market largely due to: 1) the increased complexity in the product’s stakeholder network and 2) the exacerbation of existing issues with sensing the market.

The gathered data suggested at least two notable sources of complexity introduced by marketing a product to a new customer base. Firstly, the number of customers and the diversity of their needs increase:

“As the number of our customers grew, we did not realize right away that we cannot continue [with customer interaction] the same way we have in the past. In a way, we were forced to detach

ourselves from the customer. We were not able to understand the needs of all customers any more.”
(Tekla’s product management, December 2005)

As a consequence, it may no longer be possible to know all customers and their needs deeply. Such a change forces the organization to rethink how the voice of a customer should be extracted.

Secondly, a new communication link in the market sensing activities is introduced. In many cases, the voice of a customer will now be expressed first to the partner. The partner then may pass this information on to the product development organization *selectively*:

“Very few resellers report all of their sales cases. They typically inform us only about the sales made. If we could have the resellers commit more and have them send us more complete information regarding their sales activities, we could see better to which direction the business is heading.”
(Vertex’s management of foreign office, November 2005)

Alternatively, the partner may pass this information on as *modified* according to the partner’s own interests:

“It is typical that resellers distort the facts. This is a fundamental contradiction between the reseller and the product development organization. The reseller always tries to give a less promising view of its markets because this supports his position.” (Vertex’s marketing, November 2005)

“It is easy [for a regional reseller or country office] to make an appealing business case stating that we have great potential in our market and if you implemented this feature, I could sell the product in enormous amounts. Judging the true potential of this business case is difficult.” (Tekla’s partner management, December 2005)

When information is conveyed across company boundaries, the product organization faces higher challenges compared to interacting with its own workers in the market area. Collaboration with an external party exacerbates the issues such as conflict of interest, trust and commitment:

“Partners may continuously fear that if we see the true potential of their market, we might get rid of the partner and start our own country office. This is the basic contradiction between the product organization and the reseller. The reseller tries to emphasize how challenging the market is, how valuable his or her work is and how expensive it is for us to enter the market on our own.” (Vertex’s marketing, November 2005)

The added link in the market sensing chain has also been found to introduce delays in managing customer requests. In addition, it has increased the likelihood of misunderstandings. Interviews both in Tekla and Vertex revealed that partners often say *what* should be done instead of *why* a feature of a product should be modified or implemented—thus focusing on *their* solution and *their* perceived problem rather than

stating the problem that they wish the product to solve. Perhaps these are some of the reasons why customers in foreign markets tend to prefer direct contacts with the product development organization. However, bypassing the regional organizations also creates challenges in managing customer needs, and product development organizations have thus been reluctant to have direct contacts with customers without the presence of a regional organization.

Sensing the market is a demanding task even when an organization operates solely in its home market area. One challenge that has been witnessed across several organizations, regardless of their level of internationalization, is that it is difficult to determine what the needs of a customer truly are. Product development organizations often feel that customers are too shortsighted to be able to articulate their future needs. Customers typically give feedback only about what they experience with the current product. Furthermore, product development organizations have deficiencies of their own when eliciting needs of the customers. Not surprisingly, these challenges may be even more difficult when interacting with international customers:

“We have had problems [in sensing the market] because [the foreign customers] don’t tell us their needs. You really have to go and drag that information out of them. It does not work if you send a release to a customer and he replies “OK, nice work”. We need a huge improvement in systematic verification activities and the activeness of communication.” (Vertex’s business management, November 2005)

7.2.2 Making sense of the market

When a product is offered to different market areas, it becomes increasingly difficult to find synergy between the requests. The more the number of customers and the diversity of their needs increase, the more difficult it is to manage a single product. In such an environment, the product development organization will face increased challenges on how to be equitable to all stakeholders when making decisions regarding the future releases of a product:

“The biggest challenge towards our partner is that they feel that we are not implementing enough of their requests in a timely manner. They feel that we always give higher priority to our own needs related to theirs.” (Vertex’s product development, November 2005)

The inability to be equitable to different stakeholders will affect the commitment of the stakeholders. The decrease of commitment tends to be higher among partners compared to the product organization’s own remote workers:

“Sharing information with the partners surely affects their level of commitment. If they know that the product is going in the direction they want, their commitment towards you increases. If they feel that the product is going in the wrong direction, they will start to consider whether the road of partnership should come to the end. If there are disagreements at the moment but they can see that there are promising features to come, the shared information may be enough at the moment to

continue their commitment to us.” (Vertex’s partner management, November 2005)

On the other hand, partners tend to have less interest when it comes to the future direction of a product as a whole. They are mostly interested in ensuring that their wishes are implemented. They are often little aware of the problematic overall trade-offs that the product development organization has to make:

“Stakeholders from different market areas are often very precise concerning how well each party has succeeded in having their requests implemented. If someone else succeeds better, it will be talked about for sure. Different stakeholders tend to want to be active in decision making only related to features that are important to their own market area.” (Vertex’s partner management, November 2005)

One reason for this, however, is that the partners may not even have the possibility to see the whole picture, as the product organization may have concerns about sharing detailed information with partners:

“When we have discussions with our country offices, we typically share more information with them than with the partners. For instance, we may discuss details of our present workload or customer cases. You could say that we have more open and in-depth conversation with our country offices compared to the discussion with partners.” (Vertex’s partner management, November 2005)

The findings thus indicate that there is a notable difference in sensemaking activities between collaboration with a partner and collaboration with the company’s own remote workers. The difference can be seen in the level of commitment that the remote party takes in the sensemaking activities and in the richness of information that is being exchanged.

Much of the challenges related to making sense of the market can be traced to the problem of determining the value of a request. An articulated market need requested in a certain geographical area may benefit other regions and other customer segments to some extent:

“We have a challenge in the future that the ever increasing product offering should be taken into the global marketplace. How to set the priorities in such a situation? They are convergent to some extent [in different geographical areas] but not completely the same.” (Tekla’s business management, December 2005)

However, transparency and systematical decision making rules are difficult to put in place if the product development organization has not collected enough data regarding the value that different stakeholders perceive in a request. In the absence of detailed data regarding the needs of stakeholders, a product development organization often relies on a gut feeling, which leads us again to the challenge of being equitable.

7.2.3 Acting upon knowledge

Once the stakeholders' needs originating from different market areas have been understood to the extent that priorities can be given to them and a release plan can be made, it is time to verify the plans and act upon them. In this phase, collaboration with the remote parties will focus on building the sales readiness for the forthcoming release. The release management process description given to us by one of the companies revealed that publishing a new release requires the launch readiness to be secured across functions within the company (sales, services, marketing, product management, software production, etc.) in *each* of the markets separately. Building sales readiness in international settings places great demands on communication and collaboration. When interaction occurs across organizational and geographical boundaries, trust will easily start to play an increased role. In addition, reaching a common understanding becomes increasingly difficult. Furthermore, when selling through partners, sharing information regarding the new release is not sufficient. Partners also need to be *motivated* to sell the new release. The product development organizations have, in such cases, met a greater need to develop easy-to-understand content for the future plans of a product. One way to resolve this challenge may be to use a roadmap as a communication vehicle:

"I plan to prepare a roadmap that can be shown to stakeholders in the market areas, salespersons and country managers. In the roadmap, I hope to be able to describe the future plans in a way that the stakeholders can understand. I hope to do this in such a way that I can just say: 'here are our plans and schedule, read this and then ask questions'." (Tekla's product management, December 2005)

7.3 Discussion

The findings from this round of analysis are summarized in Figure 18. When a product is sold to a new customer, the characteristics of the design problem change. New customers may introduce new requests that may conflict with the needs of previous customers. The change is even more dramatic when a product is introduced in a new market area. Different market areas are often in different technological maturity phases and tend to have different preferences regarding the functionality of a product. It can thus be said that, in market-driven software development, the characteristics of a product's design problem changes continuously and the internationalization of a product accelerates this change even further.

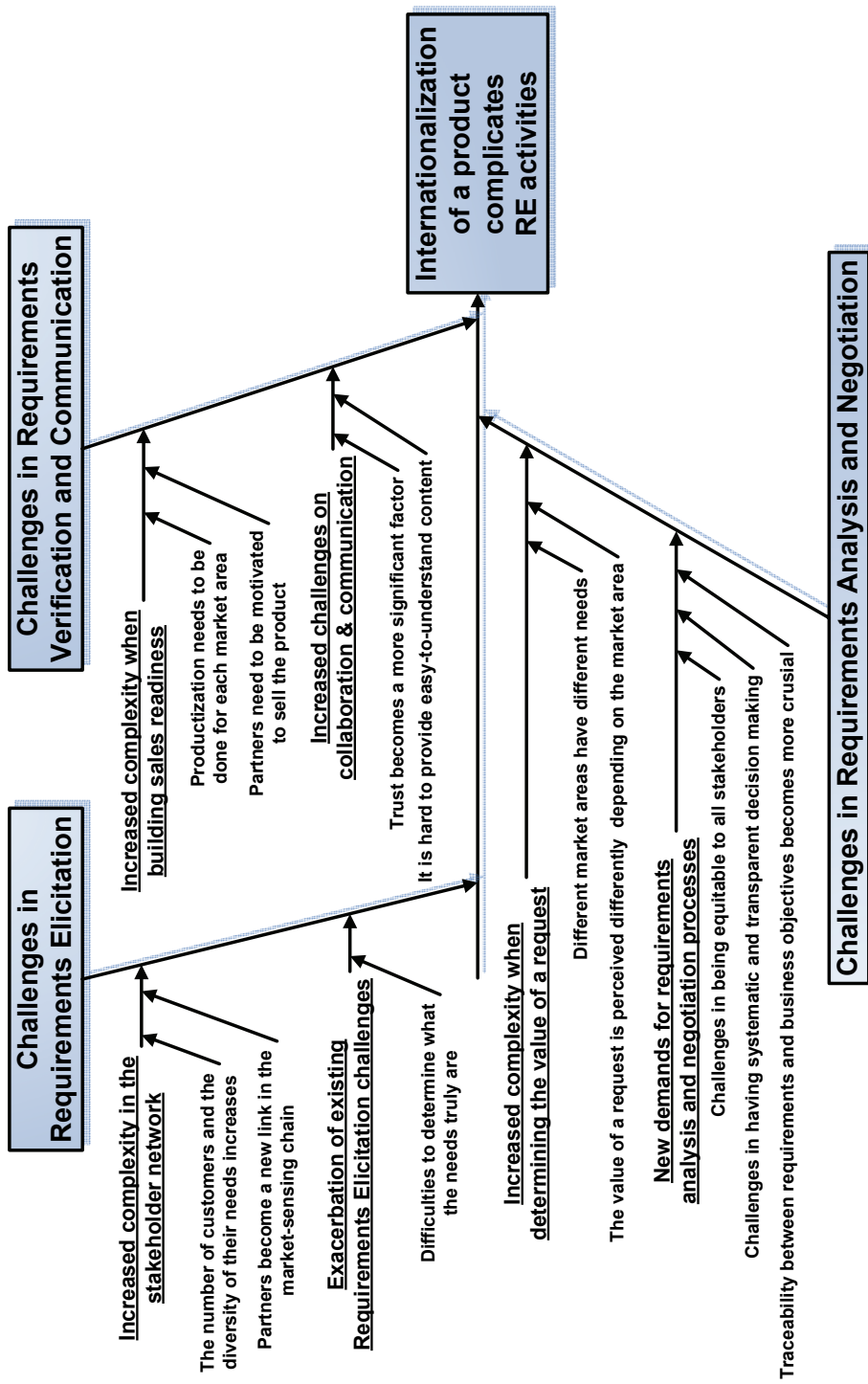


Figure 18. Summary of how internationalization of a product changes the product development challenge.

The fact that new market areas are often entered with partners introduces further risks. By collaborating with partners, the organization is taking the risk of losing some of its control over the product development activities (Figure 19). The underlying cause for the loss of control lies in the fact that partners' interests may not be the same as those of the product organization. The consequences of the conflict of interest may potentially be seen throughout the life-cycle of a product.

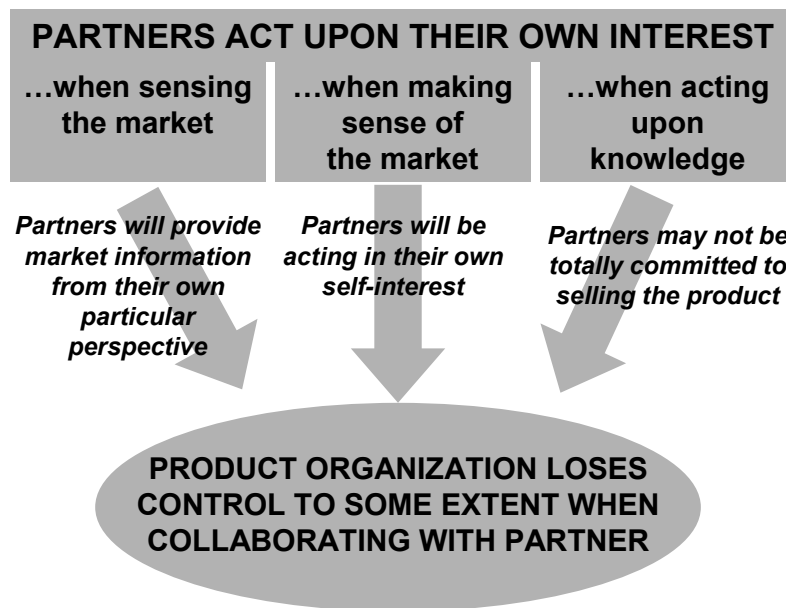


Figure 19. A model describing the loss of product-related control when collaborating with partners.

The risk of losing control when operating with partners has already been recognized within the analyzed companies:

“We have better touch for our own country organizations on what activities are going on and what are the competences of resources. We know how well they are able to support the local customers and what their sales activities are. We do not genuinely know these pieces of information about our partners. From them, we are mainly able to get what they are selling. In summary, we are able to get closer to the operative action with our own country office than with collaborating with partners.” (Vertex’s partner management, November 2005)

“After dealing with so many resellers, I feel that if the market area is significant for our business, I prefer to manage it through our own country organization. In this way, we have it completely in our control.” (Vertex’s business management, November 2005)

However, examples from both of the case companies revealed that partners may also turn out to be valuable companions. Such partners typically have based their business on being the product's reseller and are thus very committed and motivated to grow with the product organization. In both cases, the case companies have rewarded partners' commitment and willingness to grow by granting partners large sales responsibilities. Such partners have also proved to be valuable resources in product development activities ranging from product innovation and development to product support and training.

7.4 Comparison to the literature

Studies exploring how the internationalization of a product changes requirements engineering are still sparse. There is not much information available on how firms could anticipate the likely RE-related challenges introduced by the product's entry to a foreign market. Damian (2007) has reported challenges of stakeholders' interaction in global RE that are similar to the results of this chapter, with a call for new collaborative ways to achieve a shared understanding of the client's needs as well as the technological possibilities to address them. Mahemoff and Johnston (1998) have reported that when software development is taken into a global context, the requirements are not only impacted by overt factors (e.g. measurement units, calendars), but also covert factors that fall into four major categories: 1) the *mental disposition* that results from different cultures leading to differing preferences; 2) *perception* that results from variation in life experience leading to vastly different interpretations of the same stimulus, 3) *social interaction rules* that exist because body language, facial expressions, and dialogue styles all vary with culture, and 4) the *context of use* that arises because the environment in which a user operates can vary markedly, and therefore impose a range of constraints.

Some studies have touched upon the topic of internationalization in the context of market-driven software development. For example, Regnell *et al.* (2001) have addressed the challenge of combining information from different market segments and making a trade-off between their priorities. Coronado and Livermore (Coronado & Livermore 2001) have described how the internationalization of a product has been organized in one company.

The challenges caused by internationalization are also related to a more general topic of Global Software Development (GSD), which addresses issues of software engineering in geographically distributed settings. GSD can be organized and managed in many different ways (Berenbach 2006; Ebert, Christof & De Neve 2001), each having their own advantages and drawbacks. An overview of opportunities and threats in distributed development has been reported by Ågerfalk *et al.* (2005).

Despite the fact that there is a wealth of literature on market-entry modes, it seems that most studies provide only descriptive information on the chosen entry modes (see Bell 1995; Shrader, Oviatt & McDougall 1997 for exceptions). Surprisingly few studies have pursued explaining how to choose and cope with the alternative entry modes. Anderson and Gatignon (1986) have developed propositions that assist the organization in its market-entry determination based on the characteristics of the organization, product and environment. This study provided evidence for such propositions in the following way (Jantunen & Saarenketo 2007):

P1: Modes of entry offering greater control are more efficient for highly proprietary products or processes. (Anderson & Gatignon 1986)

Supporting evidence for the proposition was identified, suggesting that if the product's flexibility is not at a sufficient level, it may not be partner capable. The customization of a proprietary product easily leads to a discussion of details that are difficult to share across company boundaries. The information may be too difficult to articulate in easy to understand form or it may be too sensitive to share.

P2: Entry modes offering higher degrees of control are more efficient for unstructured, poorly-understood products and processes. (Anderson & Gatignon 1986)

According to Anderson and Gatignon (1986), the challenge of unstructured, poorly-understood products and processes refers to difficulties in reaching a common understanding of what the problem and its parameters are. As discussed earlier in this chapter, the analyzed companies claimed to have better touch for foreign market areas through their own country offices compared to collaborating with partners. Therefore, when the products and processes are unstructured and poorly understood, it may be better to enter the new markets with one's own workers.

P3: Entry modes offering higher degrees of control are more efficient for products customized to the user. (Anderson & Gatignon 1986)

When a product needs to be customized for the user, there will be intense collaboration regarding the details of customization. If the product is flexible enough to allow easy customization, this task could be given to the partner. In fact, examples were identified from both of the case companies, in which partners were successfully used in relieving the product organization's customization related workload. However, developing the partner relationship to the level that customization related work can successfully be transferred may require a long period of time and effort. In such cases, the safest option may be to enter the market with the company's own workers.

P4: The more mature the product class, the less control firms should demand of a foreign business entity. (Anderson & Gatignon 1986)

If a product has matured in the sense that most of the known customers' needs have already been fulfilled, the impact of the challenges identified in this chapter decreases. In such situations, the loss of control related to the product is no longer a significant factor.

7.5 Conclusions

Two software product development organizations were explored in order to understand how the internationalization of their product has affected their product development activities. The results revealed that the internationalization of a product introduces and intensifies the product development related challenges in many ways. When moving into new market areas, the product's stakeholder network increases and becomes more diverse. This introduces several new challenges in the contexts of *sensing the market*, *making sense of the market* and *acting upon knowledge*. Furthermore, the decision to utilize partners in entering a new market area forces the product organization to increase product related communication across company boundaries. Co-operating with partners introduces risks due to the fact that partners first and foremost act in their own interest. Thus, many of the challenges of internationalization and the way organizations have responded to these challenges are strongly related to human interactions. Despite the acknowledged importance of human interaction in RE research (Nuseibeh & Easterbrook 2000), it appears to us that this topic may still be undervalued.

The analysis conducted up to this point suggests that changes in the organization's operating environment may be a significant source of the perceived product development challenges. Evidence for such a claim was first introduced when the challenges caused by organizational growth were discussed (section 6.4). This chapter has identified the internationalization of a product as another potentially disruptive moment for the organization's product development activities.

Then, what is the gathered data a study of? What is actually happening in the data? These fundamental questions in grounded theory (Glaser, B. G. 1978, p. 57) are eventually answered in the following chapter leading, finally, towards a theory.

8 Making sense of software product requirements⁴

This chapter reports the final round of analysis and proceeds eventually to propose a theory. The quest towards a theory begins by describing the research process for this round of analysis (section 8.1). The theory proposal is prepared by analyzing 40 years of software development within one company and comparing the findings with RE-related studies of the same time period (section 8.2). The findings from this analysis are then developed further into a substantive theory, fitting the proposed theory with all gathered data of the entire research effort (section 8.3).

The conclusions, implications and limitations of this study will be discussed in PART III

8.1 Research process

The goal of grounded theory is to generate a theory that accounts for a pattern of behavior which is relevant and problematic for those involved (Glaser, B. G. 1978, p. 93). The generation of a theory occurs around a *core* category that *integrates* the theory

⁴ Substantial sections of this chapter have earlier been published in:

Jantunen, S, Gause, DC & Wessman, R 2010, 'Making Sense of Product Requirements', paper presented to 18th IEEE International Requirements Engineering Conference (RE'10), Sydney, Australia, September 27th, 2010.

and renders the theory *dense* and *saturated*. This leads to theoretical *completeness* – accounting for as much variation in a pattern of behavior with as few concepts as possible, thereby maximizing parsimony and scope (Glaser, B. G. 1978, p. 93). Discovering the core category is the grounded answer to the perennial research problem of “which focus” (Glaser, B. G. 1978, p. 94).

Upon choosing a core category, the first delimiting analytic rule of grounded theory comes into play: only variables that are related to the core will be included in the theory. Another delimiting function of the core category occurs in its necessary relation to *resolving the problematic* nature of the pattern of behavior to be accounted for (Glaser, B. G. 1978, p. 93). The analyst should consciously look for a core variable when coding his or her data. The analyst is constantly looking for the “main theme,” for what the main concern or problem is for the people in the setting, for what sums up in a pattern of behavior the substance of the what is taking place in the data, for the essence of relevance reflected in the data, for gerunds which bring out the process and change (Glaser, B. G. 1978, p. 94). The core category must be proven over and over again by its prevalent relationship to other categories, thereby integrating them into a whole (Glaser, B. G. 1978, p. 94).

Certainly deciding on a core category tests the analyst’s skill and abilities. If the analyst acts too fast on a thin amount of data, he or she risks ending up with a large array of loosely integrated categories, and an undeveloped, undense theory with little explanatory power (Glaser, B. G. 1978, p. 95).

It is helpful to sum up the criteria by which an analyst can make his or her judgment as to the core category (Glaser, B. G. 1978, p. 95):

1. It must be central, that is related to as many other categories and their properties as possible and more than other candidates for the core category.
2. It must reoccur frequently in the data.
3. By being related to many other categories and reoccurring frequently, it takes more time to saturate the core category than other categories.
4. It relates meaningfully and easily with other categories. These connections need not be forced; rather, their realization comes quick and richly.
5. A core category in a substantive study has clear and grabbing implications for formal theory.
6. Based on the above criteria, the core category has considerable carry-through. It does not lead to dead ends in the theory nor leave the analyst high and dry. Rather, it gets the analyst through the analyses of the processes he or she is working on by its relevance and explanatory power.
7. It is completely variable. Its frequent relations to other categories make it highly dependently variable in degree, dimension and type. Conditions vary it easily. It is readily modifiable through these dependent variations.

8. While accounting for variation in the problematic behavior, *the core category is also a dimension of the problem*. Thus, in part it explains itself and its own variation.
9. The criteria above generate such a rich core category that in turn they tend to prevent two other sources of establishing a core which are not grounded, but without grounding could easily occur: (1) sociological interest and (2) deductive, logical elaboration. These two sources can easily lead to core categories that do not fit the data, and are not sufficiently relevant or workable.
10. The above criteria also generate a false criterion yet which indicates it is core. The analyst begins to see the core category in all relations, whether grounded or not, because it has so much grab and explanatory power. This logical switch must be guarded against, while taking it simultaneously as a positive indicator of the core.
11. The core category can be any kind of theoretical code: a process, a condition, two dimensions, a consequence and so forth. When it is a process, additional criteria also apply.

A popular type of core variable can be theoretically modeled as *a basic social process* (BSP) that accounts for most of the variation in change over time, context, and behavior in the studied area. BSPs are ideally suited to generation by grounded theory from qualitative research which can pick up process by field work continuing over time (Glaser, B. G. 1978, p. 97). They are labeled by a “gerund” (“ing”) which both stimulates their generation and the tendency to overgeneralize them (Glaser, B. G. 1978, p. 97).

A process is something which occurs over time and involves change over time. These changes ordinarily have discernable breaking points. Therefore, they can be treated as theoretical units in themselves, with conditions, consequences, other properties, and so forth, which are unique in form to each particular stage (Glaser, B. G. 1978, p. 97). There must be a minimum of two clear, emergent stages. If not, the stages collapse conceptually and there is no BSP (Glaser, B. G. 1978, p. 97). The stages, then, function as an integrating scheme with which to tie together various sets of conditions, properties, etc., in a manner which allows for a high amount of densification and integration. At the same time, it allows for conceptual grab and tractability (Glaser, B. G. 1978, p. 99). The transition from one stage to another is ordinarily contingent upon one or more events taking place. This contingency may be in the form of a *critical juncture* – a period of time between stages when the occurrence or non-occurrence of a particular critical event will determine whether a new stage is entered (Glaser, B. G. 1978, p. 99).

Earlier rounds of data analysis suggest that organizations’ product-related requirements engineering activities show distinctively different characteristics under different circumstances. While smaller organizations relied on human collaboration, larger ones were forced to establish more formal work practices (chapter 6). Furthermore, organizations’ decisions to move into the global marketplace appeared to introduce new challenges (chapter 7). One potential explanation for the perceived

differences could be that the companies are at different evolutionary stages. This would imply that the core variable of this study may take the form of BSP.

What, then, would be the core category? The interviews conducted largely investigated current practices and challenges related to organizations' efforts to make sense of product-related requests and needs. However, the gathered data suggests that the core category is more abstract than the organization's challenge of sensemaking. The data is not about making sense of requirements for a particular product release. Rather, the data is more about organizations' efforts to find effective ways to deal with the design problem at hand. Following the rule (Glaser, B. G. 1978, p. 108) of turning a substantive noun or verb into a gerund, the core category is now defined to be *adjusting*. Hence, I am now ready to state what I believe this study primarily deals with:

This is a study of organizations which are adjusting their behavior to the changing design problem in order to make sense of what their new product requirements are.

The assumption that the core variable takes the form of BSP guides the final round of data analysis to search for stages and critical junctures and to define their properties and conditions. This, in turn, has led to the decision to take a historical perspective to more than 40 years of software development within a company that is currently delivering its products to a diverse set of customers throughout the world. The purpose of such data analysis is to understand:

1. how the nature of the design problem has evolved in the course of time;
2. what factors in the organization's operating environment have changed the nature of the design problem;
3. what the critical junctures and their properties are;
4. what actions the case company has taken in its effort to adjust to the changing problem.

The target of this final round of analysis is Tekla, which was already analyzed in chapter 5. We had gathered data from Tekla in December 2005, soon after Tekla had reorganized its product-related activities. The interviews conducted and documents gathered contained rich data describing the origins triggering the organizational realignment and the actions Tekla had taken to adjust its behavior.

Tekla reorganized again in 2008. The previously gathered data was then complemented with two new interviews and additional documents addressing the latest reorganization. The two interviewees were managers of newly formed teams.

One was responsible for product development, whereas the other's responsibilities were closer to product management. The interviews continued to focus on the origins triggering the organizational change and on the measures Tekla had taken.

Our empirical data was thus situated into the two latest moments in time when Tekla adjusted its behavior in order to deal more effectively with its design problem. The understanding of Tekla's past was then expanded by complementing the empirical findings with Tekla's published history covering the years from 1966 to 2006 (Tamminen 2006; Tekla 2009a).

While the longitudinal analysis of Tekla's history illustrates its theoretical development, it is important to keep in mind that the proposed theory must fit with *all* gathered data. The fitness of the proposed theory will be evaluated further in PART III.

8.2 Forty years of Tekla software

Greiner (1972) has claimed that the life of a company may be described as a series of developmental phases through which companies pass as they grow. Each phase begins with a period of evolution and ends with a revolutionary period of substantial organizational turmoil and change (Greiner 1972). Each evolutionary period is characterized by the dominant management style used to achieve growth. Management practices that work well in one phase may bring on a crisis in another. The critical task for management in each revolutionary period is to find a new set of organizational practices that will become the basis for managing the next period of evolutionary growth (Greiner 1972).

Empirical findings from this research effort suggest that a similar pattern with periods of evolution followed by revolution may be identified in the organizations' efforts to deliver software that satisfies the customers' needs. This section outlines three evolutionary phases in time leading to a revolution (Figure 20). The phases are illustrated with a historical perspective to Tekla's software product development and accompanied with a review of literature relevant to the time period.

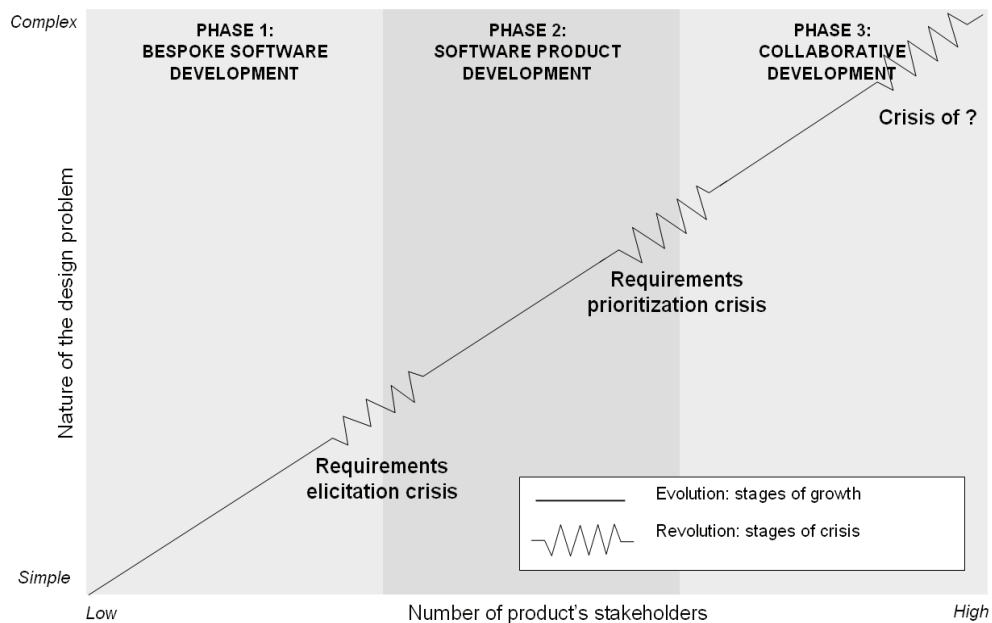


Figure 20. Historical perspective to software product development. Visual presentation adopted from Greiner's (1972) growth model

8.2.1 Phase 1: From punch cards to software products

By the mid-1960s, computers and automatic data processing (ADP) were well established in Finland. The opportunities of ADP were also recognized in the companies that performed advanced engineering computing. Computerized calculations changed the way of working in engineering offices significantly. Time saving calculations made engineering more efficient, allowing more comprehensive and reliable plans to be made. Due to the ever-increasing amount of computing work and a lack of resources, a group of engineering offices established a joint software company. The company, named Teknillinen laskenta Oy ("technical computing"), was registered in February 1966, making it one of the oldest software companies in Finland. The same spring, the company trading name was abbreviated to Tekla (Tamminen 2006).

The foundation for Tekla's operations was defined as ADP consultation, computing services, training courses and software development. Six planning committees were formed in 1967 for the latter purpose, representing the different industries of the shareholding companies. The goal of the planning committees was to define the features of common software in cooperation with Tekla employees. In fact, these

committees created the model for Tekla's future way of working: starting projects to develop new programs in conjunction with customers (Tamminen 2006).

Since the founding moment, Tekla has passed many milestones (Tekla 2009a), each of them leaving its mark on what Tekla is today. Many such milestones have been triggered by new advancements in technology. One of the earliest disruptive changes occurred in 1970. With the possibility to access the computing center remotely, customers were able to perform computing via their own terminals. This changed Tekla's business logic completely. Instead of charging the customers according to the computing time used, Tekla started to collect lease fees for its software – being the first company in Finland to do so (Tamminen 2006). Other technological innovations followed soon after. The introduction of minicomputers in 1973 opened the way for the development of new types of software solutions. In 1976, plotter software and graphic printing were adopted, leading to significant improvements in the visualization of engineering calculations. Then, in 1987, the continuous technological advancements in computers culminated with Tekla's first system combining graphics and a relational database. This achievement proved to be a major landmark paving the way for Tekla's future in providing model-based solutions for various engineering industries.

Despite the increased opportunities to utilize computers, the challenge of developing software remained largely the same for more than the first 30 years. It mostly involved developing a software solution to a well known small customer group with a common voice and a clearly understood problem. However, in the early 1990s, new types of challenges started to arise. With the effort of providing the same software solution to a larger group of customers, Tekla's software development took a turn from bespoke software development to software product development. While at the beginning such a change may have been subtle, the new challenges became increasingly apparent with every new customer, forcing Tekla to rethink how the voice of a customer should be extracted. Tekla was forced to detach from the customers.

Tekla was not alone with such new challenges. The movement from bespoke software development towards software product development began to receive attention also from academia in the late 1990s and early 2000s⁵. One of the main findings in related studies was that the development of software products poses particular problems for the way in which requirements are elicited and handled (Sawyer, P., Sommerville & Kotonya 1999). These challenges suggest that, as the companies turn to software product development, they are likely to face a *requirements elicitation crisis*. When developing software products, it is more difficult to form a mental image of who the

⁵ See section 5.3 for a further review.

customer really is (Lubars, Potts & Richter 1993). At product conception, there will be only potential customers. For newly packaged software, requirements are invented, not elicited (Potts 1995; Sawyer, P., Sommerville & Kotonya 1999). Once the product has entered the market, the further needs of the stakeholders have to be interpreted from existing and potential customers (Keil & Carmel 1995; Lubars, Potts & Richter 1993). Existing products lead to a steady stream of new requirements, which may have interdependencies (Carlshamre et al. 2001) and conflicts (Lubars, Potts & Richter 1993) with other requirements. These elicitation challenges closely resembled what Tekla had experienced, and laid the foundation for the evolvement of MDRE.

8.2.2 Phase 2: Software product development

In 1999, Tekla established a product business unit with the responsibility of standardizing product processes, product management and business methods. The aim was to develop the Tekla way of working, and Tekla's product management was born as a result. In particular, organizational development sought change from a technology-driven company to a product- and service-oriented company (Tamminen 2006).

With the newly established product business unit, Tekla encapsulated the requirements elicitation challenges within a product management team. It became the product management team's responsibility to cope with the continuous flow of incoming requirements and to build an understanding of what should be implemented in the product's forthcoming versions. The software development activities remained relatively unchanged. Tekla was able to continue with a similar software development style that it had learned to master over the past 30 years – starting projects to develop new programs in conjunction with a customer. Only now, the customer had changed. The product management team had become a surrogate representing all of the product's customers, thus providing a single customer interface to the software developers.

Nevertheless, the product management team's responsibilities proved to be a complex endeavor. Even though Tekla had a system in place to elicit product-related needs, it was far from easy to develop an understanding of what the customers really wanted. Customers tended to give feedback only about what they were experiencing with the current product:

“It is very difficult to find visionary views from the customers. Furthermore, customers often lack the ability to see what kinds of features would be technologically possible.” (Tekla's business management, December 2005)

Consequently, it became Tekla's role to understand the product's business domain and possibilities of technology in order to determine what new product features would be most beneficial for the customers. Not only did the elicited requirements need to be

processed, but they also became a basis for developing a long-term strategic view of the product's future. This introduced demands to expand existing requirements engineering activities.

Another factor expanding the existing requirements engineering activities was the decision to move into international markets⁶. Since Tekla's products had become market leaders in Finland relatively quickly, Tekla had to go abroad to find further growth. In 1993, Tekla's structural steel software XSteel was released for international markets. The product was initially sold by resellers, but in 1998, Tekla started building its partner network and establishing its representative offices across the world (Tamminen 2006). The decision to move to international markets proved to be successful in terms of growth. Yet, the decision also laid the seeds for the next challenges to follow in product development. With the establishment of the international organization, new links were added to the communication chain through which the customer's needs could be heard. The expansion increased the politics and conflicts of interests within the organization when decisions on future releases were being made. Such challenges were particularly exacerbated when co-operating with partners, as their interests were not always the same as with Tekla's.

As the number of Tekla's customers and the diversity of their needs increased, it became more difficult to find a solution that satisfied everyone. The value of a request was perceived differently by different stakeholders. There were different types of values, such as strategic or operative, attached to the requirement. Furthermore, the value of a requirement sometimes depended on whether it was implemented together with other requirements. It became increasingly difficult to reach a consensus on a requirement's value. Without being able to determine the net value of a requirement, prioritization became inaccurate. This, in turn, made it impossible to select the most profitable combination of requirements to be implemented into the product's forthcoming versions. These were significant challenges contributing to the *requirements prioritization crisis*. Characteristic to the challenges is also the fact that vast amounts of gathered data do not help in making decisions.

Symptoms characterizing the requirements prioritization crisis are already well known in existing literature (Carlshamre 2002; Damian, D. E. & Zowghi 2003; Karlsson, Lena et al. 2007; Lehtola & Kauppinen 2006). Software companies have been reported to be overloaded by requirements that originate from different markets and local offices. The requirements lack important information from different viewpoints indicating why the requirement is needed and how important it is for different stakeholders (Lehtola & Kauppinen 2006). Furthermore, the product development

⁶ See chapter 7 for further analysis.

organizations have been found to be forced to perform release planning based on uncertain estimates and to suffer from communicational bottlenecks (Karlsson, Lena et al. 2007). The origins of the requirements prioritization crisis have also been analyzed to a certain extent. It has been claimed that the complexity of release planning is partly due to the incompleteness and uncertainty of the contextual information (Ruhe & Saliu 2006), forcing people to guess what the actual rationale or meaning of the requirements were (Damian, D. E. & Zowghi 2003). Studies addressing such issues are largely yet to be seen.

8.2.3 Phase 3: Towards collaborative product development

Tekla's success with its product has continued to increase. This has steadily made the nature of Tekla's product-related design problem more complex. Processes tuned to support information processing and decision-making have begun to age and degrade in terms of supporting product development activities. Practice has shown that making rational decisions always involves many simplifying assumptions, each made in an attempt to bring the design decisions from the domain of uncountable possibilities and cost into the realm of countable, documentable, and traceable accountability and reasonable implementability. These simplifying assumptions made in many steps of information processing by a small number of people have begun to be a source of misunderstandings within Tekla. Insufficient product-related communication has become a significant issue. The most notable communicational blockages have been identified to be the product management unit's relations to the business interface and product development.

Alleviating the challenges with communication has been the primary theme in many of Tekla's recent efforts to update its product management activities. Hence, Tekla has increasingly attempted to cope with the requirements prioritization crisis through organizational measures. Tekla reorganized in 2008. According to an internal memo from 2007, the primary driving forces for the reorganization have been a desire to:

- 1) improve the understanding of how the business objectives are linked to the requirements;
- 2) open communicational bottlenecks that the product management organization has inadvertently caused;
- 3) bring customers closer to the product development;
- 4) improve the ability to select the right features to be implemented;
- 5) enable deeper collaboration between individuals.

With the latest reorganization, Tekla has pushed to increase its responsiveness and problem solving capabilities by dividing its resources into smaller multi-disciplinary teams with greater powers for decision-making. Central in accomplishing such an objective has been the establishments of 1) a *product foundation* organizational unit responsible for implementing a common functionality in the product's core; and 2) a *product offering* organizational unit responsible for adapting the common core into a particular engineering discipline in a particular market area.

Although the challenge of the requirements prioritization crisis has still not been completely resolved, the characteristics of the next evolutionary phase are becoming evident. Product management is moving toward a collaborative direction. The interviews in 2008 revealed positive reactions toward the recent organizational changes:

"I feel that the new organizational structure is definitely an improvement. We now have good opportunities to remove some of the fences between the units and make communication more flexible." (Teklas product development, June 2008)

8.3 Towards a theory

"We all have our philosophies, whether or not we are aware of this fact, and our philosophies are not worth very much. But the impact of our philosophies upon our actions and our lives is often devastating." (Popper 1979)

Tekla's published milestones (Tekla 2009a) are presented in Figure 21 and the findings from analyzing forty years of Tekla's software product management are summarized in Figure 22. Citations illustrating the conceptualized *requirements elicitation* and *requirements prioritization* crises have been presented earlier in section 5.1.

This section proceeds to develop these findings towards a theory proposal.

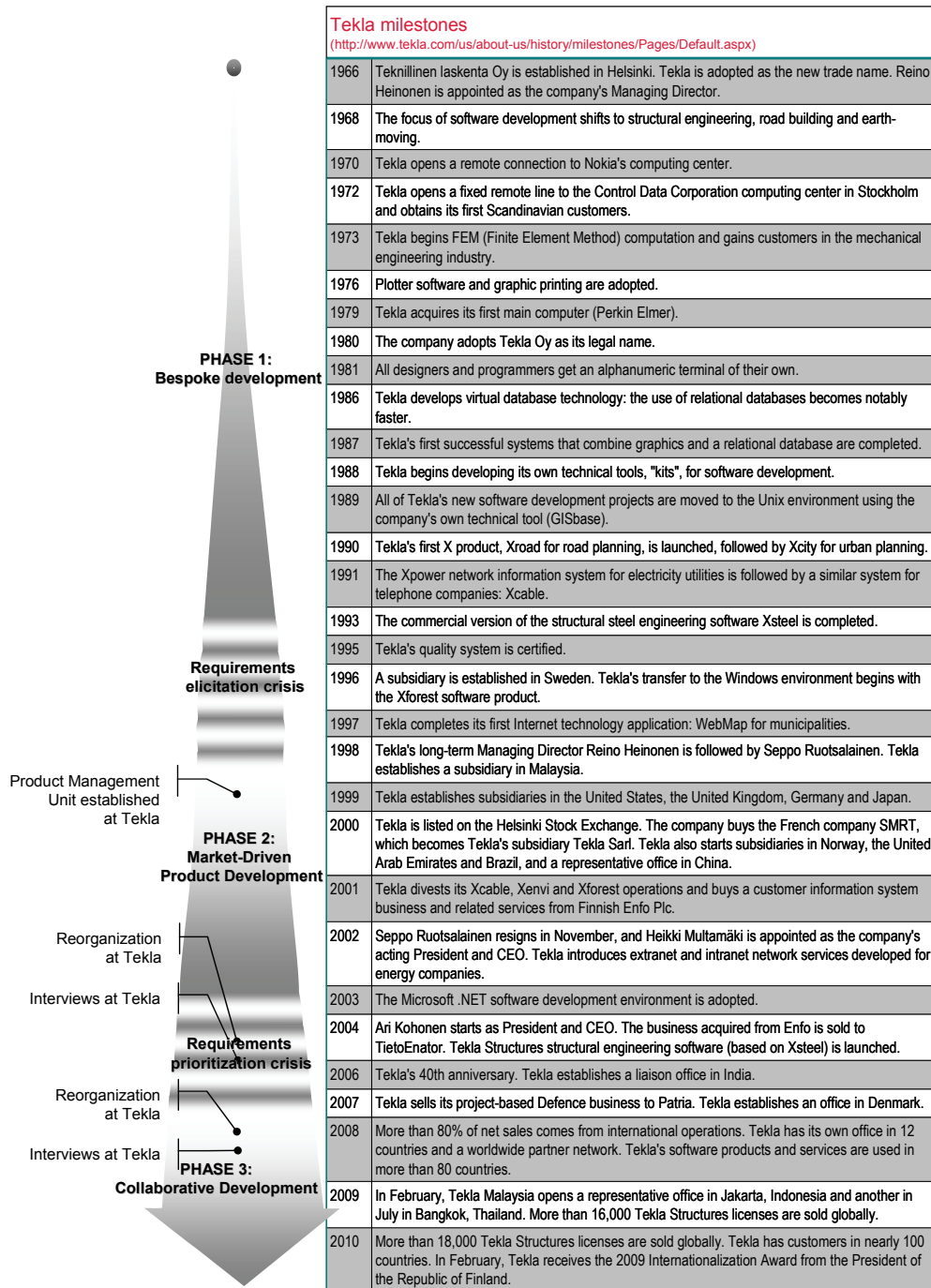


Figure 21. Tekla's milestones.

PHASE:	BESPOKE DEVELOPMENT	PRODUCT DEVELOPMENT	COLLABORATIVE DEVELOPMENT
<i>Nature of the design challenge:</i>	<ul style="list-style-type: none"> •Emphasis on calculation and algorithms. •Problems are explicitly definable. 	<ul style="list-style-type: none"> •Requirements originate from a diverse group of customers. •Requirements need to be examined from many angles (e.g. strategy, product vision, competition) in order to build a holistic basis for decision-making. 	<ul style="list-style-type: none"> •Conflicting views. •Multiple meanings. •Difficult to comprehend the problem as a whole.
<i>Problem-solving approach:</i>	<ul style="list-style-type: none"> •Rational and systematic software development processes aiming at the efficient utilization of resources. 	<ul style="list-style-type: none"> •Establishment of roadmapping, release planning and requirements prioritization practices (MDRE). 	<ul style="list-style-type: none"> • To be defined.
<i>Environmental factors forcing the working methods to evolve:</i>	<ul style="list-style-type: none"> •Advancements in technology allow increasingly complex systems to be built. •Software is packaged as a product. 	<ul style="list-style-type: none"> •Diversity and the number of the product's stakeholders increase. •Turbulence in the business and technological environment. 	<ul style="list-style-type: none"> •To be defined.

CRISIS:	REQUIREMENTS ELICITATION	REQUIREMENTS PRIORITIZATION
<i>Symptoms:</i>	<ul style="list-style-type: none"> •Detachment from a single customer. Requirements need to be interpreted or invented from a number of existing or potential customers. 	<ul style="list-style-type: none"> •Difficulties in determining the value of requirements. •Difficulties in selecting the best possible set of requirements to be implemented in the product's next versions. •Difficulties to understand the 'big picture'. •Bottlenecks begin to form in the organization.

Figure 22. Summary of findings.

All software developers approach the development task with a number of explicit and implicit assumptions about the nature of human organizations, the nature of the design task, and what is expected of them (Hirschheim, R. & Klein 1989). The most fundamental set of assumptions adopted by a professional community that allows its members to share similar perceptions and engage in commonly shared practices is called a “*paradigm*” (Hirschheim, R. & Klein 1989).

The emphasis in developing the early computer applications of the 1960s and 1970s was on programming and solving technical problems, particularly those resulting from the rather limited hardware of the time (Avison, D. E. & Guy 2003). The design problems of the early days of computing had strong links with science and mathematics, seeding the belief that, in the world of computing, there is one reality that is measurable and essentially the same for everyone. The problems software developers needed to solve were seen as *tame* (Rittel & Weber 1973) by nature, meaning that the they:

- could be stated with an exhaustive formulation containing all information that the problem-solver needs for understanding and solving the problem;
- could be defined in terms of success criteria, enabling the evaluation of the goodness of a potential solution;
- had a definite stopping point, i.e. we know when a solution is reached;
- belonged to a class of similar problems which can be solved in a similar manner;
- had solutions which could be tried and abandoned.

Historically, there were no generic methods or techniques for bridging the gap between user needs and technology capabilities (Jayaratna 1994, p. 4). This was the era of *just building the software* (Gause 2005). As the focus in software engineering has evolved from the early days towards *designing* (1970s and 1980s), and *defining the functionality* (the 1990s and 2000s) (Gause 2005), the task of software development organizations has become the job of designing and implementing the software that models the single reality that all stakeholders share. These assumptions have laid the foundation for a professional paradigm that is dominant still today. Software development organizations have learned to see themselves as being *experts* in technologies, tools, software development methods and project management (Hirschheim, R. & Klein 1989). The self-image of expert has resulted in the organization's desire to design software in a manner that is systematic, formal and rational. With such measures, organizations have aimed at the efficient use of their employees.

Software development approaches basing their assumptions on the *expert paradigm* are not difficult to find. One of more extreme example is the Cleanroom Software Engineering process (Mills, Dyer & Linger 1987), which permits a sharper structuring of development work between specification, design, and testing in order to place software development under statistical quality control. Another, perhaps the most influential example, is one of the earliest efforts to introduce discipline into software development activities. Through his experience in software development projects in the 1960s, Royce (1970) noted that software development effort consists of stages that are distinctly different in the way they are executed. The stages must be planned and staffed differently for the best utilization of resources (Royce 1970). This led Royce to define the waterfall model (Royce 1970) consisting of a number of development stages to be followed in sequential order. One phase had to be completed before the next one could begin (hence the term waterfall), and each phase had a set of defined outputs or deliverables to be produced before it could be deemed complete (Avison, D. E. & Guy 2003). Many other approaches to developing software have been defined since the waterfall model. Yet, similar objectives for organizing software development have persistently remained. That is, software development efforts are best managed with processes allowing resources to specialize in their areas of expertise and helping them to contribute to the whole by producing specifications written as explicitly and

objectively as possible. The ones sharing the assumptions of the expert paradigm see software development primarily as a technical process.

Since 1967, there have been numerous revolutions on the hardware side and amazing improvements in man-machine interfaces (Parnas 2010). Such technological advancements have allowed software to deal with increasingly complex tasks involving an increased number of stakeholders. Nevertheless, the sense of professionalism, having its roots in the expert paradigm, has become so strong that software engineers have held on to it even though the problems to be solved have started to change. Potential indicators for changing problem characteristics are the moments when an organization is facing new challenges in following its software development processes. At the time of the *requirements elicitation crisis*, organizations responded to the perceived challenges by encapsulating them. It became the product management team's task to manage all complexities, conflicts and dependencies introduced by the multitude and diversity of the customers, and then to provide clear, explicit and objective requirements to be implemented by the software developers. Such adaptation to the problem has resulted in MDRE processes that appear to play the traditional game of discovering the "correct" interpretation through intelligence gathering, linear thinking and rational decision-making. As the complexity of the organization's design problem has continued to increase, resulting in a *requirements prioritization crisis*, research and practice have still largely maintained the belief that the external environment continues to be concrete, that events and processes are hard, measurable, and determinant.

Now that the focus in software engineering has started to shift towards *defining the context* (Gause 2005), organizations are increasingly facing the conflicts and complexities of their design problems. Tekla's effort to make sense of the market has currently been discovered to be a challenge with overwhelming amounts of gathered data, conflicting interpretations, a shortage of resources, dependencies and conflicts, a lack of clear goals, challenges in understanding values and difficulties in decision-making. These symptoms closely resemble the characteristics of an ambiguous and changing situation (McCaskey 1982; Weick 2001, p. 45), as described in Table 5.

Table 5. Characteristics of ambiguous, changing situations (McCaskey 1982; Weick 2001, p. 45).

<i>Characteristic</i>	<i>Description and comments</i>
Nature of problem is itself in question	“What the problem is” is unclear and shifting. Managers have only vague or competing definitions of the problem. Often, any one “problem” is intertwined with other messy problems.
Information (amount and reliability) is problematical	Because the definition of the problem is in doubt, collecting and categorizing information becomes a problem. The information flow threatens either to become overwhelming or to be seriously insufficient. Data may be incomplete and of dubious reliability.
Multiple, conflicting interpretations	For those data that do exist, players develop multiple, and sometimes conflicting, interpretations. The facts and their significance can be read several different ways.
Different value orientations, political/emotional clashes	Without objective criteria, players rely more on personal and/or professional values to make sense of the situation. The clash of different values often politically and emotionally charges the situation.
Goals are unclear, or multiple and conflicting	Managers do not enjoy the guidance of clearly defined, coherent goals. Either the goals are vague, or they are clearly defined and contradictory.
Time, money, or attention are lacking	A difficult situation is made chaotic by severe shortages of one or more of these items.
Contradictions and paradoxes appear	The situation has seemingly inconsistent features, relationships, or demands.
Roles vague, responsibilities unclear	Players do not have a clearly defined set of activities they are expected to perform. On important issues, the locus of decision making and other responsibilities is vague or in dispute.
Success measures are lacking	People are unsure what success in resolving the situation would mean and/or they have no way of assessing the degree to which they have been successful.
Poor understanding of cause-effect relationships	Players do not understand what causes what in the situation. Even if sure of the effects they desire, they are uncertain how to obtain them.
Symbols and metaphors used	In place of precise definitions or logical arguments, players use symbols or metaphors to express their points of view.
Participation in decision-making fluid	Who the key decision makers and influence holders are changes as players enter and leave the decision arena.

Over time, ambiguous and changing situations have also been called ill-structured problems (Mitroff, Ian I. & Turoff 1973), messes (Ackoff 1974), messy situations (Schön 1983), and wicked problems (Rittel & Weber 1973). For the sake of consistency within the existing release planning literature, I shall from now on adopt the term used by Carlshamre (2002) and refer to this category of problems as *wicked problems* (Rittel & Weber 1973).

The nature of Tekla's design problem has changed so severely that current assumptions and beliefs about the problem need to be questioned. There may be a need for a *paradigm shift* (Couger 1996, p. 62), an alternative way of dealing with the problem. Yet, both research and practice appear to have a barrier in thinking. We tend to see the world through our paradigms. Any data that contradicts with our paradigm will have a difficult time getting through our filters (Couger 1996, p. 62-63). The data that do fit our paradigm not only make it through the filter, but are concentrated by the filtering process, creating an illusion of even greater support for the paradigm (Couger 1996, p. 63). This phenomenon is known by many names. Barker (1992) calls it the "Paradigm Effect". Psychologists call it "confirmation bias" (Nickerson 1998). I have adopted the term "*Paradigm Paralysis*" (Couger 1996, p. 65; Harrison 1994), because it conveys the inability or refusal to see beyond the current models of thinking.

Hence, building on existing concepts of *tame* and *wicked* problems (Rittel & Weber 1973), *the expert paradigm* (Hirschheim, R. & Klein 1989), and *paradigm paralysis* (Couger 1996, p. 65; Harrison 1994), the proposed grounded theory is as follows (Figure 23):

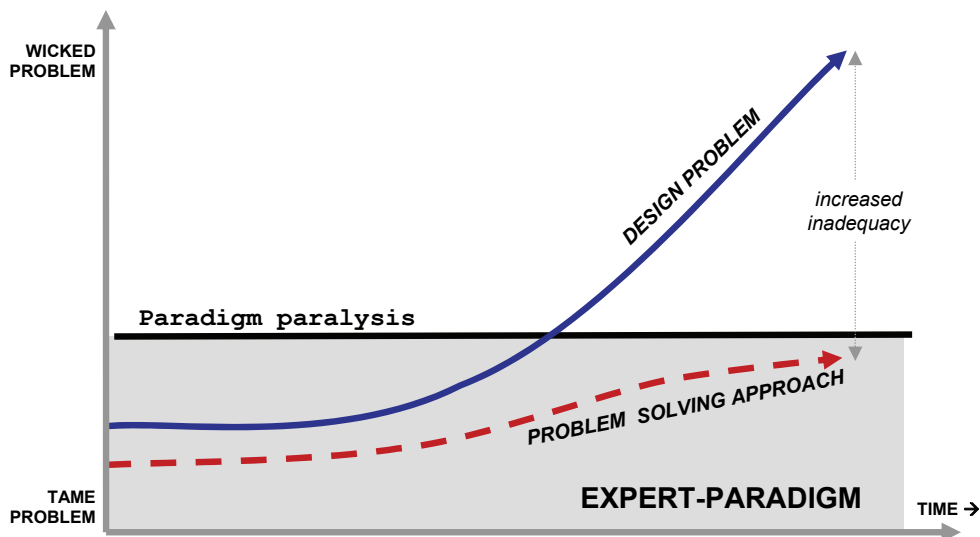


Figure 23. Theoretical development of the findings.

PROPOSED THEORY:

Software product companies are constantly facing the challenge of adjusting their problem-solving approaches to fit with the changing nature of the problem to be solved.

During the early days of computing, the design problems closely resembled the characteristics of a *tame* problem (Rittel & Weber 1973). As a result, organizations have initially learned to believe that the effectiveness of software development is embodied in explicit knowledge and its processing. Design problems were solved with *technical approaches*.

The sense of professional conduct in Software Engineering has started to take shape at the moment in history when the beliefs and actions belonging to the expert paradigm have responded well to the problem to be solved. The initial success in applying the *expert paradigm's* beliefs in organizing software development activities has strengthened the position of the expert paradigm. Therefore, for historical reasons, the expert paradigm has gained a dominant position within Software Engineering.

In time, the opportunities of technology have increased, leading to significant increases in the potential user base of software. This, in turn, has altered the design problem to resemble more and more the characteristics of a *wicked* problem (McCaskey 1982; Rittel & Weber 1973) (Table 5).

As the software product organization's design problem has evolved to be more difficult to comprehend, the tools, techniques and methods belonging to the expert paradigm have begun to lose their effectiveness. Yet, software product development organizations have been tempted to hold on to the actions that were once successful. Thus, in the time of a *paradigm shift*, research and practice have, to a certain extent, suffered from *paradigm paralysis*. Requirements elicitation crises and requirements prioritization crises are symptoms of such paradigm paralysis.

The inadequate fit between the nature of the design problem and the problem solving approach continues to increase until the beliefs and assumptions of the expert paradigm are questioned and a new paradigm is adopted.

PART III: CONCLUSIONS

"What the man in the know does not want is to be told what he already knows. What he wants is to be told how to handle what he knows with the increment in control and understanding of his area of action."

(Glaser, B. G. 1978, p. 13)

9 Summary of the results

“When the researcher is convinced that his conceptual framework forms a systematic theory, that it is a reasonably accurate statement of the matters studied, that is couched in a form possible for others to use in studying a similar area, and that he can publish his results with confidence, then he is near the end of his research. He believes in his own knowledgeability and sees no reason to change that belief. He believes not because of an arbitrary judgment but because he has taken very special pains to discover what he thinks he may know, every step of the way from the beginning of his investigation until its publishable conclusion. The researcher can always try to mine his data further, but little of value is learned when core categories are already saturated” (Glaser, B. & Strauss 1967, p. 224-225).

The initial case study, presented in chapter 5, illustrated real-life product management practices and challenges within one case company. Such challenges were expressed vividly with the following statements presented in section 5.1:

“There does not exist any equation that can determine the priorities of market needs correctly. It takes a certain touch, hunch and experience to understand the priorities. This knowledge has just been built into the organization. [...] The more we have conducted business, the more we have gained this tacit knowledge.” (Tekla’s business management, December 2005)

“It is a huge challenge to set up the organization to support the product-related decision making. It is difficult to determine the criteria according which the requested features are decided to be implemented. We have recently put much effort in finding ways to organize the decision making in a business oriented manner.” (Tekla’s business management, December 2005)

“Who is it to say that what is the right interpretation of the data we have gathered? This is the challenge that we have been tackling continuously. The more we have conducted business, the more experience we have gained [on understanding the customers]” (Tekla’s business management, December 2005)

Although these challenges were considered salient in the data already at the beginning of the study, the origins of the perceived challenges were largely unknown. There was no theory to explain why these challenges occur and how these challenges may be alleviated. Building that theory from the gathered data (Figure 24) emerged as the purpose of this thesis.

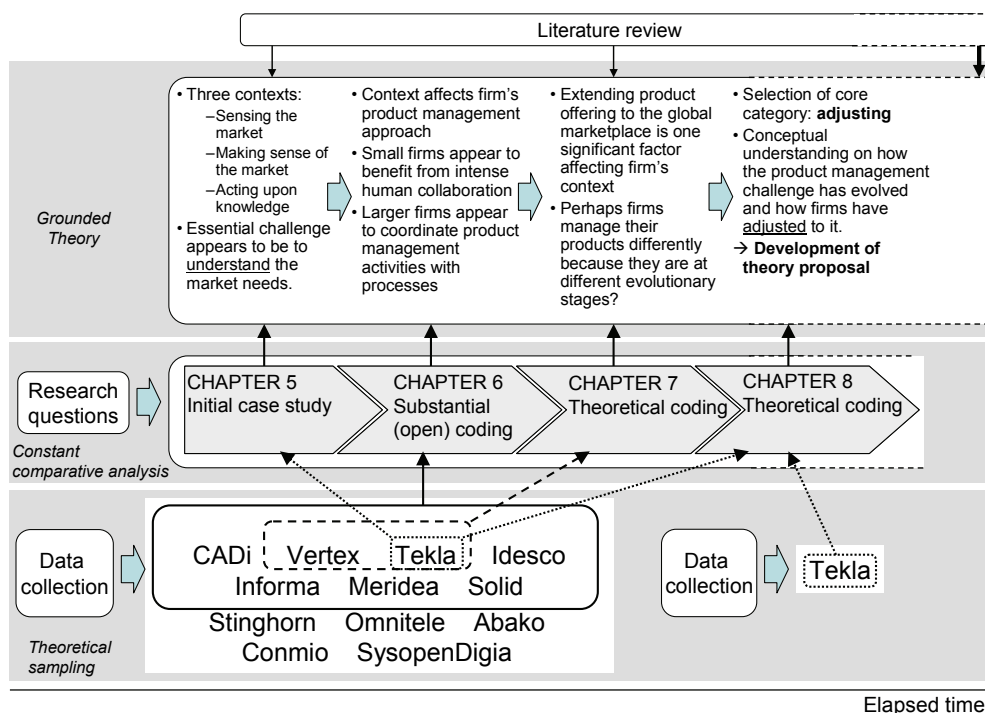


Figure 24. Overview of the research steps.

According to the proposed theory, the challenges presented above may be symptoms of an inadequate fit between the organization's problem-solving approach and the nature of the problem to be solved. Such an inadequate fit may be due to *paradigm paralysis*. Although the nature of the case company's design challenge may have changed, the company has been tempted to continue with software development processes that worked well in the past.

The theory I have proposed is based on what I know systematically from my observations of the data we have gathered. This is what I have studied and lived through. These are my perceptions, my personal experiences and my own hard-won analyses (Glaser, B. & Strauss 1967, p. 225). My confidence in the proposed theory

does not mean that my analysis is the only plausible one that could be based on the data (Glaser, B. & Strauss 1967, p. 225).

This chapter summarizes the findings of this thesis, providing answers to the first of the two research questions initially defined in section 3.1:

1. How can the role of human interaction be described in an organizations' attempt to position their software product in the marketplace?
 - a. How do software product development organizations develop understanding regarding the market?
 - b. How do software product development organizations utilize the understanding regarding the market in their product development?
 - c. What are the challenges faced by the software product development organizations?

Answers to the research question 2: *How can the organizations' attempt to position their software product in the marketplace be supported?* will be discussed in section 12.2.

The role of human interaction in the organization's attempt to position its software product in the marketplace (research question 1) may be described in terms of the conceptual framework developed in section 6.4. This framework emerged by identifying commonalities between the analyzed companies. The framework consists of three contexts people participate in and seven phases the organization passes when it positions its software product in the marketplace (Figure 16). The three identified contexts (*sensing the market*, *making sense of the market* and *acting upon knowledge*) are instances of what is known in knowledge management literature as 'ba', a shared context in motion, in which knowledge is shared, created, and utilized (Nonaka & Toyama 2003).

While the developed framework describes the similarities among the analyzed companies, it also assists in illustrating the differences (Figure 17). Such analysis provides answers to the question of how organizations develop and utilize the understanding of the product's market needs (research questions 1a and 1b).

The major difference appeared to be *who* are taking part in each of the seven phases. This thesis identified two extremes in the continuum of product management approaches. At one extreme, organizations relied on *human collaboration*, in which people took many roles and emphasized face-to-face collaboration. At the other extreme, the organization's emphasis was on following *processes* that led to the specialization of people.

Chapter 6 revealed that an informal collaboration-based approach appeared to have natural tendencies to mitigate the product management-related challenges. The fact that people perform diverse sets of tasks enabled them to gain tacit knowledge in one context and utilize it in another. Furthermore, continuous face-to-face connections allowed people to share information in a richer format than with documents.

When the organization grows, it begins to face coordination challenges. Organizations typically react to such challenges by introducing MDRE processes (Figure 11). With processes, people begin to specialize and information begins to be shared more in documented form. The people who gather the product related needs are not necessarily those who use the information to make decisions.

The thesis identified a wide variety of challenges in the product organizations' attempt to position the product in the marketplace (research question 1c). Even though human collaboration appeared to mitigate product management challenges, the organizations were forced to establish processes as they grew. The first symptom of the pressure to establish processes appeared to be coordination challenges. Establishing MDRE processes did not seem to introduce notable challenges for listening to and sharing the requests. The companies tended to gather plenty of market information into their requirements repositories – perhaps more than they were able to digest. The real challenge appeared to be to understand what the gathered information really meant. The gathered information needed first to be developed further into explicit product requirements. It was then necessary to develop an understanding of how important the product requirements were in terms of the product business. Without such understanding, it was difficult to determine which of the requirements should be implemented in the product's forthcoming versions.

The gathered data suggested that process-based companies communicated largely with the artifacts resulting from following processes. This was a source of misunderstandings. Not knowing the full picture of product-related decisions has occasionally caused challenges in the organizations. The unawareness of product-related decisions was particularly problematic in marketing and product development units, which were responsible for acting on the decisions made (section 5.2.3).

The challenges organizations face in positioning their product into the marketplace seemed to evolve as the organization grew. However, the growth of the organization's headcount was not the only factor to consider. Chapter 7 revealed that another important factor causing challenges to the product organization is the evolution of the design problem. While the growth of the headcount likely induces communication challenges, the evolution of the design problem is likely to induce *comprehension* challenges. Chapter 7 illustrated this with an analysis of how the design problem changes when the product is taken into the global marketplace. The chapter concluded that with every new customer, the design problem becomes more complex.

New customers may present new requests that may conflict with the needs of previous customers. The utilization of partners will generate further challenges, as they may act in their own interest. The challenges in comprehending the design problem culminate in the context of making sense of the market. Even though the organizations tried, prioritizing the requirements proved to be very difficult, if not impossible. When the organizations were making product-related decisions, they relied on tacit knowledge. The risk in making decisions based on tacit knowledge is that the decisions are based on too limited a view of the problem.

In conclusion, in some organizations, the challenge of developing a software product has eventually evolved into one that has multiple and conflicting interpretations, different value orientations, unclear goals, contradictions and paradoxes. In other words, the nature of the software product organization's design challenge has started to resemble more and more the characteristics of a wicked problem (Table 5). Even though the nature of the design challenge has changed, software product development organizations have been tempted to hold on to the actions that were once successful. Thus, in the time of a *paradigm shift*, research and practice have, to a certain extent, suffered from *paradigm paralysis*. As the software product organization's design challenge has evolved to be more difficult to comprehend, the tools, techniques and methods belonging to the expert paradigm have begun to lose their effectiveness. This claim will be elaborated further in the following chapter.

10 Integrating the literature⁷

“When the theory seems sufficiently grounded in a core variable and in an emerging integration of categories and properties, then the researcher may begin to review the literature in the substantive field and relate the literature to his own work in many ways” (Glaser, B. G. 1992, p. 32).

The purpose of this chapter is to integrate the results of this thesis with existing literature. The literature review particularly emphasizes the topics that have been found central in the gathered data, the process area of *release planning* and its sub-process *requirements prioritization* (van de Weerd et al. 2006).

The proposed theory will be integrated with existing literature through the following distinct discussions:

1. Existing release planning approaches originate primarily from the beliefs of the expert paradigm (section 10.1).
2. Planning releases with existing approaches has been reported to be challenging (section 10.2).

⁷ Substantial sections of this chapter have earlier been published in:

Jantunen, S, Lehtola, L, Gause, DC, Dum Dum, UR & Barnes, RJ 2011, 'The Challenge of Release Planning: Visible But Not Seen?' paper presented to 5th International Workshop on Software Product Management (IWSPM 2011) in conjunction with 19th IEEE International Requirements Engineering Conference 2011, Trento, Italy, August 30th, 2011.

3. Release planning often deals with a wicked problem (McCaskey 1982; Rittel & Weber 1973), for which the expert paradigm does not provide a sufficient problem-solving approach (section 10.3).
4. Existing MDRE approaches are less effective than preferred in utilizing the diverse wisdom that a product's stakeholder network possesses (section 10.4).
5. New approaches are needed within RE for solving problems that are beyond the levels of complexity of problems addressed by the expert paradigm. These levels of complexity result in RE from ambiguity, changing perceptions, changing conditions, vested interests, miscommunication, the diversity of user roles and cultural differences (section 10.5).

10.1 Release planning: state of the art

Release planning is the activity through which the gathered requirements are realized into a product release. Hence, the input for the release planning process is a set of requirements that evolve over time due to changing user needs and better problem understanding (Ruhe 2010). During release planning, the product manager communicates with other roles in the development team: project manager, software engineers, testers, technical authors, translators, marketing, etc. (Regnell & Brinkkemper 2005). The challenge in release planning is to select the 'right' requirements out of a given superset of candidate requirements in order to fulfill all of the different key interests, technical constraints and preferences of the critical stakeholders and to maximize the overall business value of the product (Ruhe, Eberlein & Pfahl 2002). The sub-processes assisting in meeting such an objective have been reported to consist of requirements prioritization, requirements selection, release definition, release validation, scope change management, and launch preparation (van de Weerd et al. 2006).

Different release planning methods have been proposed during the past decade (see Ruhe (2010) for overview) including:

- *Greedy release planning* (Cormen, Leiserson & Rivest 2006), which uses an algorithm designed to make a locally optimal choice at each stage in selecting requirements based on their priority and the resource consumption.
- *Optimizing value and cost* (Jung 1998), which applies an algorithm to balance the cost and value of the requirements and then implements the most cost-effective set.

- *Combining the optimized value and cost with the interdependencies of requirements* (Carlshamre 2002), which selects requirements based on the trade-off between the requirement's value and cost while considering the interdependencies between requirements.
- *The next release problem* (Bagnall, Rayward-Smith & Whittlely 2001), which looks exclusively at the cost per feature. The objective of planning is to ensure that the demands of the company's client base are satisfied as much as possible while ensuring that they themselves have the resources to undertake the necessary development. There is no involvement of stakeholders in the prioritization of requirements.
- *The incremental funding method*, which aims at delivering functionality in chunks of customer-value features, sequenced to optimize the project's net present value (Denne & Cleland-Huang 2004). The method is focused on the maximization of the overall financial value.
- *EVOLVE* (Greer & Ruhe 2004), which is an evolutionary and iterative approach for software release planning looking ahead to more than one release. The method tries to balance the conflicting stakeholder opinions to achieve the highest degree of satisfaction with the resources available. The method generates more than one alternative, each of which represents a trade-off between the fulfillment of stakeholder expectations and the total benefit of the proposed plans.
- *Software product release planning through optimization and what-if analysis*, which attempts to apply mathematical programming to provide a solution to the next release problem (Van den Akker et al. 2008).

Requirements prioritization is commonly seen as a crucial step towards making release planning decisions (Berander & Andrews 2005). Prioritization helps to identify the most valuable requirements from the repository by distinguishing the critical few from the desired many (Berander & Andrews 2005). Several requirements prioritization approaches have been presented for dealing with such complexity. These varying approaches work on different measurement scales, focus on different aspects, and have different levels of sophistication (Berander & Andrews 2005). The prioritization approaches introduced in the literature vary from generic prioritization process descriptions to detailed prioritization algorithms (Berander, Khan & Lehtola 2006). The most commonly referenced prioritization techniques are (see Berander & Andrews (2005) for overview):

- *Numerical Assignment (Grouping)* (Leffingwell & Widrig 2000; Sommerville & Sawyer 1997), which is based on grouping requirements into different priority groups based on one criterion or more. Numerical assignment has been claimed to be the most common prioritization technique in practice, and it is also suggested in existing IEEE standards (Berander & Andrews 2005).
- *Ranking* (Karlsson, Lena, Wohlin & Regnell 1998), which is based on an ordinal scale, but the requirements are ranked without ties in rank. The most important requirement is ranked 1 and the least important is ranked n (for n requirements).

Ranking has been found to be more suitable for a single stakeholder because it might be difficult to align several different stakeholders' views (Berander & Andrews 2005). Ranking, in fact, also relies on a static and transitive relationship between requirements which, in actuality, does not hold.

- *Top-ten requirements* (Lauesen 2002), in which the stakeholders pick their top ten requirements from a larger set without assigning an internal order between the requirements.
- *Cumulative Voting (also called e.g. the € 100 test)* (Leffingwell & Widrig 2000), in which the stakeholders are given imaginary units (money, hours, etc.) to distribute between the requirements.
- *The Analytical Hierarchy Process (AHP)* (Regnell, Höst et al. 2001; Saaty 1980), which is conducted by comparing all possible pairs of hierarchically classified requirements in order to determine which has higher priority, and to what extent.
- *Cost-value analysis* (Karlsson, J. & Ryan 1997), in which requirements are compared pair-wise according to their value and cost and then plotted into a cost-value diagram for further analysis.

Despite of the variety of proposed release planning approaches, commonalities among them can be seen clearly. Many of the proposed approaches view release planning as a combinatorial optimization challenge, commonly known as *the knapsack problem* (Kellerer, Ulrich & Pisinger 2004):

Given a set of items, each with a weight and a value, determine the number of each item to include in a collection so that the total weight is less than or equal to a given limit and the total value is as large as possible.

As a result, product releases are largely planned with an approach which typically manifests the following properties:

1. The value of requirements is evaluated with categorization or by assigning numerical values to individual requirements or requirement pairs so that rational decisions can be made about which of the requirements are likely to be the most profitable to implement.
2. The great majority of the identified release planning practices is based on the assumption that there is an expert or small group of experts who skillfully work with explicit knowledge and shape the requirements towards increased precision and accuracy. If problem is too large to be coped with by a small number of experts, algorithms and complex calculations are believed to help.

The fact that the majority of proposed release planning methods approach the problem in a similar way suggests that there is a set of assumptions about the release planning challenge that are commonly shared within the professional community. Based on the review of existing release planning approaches, it seems that the following assumptions about the problem are believed to be valid:

- There is an ideal solution to be found because the social world has an existence which is as hard and concrete as the natural world (the view of *realism* on *ontological debate* (Burrell & Morgan 1979)) .
- The solution can be found with a systematic protocol and technique (*nomothetic approach to methodological debate* (Burrell & Morgan 1979))
- The solution can be found by shaping the requirements towards increased accuracy. The growth of knowledge is essentially a cumulative process in which new insights are added to the existing stock of knowledge and false hypotheses are eliminated (*positivist view of on epistemological debate* (Burrell & Morgan 1979)).
- People act rationally, being completely determined by the situation or environment in which they are located (the view of *determinist* on *human nature debate* (Burrell & Morgan 1979))

These assumptions, adopted by a professional community, constitute a sense of professionalism or '*world view*' that allows its members to share similar perceptions and engage in commonly shared practices (Hirschheim, R. & Klein 1989). A '*received view*' refers to any world view that is taken for granted or that is assumed to be true without further criticism.

The review of existing release planning approaches suggests that there may be a received view of release planning that appears to be prevailing, dominant and deeply entrenched.

10.2 Reported challenges of release planning

It is widely accepted that release planning is a challenging and complex decision-making activity (Carlshamre 2002; Karlsson, J. & Ryan 1997; Lehtola, Kauppinen & Kujala 2004). Based on the review of existing literature, the challenges of release planning can roughly be considered to consist of 1) challenges of prioritization, 2) challenges caused by requirements interdependencies and 3) challenges caused by the fact that the problem changes constantly in various ways.

Determining priorities for requirements has proved to be difficult. Priority itself is an ambiguous term. For instance, in some cases the term 'priority' could be considered as a quantity meaning 'the importance of a requirement to the customer'. In other cases, priority could be understood to describe how soon the requirement should be implemented (Lehtola, Kauppinen & Kujala 2004).

Priority has also been found to be a complex amalgam of different aspects (Carlshamre 2001; Lehtola, Kauppinen & Kujala 2004; Ruhe 2010). The common aspects have been identified to be importance, penalty, cost, time and risk (Berander & Andrews 2005). Each aspect of priority may itself be an extremely multifaceted

concept (Berander & Andrews 2005). Importance could, for example, be a combination of urgency of implementation, importance of a requirement for the product architecture, strategic importance for the company, etc. (Berander & Andrews 2005; Lehtola, Kauppinen & Kujala 2004).

It has been claimed that decision-makers should consider multiple aspects before deciding if a requirement should be implemented directly, later, or not at all (Berander & Andrews 2005). The number of aspects affecting the requirements priorities, however, seems to expand in product companies compared to the companies operating in the project business (Lehtola & Kauppinen 2006). In order to prioritize requirements, domain knowledge and estimation skills are required (Karlsson, L. et al. 2004).

Coping with the multiple aspects of priority has turned out to be difficult in practice. Decision-makers have found it challenging to determine which aspects are important in making prioritization decisions (Carlshamre 2002). Furthermore, it has sometimes been difficult to obtain real information on the aspects that have been found to be necessary for decision-making (Lehtola, Kauppinen & Kujala 2004). Not only does prioritization depend on the aspects chosen, but also on the stakeholders selected (Ruhe 2010). To make matters more complex, requirements' priorities may vary as a function of time (Lehtola & Kauppinen 2006). An important requirement in one release or to a certain customer may not be as important in the next release or to another customer (Carlshamre 2002). Instead of being just a one-off activity, requirements prioritization is needed in many phases of the development work and the importance of different viewpoints depends also on the development phase (Lehtola, Kauppinen & Kujala 2004).

Requirements are often related with each other in various ways. The challenges of requirement interdependencies tend to grow over time. The change in complexity is even more dramatic when the product is introduced to a new market area or new customer segment (chapter 7). Customers from different geographical areas or from different market segments may prefer different technologies and may have different preferences regarding the functionality of a product.

Dahlstedt and Persson (2005) have developed an overall view of existing interdependency types presented in the literature, claiming that the interdependency types most useful to consider during release planning are *requires*, *similar to*, *conflicts with*, *increases/decreases cost of* and *increases/decreases value of*. Although the impact of requirements interdependencies can be tremendous, most prioritization techniques assume that requirements are independent from each other (Berander & Andrews 2005).

One significant challenge in release planning is that the criteria for successful solution keep changing continuously. The reasons for such turbulence are numerous. Technologies constantly evolve enabling new possibilities, regulations change, and competition or other changes in the marketplace force the product company to change focus. In such turbulence, the capability to react quickly to changed demands and to exploit efficiently the opportunities of new technologies is a driving factor of a company's success (Ruhe 2010).

10.3 The challenge of release planning: visible but not seen?

A summary of the findings originating from the review of MDRE related literature is presented in Figure 25. The review of reported release planning challenges (section 10.2) reveals that software product companies often deal with a wicked problem, as suggested by Carlshamre (2002). Characteristic to the problem is that stakeholders have differing interpretations and value orientations regarding the gathered information, the understanding of how requirements are related with each other is insufficient, and finally, the criteria for successful release continuously change.

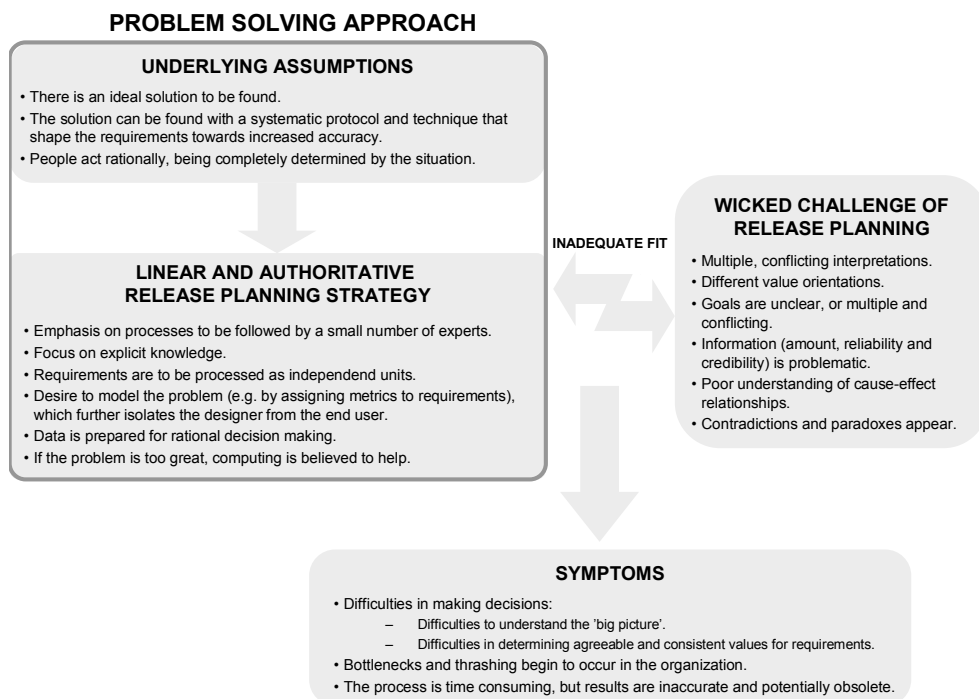


Figure 25. Summary of MDRE related literature review

The review of existing release planning approaches in section 10.1, on the other hand, reveals that there is an inadequate fit between the characteristics of the assumed problem and the problem in reality. Assumptions about the release planning challenge have led research and practice to deal with the problem with *linear and authoritative strategies*. This can be seen in the tendency to emphasize processes that attempt to prepare gathered requirements one by one for rational decision making.

Linear and authoritative strategies are ‘taming strategies’ (Roberts 2000). They diminish the level of conflict inherent in wicked problems by putting problem solving into the hands of a few stakeholders who have the authority to define a problem and come up with a solution (Roberts 2000). Instead of dealing with the full wickedness of the problem, one simplifies it in various ways to make it more manageable – to make it solvable (Conklin 2005). However, if problem solving is left solely to experts, then the product’s stakeholders can become further and further distanced from the important product related issues (Conklin 2005). According to Roberts (2000), experts tend to search for solutions within their narrow bandwidth of experience, potentially missing other important issues and considerations.

Even the most sophisticated release planning algorithms provide unreliable results if priorities cannot be defined accurately in the first place and if the interdependencies of the requirements have not been taken into account. Practitioners have been found to keep changing the priorities until they result in a release content that meets their mutual expectations (Lehtola & Kauppinen 2006).

Paradoxically, taming the release planning challenge has made the problem solving more complex. Modelling more and more details while listening to more and more stakeholders cannot scale. Complex models become a burden when situations change quickly. The attempt to deal with differing perceptions, viewpoints, ideas and opinions in an explicit form leads eventually to a situation where the organization is forced to suppress cognitive conflict rather than resolve it. This, in turn, may result in stifled communication and “Group Think” (Janis 1982). While losing opportunities to understand the problem at a deeper level, the suppression of cognitive conflict may also result in the over-stimulation of affective conflict, where disagreements on requirement priorities devolve into emotionally charged and personalized exchanges, resulting in distraction and collateral damage to group cohesion, cooperation and future relationships (Jehn 1995; Parayitam & Dooley 2009). As an example, stakeholders who shout the loudest have been found to have better opportunities in having their wishes implemented, leaving others with the feeling that they have not been treated equitably (chapter 7).

As techniques and methods become increasingly complex with the goal to provide more help for practitioners, the results are seldom used in industry (Berander & Andrews 2005). On the contrary, as turbulence increases, so too does the use of

intuition and heuristics (Weick 1995b, p. 88). In the absence of information necessary for decision making, people begin to rely more on tacit knowledge. The risk for organizations is that those who are making the decisions do not possess the right kind of tacit knowledge that is necessary to make good decisions.

According to the literature review conducted on release planning, the current approaches introduced in the literature are unsuitable to deal with wicked problems because their corresponding methods and tools (Dumdum 1993):

1. presume an agreement of goals and objectives and hence concentrate their efforts primarily on the search for, the generation of, and the selection of the most efficacious means to achieve predefined goals (Checkland, P. B. 1981). As the number of stakeholders increases, there will typically be a lack of consensus on goals, objectives, constraints and the prioritization of requirements. Thus, there is a need to identify who these critical constituencies are and methods and tools that will enable them to reach a common understanding and a consensus through joint interaction;
2. presume that the underlying values, beliefs and reasons for release planning are largely noncontroversial and thus unquestioned (Hirschheim, R. A. & Klein 1992). Since wicked, complex situations require the interaction and sharing of various constituency perspectives and information (Mason & Mitroff 1981), their underlying assumptions, values, beliefs, and reasons must be surfaced and discussed;
3. view requirements as “needs that must be discovered and documented and taken at face value or as generally accepted principles rather than as propositions that must be examined and tested” (Vitalari 1992);
4. typically trivialize or “throw away” inconsistencies and conflicts in the requirements repository. Since wicked, messy, complex situations are filled with inconsistency, conflict, and ambiguity and since these inconsistencies may be some of the most valuable items in the requirements repository, we need approaches that will help us recognize, appreciate and locate the inconsistencies and conflicts, keep track and take positive advantage of them instead of trivializing them or throwing them away (Mitroff, I.I., Mason & Barabba 1982).

In order to mitigate known challenges with existing release planning approaches, release planning approaches need to be expanded with new ones that support the utilization of a wider spectrum of knowledge that the organization possesses.

10.4 MDRE and the wisdom of the organization

The purpose of this section is to integrate the findings with existing theories. To be more precise, existing theories are utilized to illustrate and explain the identified challenges and to highlight the potential risk in following MDRE processes.

Determining which features shall be implemented in the product's next version has become a complex problem for many organizations. Solving complex design problem typically require more knowledge than any single person possesses (Arias et al. 2000). Due to the fact that product-related needs are sensed by a diverse set of roles, people with important product-related information may be scattered throughout the organization. The capacity to develop organizational knowledge is thus distributed over a network of information processes and participants. Rather than being centrally controlled and coordinated, the capacity to develop knowledge emerges from the complex, unpredictable patchwork of processes in which participants enact and negotiate their own meanings of what is going on, stumble upon and wrestle with new knowledge to make it work, and creatively improvise and bend rules and routines to solve tough problems (Choo 2002).

Supporting the dialogue with multiple realities to reframe one's own and others' experience in alternative frameworks has been argued to enrich understanding of a situation far greater than when only using a single framework of reality (McWhinney 1997, p. 8). Bringing different and often controversial points of view together to create a shared understanding among these stakeholders can lead to new insights, new ideas, and new artifacts (Arias et al. 2000). The quantity and the diversity of viewpoints used for dealing with the complex design problem has become important:

"A system that is tied together more densely across time, activities, and experience comprehends more of what is occurring because the scope of heedful action reaches into more places. When heed is spread across more activities and more connections, there should be more understanding and fewer errors. A collective mind that becomes more comprehensive, comprehends more." (Weick & Roberts 1993)

"The greater the variety of beliefs in a repertoire, the more fully should any situation be seen, the more solutions that should be identified, and the more likely it should be that someone knows a great deal about what is happening." (Weick 1995b, p. 87)

Success does not necessarily go to the firms that know the most, but to the firms that can make the best use of what they know and know what is strategically most important to the firm and to the society at large (Bierly, Kessler & Christensen 2000). The judgement, selection and use of specific knowledge for a specific context is what Bierly et al. (2000) term *organizational wisdom*. Wisdom relates to the ability to effectively choose and apply the appropriate knowledge in a given situation.

The concept of organizational wisdom lead to the theories of *transactive memory* (Wegner 1986) and the *collective mind* (Weick & Roberts 1993). The theory of transactive memory suggests that the group, like the person, has a mental life that plays a part in the patterning of group behavior (Wegner 1986). A transactive memory system is a set of individual memory systems in combination with the communication that takes place between individuals (Wegner 1986). While a transactive memory system provides a shared place to store and retrieve information for an organization, it is the organization's collective mind through which the transactive memory system is appropriated (Yoo & Kanawattanachai 2001). Weick and Roberts (1993) have conceptualized the collective mind as a pattern of implicitly coordinated, heedful interrelations of actions in a social system.

The theories of both the collective mind and transactive memory suggest that knowledge in an organization resides in the connections between people rather than within individual minds. This is also the basic tenet of *social network theory* that views organizations as a network of nodes and ties. Nodes are the individual actors within the networks, and ties are the relationships between the actors (Granovetter 1973). The wisdom that an organization ideally possesses could hence be represented to reside within a network where all nodes are connected with each other.

This section views a hypothetical organization as a network of individuals (nodes) and their relationships (ties), with an attempt to understand *how comprehensively an organization utilizes its collective mind when it follows traditional MDRE processes*. The answer to such a question is sought by going through MDRE processes phase by phase and by situating the MDRE-related activities into a particular part of the hypothetical organizational network (Figure 26) where the activity is likely to be performed. The results of the analysis are organized within the contexts of *sensing the market* (section 10.4.1), *making sense of the market* (section 10.4.2), and *acting upon knowledge* (section 10.4.3). This section then ends with conclusions (section 10.4.4) containing an analysis of how the wisdom of the organization is typically utilized when adhering to existing MDRE processes.

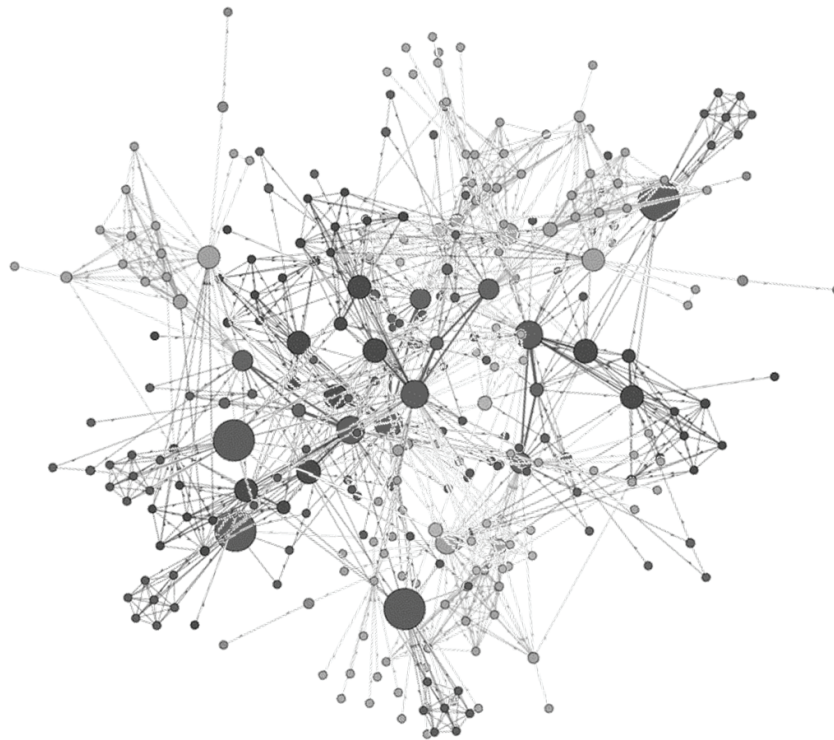


Figure 26. A hypothetical organization as described by social network theory.
The nodes are the individual actors within the networks, and the ties are the relationships between the actors.

10.4.1 Sensing the market

This thesis identified numerous sources through which the organization gathers important information on its product (Figure 8). Many of the organizations have provided the opportunity for their product's stakeholders to submit requests and suggestions into a *requirements repository* (Regnell & Brinkkemper 2005). At first glance, it would appear that by offering everyone an opportunity to submit requests, an organization is actually utilizing the wisdom of its members comprehensively. However, such an impression tends to be false. The common challenge in sensing the market is that a product's stakeholders say *what* should be done instead of *why* a feature of a product should be modified or implemented, thus focusing on *their* solution and *their* perceived problem rather than stating the problem that they wish the product to solve (section 7.2.1). The gathered data and existing literature (e.g. (Regnell & Brinkkemper 2005; van de Weerd et al. 2006)) suggests that the requests

that are submitted to the requirements repository typically represent a single point of view and are often incompletely described. As a result, much of the contextual information that would help to understand the nature of the problem is stripped away from the very beginning. This makes decision making at later steps difficult.

10.4.2 Making sense of the market

Submitted requests are typically scanned periodically in order to determine what functionality shall be implemented in the forthcoming releases of a product. This objective is related to the tasks of roadmapping and release planning (Regnell & Brinkkemper 2005). The challenges related to making sense of the market were similar to what has already been written in RE literature (Carlshamre 2002; Damian, D. E. & Zowghi 2003; Karlsson, Lena et al. 2007; Lehtola & Kauppinen 2006). Despite the fact that many organizations have more information gathered in their requirements repositories than they can digest, deciding which of the requirements shall be implemented was considered to be difficult. Karl Weick offers an explanation for such a phenomenon:

“The problem with a company’s design challenge is no longer solely one of uncertainty, with a corresponding need for increased quantities of information. Advanced information technologies have lessened this problem. The problem now is more one of multiple meanings. Designs that help people remove equivocality are needed to cope with multiple meanings. Those designs tend to be more social, more tolerant of improvisation, and more affected by action than is true for designs grounded in decision making.” (Weick 2001, p. 76)

“The design issue is not how to apply judgment to decision making. The design issue is how to construct a capability for judgment in the first place. The issue is an act of interpretation, because it necessitates an effort to get agreement on preferences. In order to construct such a framework, people have to encode events into a common set of values and implications. Once that commonality is achieved, then they can begin to act like professionals.” (Weick 2001, p. 74)

As the requests submitted to the requirements repository often lack important information to determine the value of the request, the decisions regarding the product’s future versions are often made based on tacit knowledge by those taking part in the requirements prioritization and release planning activities.

The experiences with the case companies indicate that making sense of the market is typically performed by a product management team consisting of few of resources. Having only a small number of people involved in decision making sometimes causes problems. If the people making sense of the market do not have diverse enough viewpoints on the design problem, the decisions may be based on too shallow an understanding of the stakeholders’ needs. Furthermore, the tacit knowledge affecting the decision making often remains undocumented. Hence, important information revealing why the requirement was selected to be implemented are stripped from the

actual requirement. This reduces the possibilities for others to comprehend the reasoning behind the decisions made.

10.4.3 Acting upon knowledge

In a typical scenario, the activities aiming at making sense of the market result in the artifacts of the roadmap and release plan. The requirements that are to be implemented into the next release are then documented at a more detailed level into an artifact of requirement specification. This document containing requirements in explicit form is a typical input for software implementation. Unfortunately, when the requirements specification is finally sent to the ones that need to act upon it, much of requirements' important contextual information may already be lost. People whose task was to implement the decisions made were often left ignorant or misinformed. Examples of this challenge were seen in section 5.1 with reports of unsatisfactory design decisions that were made in the absence of a sufficient amount of contextual information, and perceived difficulties to create marketing material until the new product version was implemented.

When requirements are ambiguous and incomplete, the open issues concerning the requirements are likely to be solved by the software developers themselves. These decisions are based on the *developer's view* of the design problem. It should be noted that this viewpoint may be very limited. It is not uncommon that the software developer has never visited the customers.

10.4.4 Conclusions

This section has illustrated the potential risks of gathering product-related needs in incomplete form and further losing contextual information in all steps of MDRE. The observations of this study suggest that, if enough attention is not given to the human side of MDRE activities, the decision making is likely to be concentrated into two distinct groups within the company. One of these groups is often the result of intentional organizational design. Existing literature and our gathered empirical data suggest that companies typically have a dedicated product management team to select which of the requirements shall be implemented into the product's forthcoming versions. It is important to note that the product management team makes the decisions based on the way they perceive the problem. Perhaps less intentional is the fact that, due to ambiguous and incomplete requirements, much of the decision making is actually transmitted to the software developers. Furthermore, these two teams central to decision making tended to communicate largely by documents.

Thus, with the quest of being efficient in processing information, the organization is systematically ignoring ties between individuals that could potentially be important in

understanding the market needs. Hence, an organization may, in fact, be lobotomizing its collective mind (Figure 27).

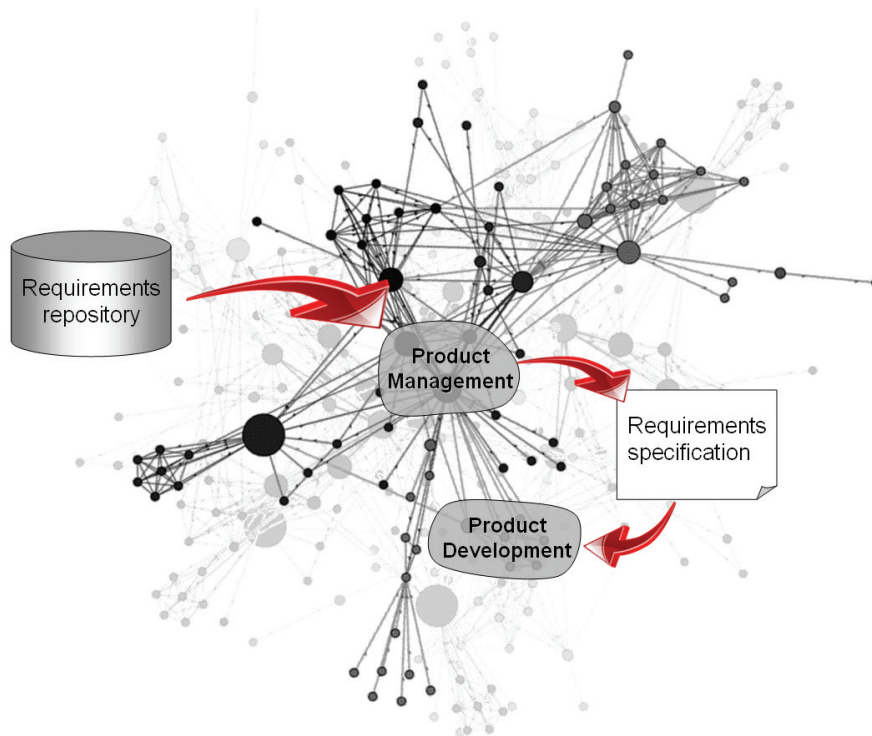


Figure 27. Hypothetical illustration of how the wisdom of the organization is utilized when adhering to MDRE processes.

10.5 Towards supporting organizational cognition in RE

Previous sections have illustrated that the activity of release planning often deals with a wicked problem (McCaskey 1982; Rittel & Weber 1973), for which current linear and authoritative release planning approaches do not seem to provide sufficient support. Section 10.4 further argued that linear and authoritative release planning approaches are less effective than preferred in utilizing the diverse wisdom that a product's stakeholder network possesses. In fact, following such release planning approaches may result in the elimination of weak ties (Granovetter 1973) between individuals that could potentially be beneficial in understanding product-related needs and potential solutions. Such removal of potentially important ties between individuals was referred to in section 10.4 as a lobotomy of the collective mind.

How, then, could we improve the utilization of the collective mind? Section 10.4 argued that, just as individuals, organizations also have a memory and a mind. In this section, I expand on such thoughts, arguing that just as individuals have cognition, so, too, has an organization.

Figure 7 on page 20 described Neisser's theory (1976) of individual cognition. According to the theory, a human's attention and action is affected by schemata, a mental map of the world and its possibilities. Individuals are more likely to notice matters that fit into their schema. Furthermore, the way individuals perceive the world affects the way they act.

When a group of individuals is brought together, each with their own knowledge structure about a particular information environment, some type of emergent collective knowledge structure is likely to exist (Walsh 1995). Through interactions among a number of different individuals, the commonly shared ideas begin to take on an existence of their own, independent of the individuals that created them (Bogner & Barr 2000). This group-level representation of an information environment would act just like an individual's knowledge structures. It, too, functions as a mental template that, when imposed on an information environment, gives it form and meaning, and in so doing serves as a cognitive foundation for action (Walsh 1995).

When taking Neisser's theory (1976) to an organizational level, we could say that also organizations have a schemata (Figure 28). An organization's *shared understanding and common goals* affect how ambiguous and complex market needs are interpreted. Furthermore, as the explicit recognition of an organization's schemata has been argued to promote effective decision making (Walsh 1995), shared understanding and common goals also determine how the organization collectively acts in its environment.

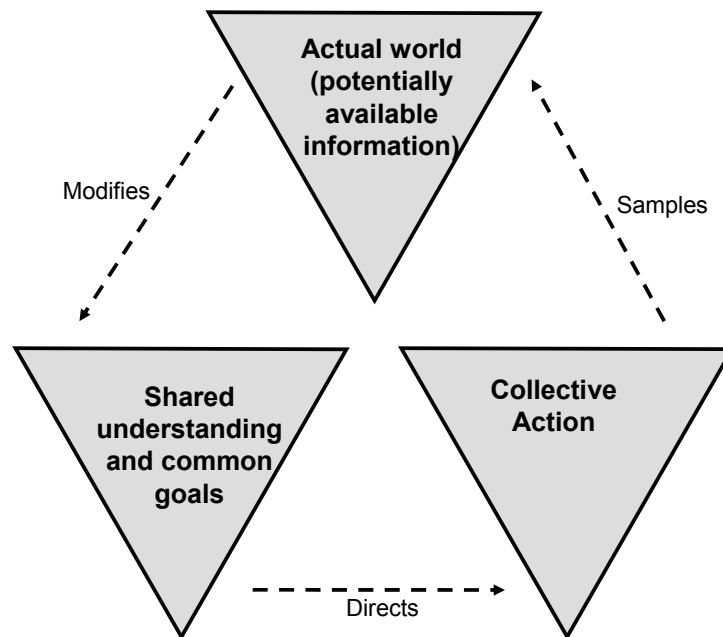


Figure 28. Neisser's theory of individual cognition (1976) taken to an organizational level.

Shared understanding and common goals are important for an organization because they set the framework for explaining the observed reality and for determining saliency and appropriateness (Choo 2002). Shared understanding and common goals help to articulate a shared organizational agenda, a set of issues that people in the organization agree on as being important to the well-being of the organization. While they may not agree about the content of a particular issue, and they may adopt diverse positions on how it should be resolved, nevertheless, there is collective recognition that these issues are salient to the organization (Choo 2002).

“A framework of shared meanings and purpose is therefore used by organizational members to assess consequentiality and appropriateness and to reduce information ambiguity and uncertainty to a level that enables dialogue, choice, and action making. Where messages from the external environment are highly equivocal, shared meanings reduce ambiguity by helping members to select plausible interpretations. Where messages from the external environment are highly incomplete, shared meanings reduce uncertainty by supplying assumptions and expectations to fill in the voids. Shared meanings need to be continuously updated against new events and conditions. By allowing ambiguity and diversity in interpretations, an organization can constantly monitor its shared meanings against the environment to ensure that they are still valid. Within the framework of its constructed meaning, agenda, and identity, the organization exploits current specializations or develops new capabilities in order to move toward its vision and goals. Movement may be blocked by gaps in the knowledge needed to bridge meaning and action” (Choo 2002).

The creation of organizational schemata is the outcome of *organizational sensemaking* (Weick 1995b). Sensemaking is the process by which people give meaning to experience. Through sensemaking, organizational members enact and negotiate beliefs and interpretations to construct a shared understanding and common goals. Enactments in organizations are often highly equivocal because there are so many diverse interests, positions, political struggles, and stakeholders involved, any one of which could understand a recent enactment quite differently (Boland 2008). Sensemaking reduces the equivocality of enactments by applying a pattern of meaning onto the enactments and thereby making sense of them (Boland 2008).

This thesis has discovered that building an understanding of the requirements has proved to be a salient challenge for many organizations. It is difficult to understand what the requirement really is, how it is constrained and how valuable the requirement is to different stakeholders. The analysis of the gathered data showed already at an early stage that when the requirements are not known well enough, it is difficult to make decisions. This challenge is illustrated at the beginning of chapter 9 with portions of the gathered data (originally presented in section 5.1). When the requirements are ambiguous, complex and constrained, processes tuned for decision making begin to degrade. In the absence of explicit knowledge, people begin to rely more on tacit knowledge. The risk for organizations is that those who are making the decisions do not possess tacit knowledge that is necessary to make good decisions.

This thesis argues that existing linear and authoritative release planning approaches need to be complemented with approaches that support organizational cognition. We need to extend current release planning approaches with new ones that support the product's stakeholders' negotiation of their beliefs so that they collectively understand their environment and collectively know how they should react to the interpreted situation. In short, we need to find ways to support organizational sensemaking in the context of release planning.

The depictions of decision making and sensemaking seem to complement each other, but we cannot easily combine them because they have such different ontological and epistemological foundations (Boland 2008). Each considers the world to be composed of quite different sorts of being, and each represents a very different way of knowing about the world. Their different assumptions about what constitutes the world and how we can know about it are, in a deep sense, incommensurable (Boland 2008). Such differences are illustrated below within the context of MDRE with two narratives. The first narrative is composed from existing literature, describing the dominant decision-making approach towards MDRE:

Narrative 1: MDRE as a decision making activity

The ones seeing MDRE as a decision making activity highlight the importance of the product manager as a decision-maker. The product manager is a "mini CEO", who is, among other things,

largely responsible for planning and prioritizing requirements into roadmaps, releases and projects (Ebert, Christof 2007). The goal of decision making is to select a set of requirements from a large set of candidates that maximizes the value added for the customers within the constraints of the fixed release date and the resources available (Carlshamre 2001, p.61). The priority of requirements is a major determinant in such decision making (Carlshamre et al. 2001; Sawyer, P., Sommerville & Kotonya 1999). The major challenge product companies have to face is to cope with the potentially enormous amount of information and to represent and organize it in an efficient way so that it can provide a good basis for efficient and effective decision making, which in turn provides the basis for a profitable software business (Regnell & Brinkkemper 2005). One of the origins for such difficulties is the fact that the requirements are often communicated in natural language. This induces several problems, such as imprecision, ambiguity, incompleteness, conflict, and inconsistency, which take time to resolve (Natt och Dag & Gervasi 2005) to useful levels. In dealing with the problem, the product company is facing a dilemma of how to analyze and evaluate every incoming requirement, customer wish and technical suggestion as soon and as thoroughly as possible (Natt och Dag & Gervasi 2005). Companies facing these challenges may arrive at a cross-road where the choice is to reduce the flow of incoming requirements or to assign more resources to handle them (Höst et al. 2000). Researchers and companies tend to apply computational algorithms in order to alleviate such challenges (Natt och Dag & Gervasi 2005; Natt och Dag et al. 2001).

Studies on sensemaking in MDRE or within the related fields of requirements engineering, software engineering and information systems development are much sparser. Ovaska and Stapleton (2009) have studied social and organizational aspects of requirements engineering in the field of information systems development. They have concluded that, although current approaches still largely assume that projects proceed with distinct phases in a more or less waterfall fashion with an attempt to satisfy the originally stated requirements, the requirement shaping is, in fact, an iterative *sensemaking* process. Filtering, negotiating and shifting of different attitudes and expectations about systems development in the process change and increase the participants' interpretation and understanding of requirements during the project (Ovaska & Stapleton 2009). In a similar vein, Crowston and Kammerer have studied two teams of requirements analysts developing requirements for larger, complex real-time systems (1998). The authors discovered that developers try to hierarchically decompose systems into pieces small enough to be handled by a single person and with minimal interactions with other pieces, even though it is never possible to eliminate the need for interaction (Crowston & Kammerer 1998). As one remedy for the identified challenge, Crowston and Kammerer suggested utilizing the *collective mind* perspective for helping individuals to understand how their work contributes to the work of the group (Crowston & Kammerer 1998). Selvin and Buckingham Shum (1999) have reported that many participants have a limited understanding (and even sheer incomprehension) of portions of the problem space, such as the subject matter, technical issues, political pressures, or factors in the external environment. The authors suggest *collaborative sense-making* as a way to view the process toward creating mutually intelligible representations of requirements that can serve as bridges between different stakeholder communities over the software development lifecycle (Selvin & Buckingham Shum 1999).

Due to the relative absence of the sensemaking viewpoint within the field of MDRE, the narrative illustrating MDRE as a sensemaking activity is built by relying on literature outside of the RE discipline:

Narrative 2: MDRE as a sensemaking activity

The ones seeing MDRE as a sensemaking activity believe that there are many interpretations of the gathered information. Therefore, there would always be a number of models in play, never simply one model purporting to describe 'what is the case' (Checkland, P. 2000). Thus, models are rather used to explore and learn about the problem situation than to describe the reality. When multiple meanings produce a shock, a greater quantity of information is less help than is a different quality of information. To reduce multiple meanings, people need access to more cues and more varied cues, and this is what happens when rich personal media such as meetings and direct contact take precedence over less rich impersonal media such as formal information systems and special reports. To resolve confusion, people need mechanisms that "enable debate, clarification and enactment more than simply provide large amounts of data" (Weick 1995b, p. 99). Requirements written in natural language are valued, because "a good story holds disparate elements together long enough to energize and guide action, plausibility enough to allow people to make retrospective sense of whatever happens, and engagingly enough that others will contribute their own inputs in the interest of sensemaking." (Weick 1995b, p. 61). Vast quantities of information are not likely to be reduced with computational measures. Instead, information is exposed to the stakeholders, because "the greater the variety of beliefs in a repertoire, the more fully should any situation be seen, the more solutions that should be identified, and the more likely it should be that someone knows a great deal about what is happening" (Weick 1995b, p. 87). Equivocality removal is essentially an interpersonal process and involves at least two members interlocking some behaviors to accomplish this removal" (Weick 2001, p. 201).

According to Boland (2008), design thinking enables us to bring the traditions of both sensemaking and decision making into a single, overreaching framework of action, which then allows us to draw upon and benefit from their complementary strengths. Being good at designing begins with being good at understanding the design situation. Being good at designing also involves being good at decision making. Decisions about materials, functionality, methods, costs, and processes are embedded within and necessary for a good design outcome (Boland 2008). A sensemaking process is always able to go further in surfacing new possibilities for meaning and invention in its rich field of organizational enactments. Design thinking tempers the potentially endless process of sensemaking by bringing project deadlines and decision requirements into the picture (Boland 2008). Design thinking also carries a higher-order cost-benefit dialogue with it, as design thinking balances the desire for further exploration of new ways to make the situation meaningful with the need to complete the design projection in time and within budget (Boland 2008).

Design thinking also helps to balance the tendency to take an existing set of alternative choices as given, by always suspecting that our initial ideas are the default ideas that anyone would think of (Boland 2008). Design thinking balances that tendency against a commitment to seek new alternatives that have not yet been created. Finally, design thinking serves as a continuing source of challenge to our

sensemaking and decision making capabilities. It keeps both sensemaking and decision making alive in organizations because of its central underlying belief that matters can be other than they are. Because design thinking is always posing the challenge that matters can be other than they are, we struggle to make sense of our situation and to plan actions that transform it into a more desirable one (Boland 2008).

11 Assessing the proposed theory

Several aspects of the presentation enter into how the reader judges the credibility of the theory. First of all, if the reader becomes sufficiently caught up in the description so that he or she feels vicariously that he or she was also in the field, the reader is more likely to be kindly disposed toward the researcher's theory than if the description seems flat or unconvincing (Glaser, B. & Strauss 1967, p. 230). Second, the reader's judgment of credibility also rests upon his or her assessment of how the researcher came to his or her conclusions (Glaser, B. & Strauss 1967, p. 230).

The challenge of assessing the credibility of a scientific work is that every mode of discovery develops its own standards and procedures for achieving them. Hence, in order to ensure that the work is evaluated with criteria appropriate for the context, it is important that all of these criteria are made explicit (Strauss & Corbin 1990, p. 250). This chapter makes such criteria explicit by discussing first the nature of theory in science and second the criteria for evaluating a grounded theory (section 11.1). Subsequently, section 11.2 discusses the criteria for evaluating the trustworthiness of interpretive qualitative studies and particularly a grounded theory study. Finally, section 11.3 discusses the relevance of the proposed theory.

11.1 What is a theory and how to evaluate it?

The purpose of science is theory (Bacharach 1989; Kerlinger 1979). However, despite the wide recognition of the need for theory development, there is still little agreement about what constitutes strong versus weak theory (Bacharach 1989; Colquitt & Zapata-Phelan 2007; Gregor 2006; Sutton & Staw 1995). Such lack of consensus is problematic

because it hinders the very fundamental purpose of science, the development of strong theories (Sutton & Staw 1995).

It appears that differences in views on theory depend to some degree on philosophical and disciplinary orientations (Gregor 2006). One view originating from the physical or natural sciences sees theory as providing *explanations* and *predictions* and as being *testable* (Gregor 2006). Samuel Bacharach (1989) has taken such a view in his work to define criteria for evaluating theories. Building his thoughts on those of philosophers such as Karl Popper, Ernest Nagel and Carl Hempel, Bacharach states that the two primary criteria upon which any theory may be evaluated are a) falsifiability and b) utility. Falsifiability determines whether a theory is constructed such that empirical refutation is possible. Utility refers to the level of usefulness of theoretical systems (Bacharach 1989).

Bacharach makes a clear point of distinguishing description from theory, claiming that the primary goal of a theory is to answer the question of *how, when, and why*, unlike the goal of description, which is to answer the question of *what* (Bacharach 1989). In particular, he characterizes categorizations of raw data, typologies and metaphors as not theories (Bacharach 1989). In a similar vein, Sutton and Staw (1995) have added items to the list of what theories are *not*, such as references, data, lists of variables or constructs, diagrams and hypotheses. Sutton and Staw acknowledge that such items are important in theory building, a point that is presented even more strongly by Weick (1995c), but these items do not alone provide the explanatory power that theories should possess.

Gregor (2006) has argued that it is important to examine the nature of theory in a given discipline. She takes the discipline of Information Systems (IS) as an example claiming that IS is at the intersection of knowledge of the properties of physical objects (machines) and knowledge of human behavior (Gregor 2006). Therefore, the discipline of IS needs to draw not only from natural sciences but also *social sciences* and what has been termed *design sciences* (Gregor 2006). It thus appears that, in some disciplines, a broader view on theories than in natural sciences is necessary.

One dimension that broadens the view on theories originates from the interpretivist tradition, where the primary goal is not to develop theory that is testable in the narrow sense (although its validity or credibility may still be assessed), but in understanding the complex world of lived experience from the point of view of those who live it (Gregor 2006). As a response to the recognized need for greater diversity in theories and theory building in IS, Gregor proposes five different types of IS theory, namely (1) theory for analyzing, (2) theory for explaining, (3) theory for predicting, (4) theory for explaining and predicting, and (5) theory for design and action. Some of these labels for theories are explicitly stated as *not* theories by Bacharach (1989).

Karl Weick (1986) shares Gregor's concern of broadening the view on theories in the discipline of IS. Weick adopts Kling's taxonomy of organizational theories (Kling 1980) and identifies two basic theories used to analyze computing in organizational settings – *systems rationalism* and *segmented institutionalism* (Weick 1986). Systems rationalists tend to see organizations as rational units. Segmented institutionalists, on the other hand, assume that conflict is more common than consensus, that definitions of the situations are multiple, that goals are diverse, that implementation is affected by vested interests and power, that relevant social forms consist of much more than task groups, and that technology can take on a variety of meanings (Weick 1986). Just as Gregor (2006), Weick (1986) acknowledges that to theorize about technology and organizations is to relate two quite different domains. Weick claims that Management Information Systems (MIS) researchers need to adopt organization theories to which they are not accustomed in order to see something other than common-sense rational processes (Weick 1986). Researchers in MIS usually expect to see rational systems, and they usually find them. What they fail to see is that additional processes and variables affecting the technology impact lie outside their rational combination (Weick 1986).

In a way, Weick appears to widen the criteria of what can be accepted as a good theory. Theories should not only have the explanation and predictive power, theories should also *delight* (Weick 1995a). Writers should feel free to use *theory* whenever they are theorizing (Weick 1995c). Research results often labeled as not theory (Sutton & Staw 1995) may, in fact, represent the interim struggles in which people intentionally inch toward stronger theories (Weick 1995c). To label these research results as “not theory” makes sense if the problem is laziness and incompetence. However, ruling out those same five may slow inquiry if the problem is theoretical development still in its early stages (Weick 1995c). Weick (1995c) notes that research products that are labeled theories are really approximations of them. Furthermore, Weick (1995c) argues that such approximations are entirely consistent when you view theory as a process and the resulting theoretical elements as in-process accomplishments. From Weick's process perspective, theory work can take a number of forms, and it includes such activities as abstracting, generalizing, relating, selecting, explaining, synthesizing and idealizing (Weick 1995c). The emergent products of these processes may not be formal theories. Nevertheless, they do have a value in summarizing progress made towards understanding a phenomenon, in providing direction for inquiry, and in serving as place markers (Locke 2001, p. 38).

Similar discussions on the role of theory and theorizing have emerged in recent years also within the discipline of RE. Similarly to Weick's view (1995c), Gause (2004) sees interim research results as important elements towards gaining deeper scientific knowledge. There has been raising concern within the RE discipline about losing opportunities by being too "fact-driven" and too critical of "unscientific" research and development approaches (Gause 2004) while still producing research results that are

largely ignored by practitioners (Davis, A. M. & Hickey 2004). Adopting the idea from evidence-based medicine, Gause (2004) proposes a levels-of-evidence concept as an enabling tool. This allows the RE community to communicate potentially useful findings while still in the uncertain or incomplete state:

Theory – Fact based. Supported by axioms, universally accepted models, well understood and defined mechanisms or a consensus of all generally accepted authorities.

Experiment – Empirically based. Supported by well-designed, rigorously controlled events.

Observation – Empirically based. Supported by well-documented observations of many events. The elements of design and control are missing.

Anecdote – Experience based. Supported by an individual event or small numbers of events. Not necessarily well-documented. Usually occurs without warning or planning.

Hunch – Intuitive based. Supported by general impressions too weak to understand, explain or even rationalize.

This thesis has drawn on social sciences with an observational research approach. It has adopted the view of what is a theory from the interpretivist research tradition. Although the thesis has developed a *theory of explaining and predicting* (Gregor 2006), in terms of Gause's levels-of-evidence (2004), the results of this thesis are largely at the *observation* level.

Strauss and Corbin (1990) suggest that a theory has a number of characteristics. To begin with, it should be a plausible statement of a series of relationships across concepts and sets of concepts which can be traced back to the data. Furthermore, a theory should be conceptually dense. It should include many conceptual relationships presented in a discursive form which is embedded in conceptual writing. Finally, theories should be seen as fluid, due to the fact that they should embrace the interactions of multiple actors, and emphasize temporality (Strauss and Corbin 1990).

According to Glaser and Strauss (1967, p. 237), the practical application of grounded theory requires developing a theory with (at least) four highly interrelated properties:

1. *Fit* - does the theory fit the substantive area in which it will be used?
2. *Understandability* – will non-professionals concerned with the substantive area understand the theory?

3. *Generality* – does the theory apply to a wide range of situations in the substantive area?
4. *Control* – does the theory allow the user some control over the “structure and process of daily situations as they change through time”?

These properties of a grounded theory are discussed further as follows.

11.1.1 Fit

Deducing practical applications from the theory rests on the assumption that the theory supplies concepts and hypotheses that fit (Glaser, B. & Strauss 1967, p. 238). When the theory does not fit well, the consequences are typically the forcing and distorting of data to fit the categories of the deduced applications, and the neglecting of relevant data that seemingly do not fit or cannot be forced into the pre-existing sociological categories (Glaser, B. & Strauss 1967, p. 239).

To my current understanding, there are no known misfits in this thesis between the data and the proposed theory. When taking a broader perspective, all organizations will fall into two categories:

1. *Companies that are currently facing very few or no challenges* in their product development activities. Such companies at the moment have an appropriate problem solving approach for their design problem.
2. *Companies that are currently facing challenges in their product development.* According to the proposed theory, there is a misfit between the design problem and the chosen problem-solving approach in such companies. If there is an unrecognized need for a paradigm shift or if the company is persistently resisting the necessary shift to a new paradigm, the company may be suffering from paradigm paralysis.

The proposed theory has identified two pairs for the design problem and the appropriate problem solving approach. Approaches for decision-making are well suited for clearly defined design problems, whereas sensemaking is more effective for wicked problems that many software product organizations currently face. This study leaves open the possibility that other dimensions for the type of design problem and the effective problem solving approaches will be identified. However, such potential dimensions will not invalidate the proposed theory. They make the existing theory more complete. Other theories are neither proved or disproved, they are placed, extended and broadened (Glaser, B. G. 1978, p. 38).

11.1.2 Understandability

A grounded substantive theory that corresponds closely to the realities of an area will make sense and be understandable to the people working in the substantive area (Glaser, B. & Strauss 1967, p. 239). Their understanding of the theory tends to engender a readiness to use it, for it sharpens their sensitivity to the problem that they face and gives them an image of how they can potentially make matters better (Glaser, B. & Strauss 1967, p. 240). The concepts of the theory provide a necessary bridge between the theoretical and practical thinking of people concerned with the substantive area, enabling them to understand and apply the theory (Glaser, B. & Strauss 1967, p. 241). The researcher finds that he or she has “a feeling for” the everyday realities of the situation, while the person in the situation finds he or she can master and manage the theory (Glaser, B. & Strauss 1967, p. 241).

The proposed theory has been discussed in several meetings at Tekla, with positive reactions. In these meetings, Tekla’s personnel, involved with product management activities, have understood the proposed theory with ease and have acknowledged it to fit with their experiences.

11.1.3 Generality

In deciding upon the conceptual level of the categories, the analyst generating a theory should be guided by the criterion that the categories should not be so abstract as to lose their sensitizing aspect. Yet, they must be abstract enough to make the theory a general guide to multi-conditional, ever-changing daily situations (Glaser, B. & Strauss 1967, p. 242). Through the level of generality of the concepts, the analyst tries to make the theory flexible enough to make a wide variety of changing situations understandable, and also flexible enough to be readily reformulated, virtually on the spot, when it does not work in application (Glaser, B. & Strauss 1967, p. 242).

Glaser (1978, p. 144) recognizes two types of theories resulting from grounded theory approach: *substantive* and *formal*. While substantive theory is developed for a substantive or empirical area of inquiry, formal theory is developed for a higher conceptual level. The analyst should focus clearly on one level or the other, or on a specific combination, because the strategies vary from arriving at each one (Glaser, B. G. 1978, p. 144).

With the focus on a substantive area, the generation of theory can be achieved by doing a comparative analysis between or among groups within the same substantive area (Glaser, B. G. 1978, p. 144). This is what I have done by exploring and comparing organizations offering a software product. However, if the focus of the level of generality is on generating a formal theory, the comparative analysis is carried out among different substantive cases and their theories, which fall within the formal area

without relating the resulting theory back to any one particular substantive area (Glaser, B. G. 1978, p. 145). Although I believe several organizations' challenges in different substantive areas may be explained with the misfit between the nature of the problem and the chosen problem-solving approach, I make no further effort towards formal theory in this thesis.

11.1.4 Control

The substantive theory must enable the person who uses it to have enough control in everyday situations to make its application worth trying (Glaser, B. & Strauss 1967, p. 245). The person who applies the theory must be enabled to understand and analyze ongoing situational realities, to produce and predict change in them, and to predict and control consequences both for the object of change and for other parts of the total situation that will be affected. As changes occur, the theory must allow the person to be flexible in revising his or her tactics of application in revisiting the theory itself if necessary (Glaser, B. & Strauss 1967, p. 245).

The purpose of the proposed theory is to guide practitioners to analyze the nature of the design problem. The controllable variable in the proposed theory is the *problem-solving approach*. The proposed theory is only the beginning in the process of increasing the success of transitioning the results to practice (Davis, A. M. & Hickey 2004) and gaining higher levels of evidence (Gause 2004). Further experiments intended to develop and test potentially more effective problem-solving approaches are beyond the scope of this thesis.

11.2 Evaluating trustworthiness

Different research styles have their own standards of evaluating the trustworthiness of the research results. The purpose of this section is to provide criteria that are appropriate for evaluating the trustworthiness of this research effort. Furthermore, this section reports measures that have been taken to ensure the trustworthiness of the results.

The basic issue in relation to trustworthiness is simple: How can an inquirer persuade his or her audience (including oneself) that the findings of an inquiry are worth paying attention to, worth taking into account? What arguments can be made, what criteria invoked, what questions asked, that would be persuasive of this issue (Lincoln & Guba 1985, p. 290)?

Conventionally, inquirers have found it useful to pose four questions to themselves (Lincoln & Guba 1985, p. 290):

1. *“Truth value”*: How can one establish confidence in the “truth” of the findings of a particular inquiry for the subjects (respondents) with which and the context in which the inquiry was carried out?
2. *Applicability*: How can one determine the extent to which the findings of a particular inquiry have applicability in other contexts or with other subjects (respondents)?
3. *Consistency*: How can one determine whether the findings of an inquiry could be repeated if the inquiry were replicated with the same (or similar) subjects (respondents) in the same (or similar) context?
4. *Neutrality*: How can one establish the degree to which the findings of an inquiry are determined by the subjects (respondents) and conditions for the inquiry and not by the biases, motivations, interests, or perspectives of the inquirer?

Within the conventional paradigm, the criteria that have evolved in response to these questions are termed “internal validity”, “external validity”, “reliability”, and “objectivity” (Lincoln & Guba 1985, p. 290). Although criteria from the positivist approach are widely accepted for the evaluation of quantitative empirical research, they do not fit qualitative research that is based on interpretive studies (Klein & Myers 1999; Wagner, Lukassen & Mahlendorf 2010). Lincoln and Guba (1985, p. 294-301) suggest replacing the traditional notion of internal validity with *credibility*, external validity with *transferability*, reliability with *dependability*, and objectivity with *confirmability* as follows (Wagner, Lukassen & Mahlendorf 2010):

1. *Credibility* is achieved if the results are believable from the perspective of the subjects under investigation.
2. *Transferability* deals with the question of whether findings from a research sample can be transferred to a broader population or to a more general theoretical proposition (Lincoln & Guba 1985, p. 290). Lee and Baskerville (2003) have presented a framework for clarifying the concept of generalizability, helping to avoid the improper assessment of generalizability on the basis of statistical sampling-based criteria.
3. *Dependability* refers to the repeatability of a study with respect to two aspects: whether it is possible to replicate the study, and whether this will lead to the same results (Wagner, Lukassen & Mahlendorf 2010).
4. *Confirmability* is the naturalist substitute for objectivity. Based on the assumption that all research is influenced by the researcher’s personal perspective, confirmability is the degree to which the interpretations and

findings of a study can be confirmed by others. Confirmability can be increased by rigorous craftsmanship during the research process.

Wagner et al. (2010) add a fifth criterion of *applicability* that refers to the context in which a method should be used. Thereby, the researcher's goal and the character of the research question to be examined determine the appropriate research method.

These general criteria have been reported to be appropriate for evaluating the results of an interpretive study. However, more specific criteria have been developed for evaluating a grounded theory. Strauss and Corbin (1990, p. 252-253) have provided detailed criteria for evaluating the research process and grounding on the data:

1. How was the original sample selected? On what grounds?
2. What major categories emerged?
3. What were some of the events, incidents, actions, and so on (as indicators) that pointed to some of these major categories?
4. On the basis of what categories did theoretical sampling proceed? That is, how did theoretical formulations guide some of the data collection? After the theoretical sampling was completed, how representative did these categories prove to be?
5. What were some of the hypotheses pertaining to conceptual relations (that is, among categories), and on what grounds were they formulated and tested?
6. Were there instances when hypotheses did not hold up against what was actually seen? How were these discrepancies accounted for? How did they affect the hypotheses?
7. How and why was the core category selected? Was this collection sudden or gradual, difficult or easy? On what grounds were the final analytic decisions made?

Strauss and Corbin (1990, p. 254-257) have also provided criteria for the empirical grounding of the study:

1. Are concepts generated?
2. Are the concepts systematically related?
3. Are there many conceptual linkages and are the categories well developed? Do they have conceptual density?

4. Is much variation built into the theory?
5. Are the broader conditions that affect the phenomenon under study built into this explanation?
6. Has the process been taken into account?
7. Do the theoretical findings seem significant and to what extent?

Glaser (1992, p. 118-119) argues that such criteria are of the adequacy of the researcher, not of the theory or method by which it was arrived. According to Glaser (1978, p. 134), the credibility of the theory should be won by its integration, relevance and workability, not by illustration used as if it were proof. The assumption of the reader, he should be advised, is that all concepts are grounded and that this massive grounding effort could not be shown in writing. Also that as grounded they are not proven, they are only suggested.

In addition to the evaluation criteria, the existing literature also proposes techniques for increasing the trustworthiness of a study. Lincoln and Guba (1985, p. 301) propose five major techniques for such a purpose:

1. Activities that make it more likely that credible findings and interpretations will be produced (prolonged engagement, persistent observation, and triangulation);
2. An activity that provides an external check for the inquiry process (peer debriefing);
3. An activity aimed at refining working hypotheses as more and more information becomes available (negative case analysis);
4. An activity that makes it possible to check preliminary findings and interpretations against archived "raw data" (referential adequacy);
5. An activity providing for the direct test of findings and interpretations with the human sources from which they have come – the constructors of the multiple realities being studied (member checking).

These techniques are important, because it is difficult to avoid the influence of my beliefs (section 2.2) and past experiences (section 1.1) when analyzing gathered data. The influence of one's beliefs cannot be avoided when interpreting data. Beliefs do limit what we see. We can, however, try to increase the chances that the interpretations are grounded to gathered data in a believable way. To this end, following techniques have been followed in this study:

- *Prolonged engagement*: The research has lasted for five years and consisted of several phases and data collection rounds. The primary researcher has good relationships with the key persons in the companies and can speak openly with them.
- *Triangulation*: Several researchers have participated in the data collection (observer triangulation). In some interviews, the other researchers have gathered data together with me, and in other cases they have conducted the interviews independent of me. The primary instrument for data collection has been interviews, but also written documents have been used and observations made in meetings and workshops (data triangulation).
- *Peer debriefing*: The research has consisted of regular meetings with research participants where the preliminary results have been presented and openly discussed.
- *Referential adequacy*: All interviews have been recorded and transcribed. The notes and memos of the study have been preserved and the data coding and analysis results are available through the analysis tool used, ATLAS.ti.
- *Member checking*: The interpretation of the data has been confirmed by presenting the results to the company participants. There have been numerous meetings and presentations in the organization where the results have been discussed. The feedback has been positive without exception.

11.3 Assessing relevance

Relevance for the grounded theorist means bringing tangible benefits to experts (Fernández, Lehman & Underwood 2002). With substantive theory, a person in the know can start transcending his or her finite grasp of things. His or her knowledge which was just known but not organized is now ideationally organized. This allows perceptible breakthroughs such as (Fernández, Lehman & Underwood 2002; Glaser, B. G. 1978, p. 13):

- 1) The ability to anticipate additional kinds of consequences, conditions and strategies of an act beside what is empirically known to him or her.
- 2) The ability to expand the description and meaning of incidents by placing them in a greater scope transcending his or her experience.

- 3) Concepts are easier to remember than incidents. Hence, replacing incidents with concepts that are integrated into a theory increases the expert's capacity to know.
- 4) The new theoretical knowledge allows the expert to expand his or her capacity to deal with new, more complex situations. This is done by the progressive transference of conceptual knowledge to new situations, broadening the expert power by allowing faster organization of the unknown by using the ideational tools provided by the substantive theory.
- 5) The theory can emancipate experts from the restriction of their specific expertise, freeing them from the status quo. Theory allows experts to become more open to change as they begin to see the change process and how their ideas can be modified to handle new knowledge and new situations.
- 6) Seeing the empirical knowledge in a theoretical light allows experts to capitalize on the theory. The theory becomes part of the experts' common sense, sharpening their judgment by making visible the many variations in strategies, conditions and consequences.

These six perceptible breakthroughs (Fernández, Lehman & Underwood 2002; Glaser, B. G. 1978, p. 13) can be used in articulating the potential benefits of the theory proposal (section 8.3) that has resulted from this study. To be more specific, the articulated characteristics of a *tame* problem (Rittel & Weber 1973) and *wicked* problem (McCaskey 1982; Rittel & Weber 1973) (Table 5) may help people in the know to see their experiences in a new light. This improves their understanding of the true nature of their design problem and may help them to consider whether the current beliefs and problem-solving approaches are still appropriate for the design problem at hand. The challenges they see in solving the design problem may be due to the misfit between the nature of the problem and the chosen problem-solving approach. Being able to see this at a conceptual level helps them to overcome the *paradigm paralysis*. Sometimes the more appropriate approach to solve the design problem is fundamentally different. Experts may not even think of such an approach unless they see and understand what is really taking place. A key to improving the ability to identify opportunities and to solve problems is to recognize our blocks so we can begin to demolish them (Couger 1996, p. 55)

In case one identifies a misfit between the nature of a design problem and the problem-solving approach, one way to alleviate the challenges is to put a greater emphasis on supporting organizational sensemaking, as suggested in section 10.5.

12 Research contribution and implications

“We should start doing research: investigate problems in the requirements process, investigate solution properties, and investigate implementations of these solutions. This will yield us theories about problems in requirements practice, about techniques that could solve those problems, and about implementations of those techniques in requirements practice that will be useful to practitioners.” (Wieringa 2005)

The traditional RE research paradigm, along with most engineering research and practice, is commonly seen to belong to the philosophical tradition of positivism, which construes knowledge as accruing through the systematic observation of stable and knowable phenomena (Potts & Newstetter 1997). Consequently, traditional requirements engineering methods tend to ignore social issues (Goguen 1993). Yet, the research challenges faced by the requirements-engineering community are distinct from those faced by the general software-engineering community. This is due to the fact that requirements reside primarily in the problem space, whereas other software artifacts reside primarily in the solution space (Cheng & Atlee 2007). That is, requirements engineering deals with defining precisely the problem that the software is to solve (i.e. defining what the software is to do), whereas other software engineering activities deal with defining and refining a proposed software solution (Cheng & Atlee 2007).

During recent years, criticism against the dominant position of the positivist perspective in RE has increased. As an example, Hinds (2008) argues that the “positivist perspective is at best detrimental, and at worst antithetical to the activity of engineering requirements”. There is notable and growing awareness of the need to take into account social and contextual factors in RE (Potts & Newstetter 1997).

In order to address social and contextual factors in RE, we first need to understand current practices and their challenges. According to Davis and Hickey (2002), this is a task that many requirements engineering researchers fail to accomplish. As a result, the researchers risk creating new knowledge that has no practical value (Davis, A. & Hickey 2002). Gause (2004) has argued that, due to the dominant role of the human being in RE, we must rely heavily on research methods of the social sciences, arts, and humanities for our findings. We must be tolerant and even encouraging of all forms of discovery within RE and embrace any form of research that offers even hints of promise (Gause 2004).

I see the contribution of this thesis as twofold. Firstly, the thesis provides empirical findings, developed for a theory proposal, illustrating the growing inadequacy of current problem-solving approaches for the challenge of release planning and initiating the search for more effective approaches. We have, in total, conducted 71 interviews in 12 different organizations. Out of the 71, 37 transcribed interviews from 7 organizations were then selected to be analyzed line by line. The analysis of the selected interviews has been conducted in four iterations, where each iteration constantly deepened the understanding beyond the previous iteration, proceeding finally towards proposing a theory. Qualitative studies within the discipline of RE with such an amount of gathered data are still sparse. Studies pursuing a theory proposal are even rarer.

Secondly, the thesis responds to the call for relying on a research methodology from social sciences and demonstrates the use of grounded theory research approach within the context of RE. Due to the deliberate avoidance of the early literature review and a priori theorizing, grounded theory approach may have been particularly effective in avoiding the paradigm paralysis and looking at the problem situation in a new way.

This study resulted in a theory proposal intended to:

1. Describe the essential characteristics of organizations' product management challenges;
2. Explain the origins of the perceived challenges;
3. Suggest strategies to alleviate the perceived challenges.

The theory that emerged achieved its intentions by:

1. Conceptualizing the nature of the product management challenge in terms of the characteristics of *tame* (Rittel & Weber 1973) and *wicked problems* (McCaskey 1982; Rittel & Weber 1973) (Table 5);

2. Explaining that the perceived challenges in managing a software product may originate from the growing inadequacy of current release planning approaches to deal with wicked problems;
3. Suggesting the need for adopting a new paradigm for planning product releases.

This thesis has discovered that when the wickedness of the problem increases, processes tuned for decision-making begin to degrade (section 10.3). Even though the nature of the problem has changed in the context of release planning, organizations have held on to the linear and authoritative problem-solving approaches that once were successful. This thesis argues that the challenges of following existing release planning approaches continue to increase until the beliefs and assumptions of the expert paradigm are questioned and a new paradigm is adopted. For dealing with the wickedness of the problems, we need approaches that support the product's stakeholders' negotiation of their beliefs so that they collectively understand their environment and collectively know how they should react to the interpreted situation.

According to the proposed theory, the primary reason for the growing inadequacy of current release planning approaches is that organizations are suffering from *paradigm paralysis*. People appear to have a tendency to resist change. Hence, the first step in coping with a wicked problem is to recognize its nature (Conklin 2005). There is a psychological dimension here – a shift from denial to acceptance. This is where the proposed theory may help. Although I cannot make claims beyond my data, I believe that the proposed theory could also be applicable in raising awareness of organizations' other problematic situations that go beyond the scope of this thesis. Wicked problems have already been found in many organizational functions and the inadequacy of the current ways of solving wicked problems has been commonly reported. Failing to recognize the “wicked dynamics” in the challenge of release planning, we persist in applying inappropriate methods and tools to them (Conklin 2005).

When finally integrating the theory with existing literature, this thesis identified the process of *sensemaking* to be essential for organization in building a *shared understanding* of complex and ambiguous market needs and for building *shared objectives* for a turbulent market environment. The following sections discuss the implications of integrating sensemaking and decision making in terms of further research (section 12.1) and practice (section 12.2). Hence, these sections seek an answer to the research question 2: *How can the organizations' attempt to position their software product in the marketplace be supported?*

12.1 Implications for further research

Researchers have proposed numerous requirements development techniques, but less attention has been paid to managing teams of requirements analysts (Crowston & Kammerer 1998). A major challenge for RE research is thus to understand this group process and, based on this understanding, find efficient ways of supporting groups of stakeholders in solving the problem of deciding what to build (Regnell, Paech et al. 2001).

The theory developed in this study suggests that the design problem for many software product companies has turned out to be more often one of multiple meanings. Coping with multiple meanings and fostering knowledge creation calls for approaches that go beyond decision making (Weick 2001). A more holistic MDRE approach is thus required. The proposed theory poses several implications for MDRE research:

First, the proposed theory suggests that there are an increasingly inadequate fit between product management problems and their corresponding problem solving approaches. Hence, further work is necessary in order to understand better how the context of product management problem affects the selection of MDRE techniques. The development of a Contingency Model for Requirements Development (Mathiassen et al. 2007) is a valuable contribution in such a line of RE research. In order to understand better the firms' product management contexts, we need to understand:

- What categories of problem types exist in the context of product management?
- What are the essential characteristics of each of the identified problem types?
- What factors in the firm's operative environment causes particular problem types to occur?
- Which of MDRE approaches are effective for a particular problem type? Why?

Second, existing MDRE approaches need to be expanded with new approaches that are designed to deal with wicked problems. This thought is not entirely unknown in existing MDRE literature. As an example, Ruhe and Saliu (2005) distinguish between the *art of release planning* addressing the need for human intuition, communication, and capabilities to negotiate between conflicting objectives and constraints and the *science of release planning* formalizing the problem and applying computational algorithms to generate the best solutions. However, methods for supporting the *art of release planning* are still largely missing. This thesis particularly discovered a need for sensemaking approaches that help people to cope with multiple meanings, are more social by nature and are more tolerant of improvisation than the traditional designs

grounded in decision making. However, the decision making and sensemaking approaches need to be integrated so that the vague ideas that are presented informally and often inconsistently eventually lead toward a desired end state where there is a common agreement of a set of relatively formalized requirements that can serve as a blueprint for software design and implementation (Jarke & Pohl 1994; Mathiassen et al. 2007). One possible way would be to fit the soft methods such as sensemaking as a 'front end' before proceeding to the 'hard' aspects of systems development (Avison, D. & Fitzgerald 2003). Another possibility could be to have these two kinds of thinking as concurrent processes with short intermittent periods of communication. In this kind of approach, there is no distinct phase of data analysis but rather different kinds of conversations between problem understanding and solution formulation that must be woven together from beginning to end (Christensen 2009). Hence, we need to understand better:

- How wicked problems can be resolved in practice?
- How organizational sensemaking can be supported in the context of product management?
- How sensemaking practices can be effectively integrated with existing MDRE practices?

Third, the results of this thesis support Greiner's (1972) argument that organizational thinking and its corresponding management style correlate with the firm's context. Existing MDRE research has largely developed solutions to organize software product management by proposing processes, techniques and algorithms (section 10.1). Organizational studies have, however, found processes to be the primary coordination mechanism for a particular type of organization - mechanical organizations that seek efficiency when dealing with stable problems (Morgan 1996, p. 46; Stähle & Grönroos 2000, p. 127). Hence, we need to learn from organizational studies in order to understand better:

- What types of organizational forms exist?
- In what kind of context a particular type of organization is effective?
- What are the key mechanisms needed to manage and coordinate a particular type of organization?
- How the choice of organizational form affects the way products are managed?

Fourth, this thesis discovered that firms often seem to suffer from paradigm paralysis (section 8.3). The product management problems are often socially more complex than our dominant problem solving approaches assume (section 10.3). Hence, we need to pay more attention to studies within psychology and social sciences in order to understand better:

- How psychological phenomena such as cognition, emotions, identity, and resistance to change may be conceptually described? How they affect product related decision making?

Fifth, the findings of the thesis indicate that decisions are often based on tacit knowledge. The thesis further discovered that small organizations appear to have a natural tendency to create and utilize knowledge (section 6.4). Studying how small organizations manage their requirements would therefore be a valuable source of information in expanding the RE approaches towards knowledge creation and sensemaking. Furthermore, we need learn from knowledge management studies in order to understand better:

- How knowledge is created and utilized in organizations?
- How knowledge creation can be supported in the context of product management?

12.2 Implications for practice

Traditional problem-solving approaches are already heavily tuned for decision making. Coughlan and Macredie (2002) claim that “traditional methodologies if rigidly applied all but eliminate the ‘user’ from design, dealing with user communications from a problem-solving perspective. Such a restrictive viewpoint affects requirements capture by placing a stranglehold on communication, which is left totally unsupported in the traditional development process”. This thesis has come to the conclusion that organizations that operate in a turbulent and complex business environment need to emphasize the support of sensemaking activities more.

According to Weick (1995b), sensemaking is a process that is:

1. *Grounded in identity construction* because what a product’s stakeholders believe to represent or affect the way they interpret events;
2. *Retrospective*, helping the group to interpret what has occurred (Nemiro et al. 2008);
3. *Enacted of sensible environments*. As people speak and build stories about their environment, it helps them to understand what they think and what actions need to be taken;
4. *Social*, because meanings are created from conversations and relationships (Nemiro et al. 2008);

5. *Ongoing*, dealing with the reality that members must act and respond as things continue to change (Nemiro et al. 2008);
6. *Focused on and by extracted cues* in order to help people to decide what information is relevant and expand it into acceptable explanations;
7. *Driven by plausibility rather than accuracy*.

These seven properties of sensemaking (Weick 1995b) suggest that shared meanings and purpose is created collectively within the community of a product's stakeholders. When a larger group of stakeholders shape the requirements, the role of Requirements Engineers shift from the role of expert towards the role of facilitator.

Supporting these seven properties of sensemaking (1995b) may turn out to be difficult when the collective mind grows. Adding stakeholders to any problem solving effort increases 'transaction costs.' There are more meetings, more people with whom to communicate and find agreement – interactions that can take a great deal of effort (Roberts 2000). Recent technological advancements, however, have created new promising opportunities to support sensemaking particularly for larger organizations. The emergence of social media (Benkler 2006) has created high expectations regarding the alleviation of many problems related to social interactions over time and place. Some of the essential characteristics of social media include support for social interaction, content sharing, virtual identity and collaborative production (Lietsala & Sirkkunen 2008). Social media supports the Weick's properties of sensemaking (1995b) in many ways, providing value to RE activities (Table 6). This finding is particularly valuable for organizations scattered to many locations all over the world.

Table 6. Sensemaking, social media and RE.

Properties of sensemaking (Weick 1995b)	Social media application	Solution proposal
1. Grounded in identity construction Giving people a sense of who they are and what they represent.	User profiles, status messages, user status levels, user action histories, user linking between social applications.	Virtual identity, that is partly maintained by the user and partly updated automatically based on user's virtual activities. "Career path" for virtual identity to evolve based on user's actions.
	Understanding the motives and rationale of requirements originating from different stakeholders. Understanding the rationale of decisions.	
2. Retrospective Preserving elapsed data and legitimize its use.	Post and blog archives, tagging and categorizing, search facilities	Improved linking (automated whenever possible) between different data items. Introduction of diverse ways to trace and search historical data (e.g tag clouds, history of users' activities, related discussions, ...).
	Possibility to find related discussions for decisions and requirements. Accessing related information that would otherwise be forgotten. Documenting the original purposes behind critical requirements and design changes.	
3. Enacted of sensible environments Encouraging actions or hesitation.	Blogs, commenting, status fields, discussion forums, voting.	Organization of virtual events, each designed for particular problem solving objective. Blogs and commenting describing real world situations.
	Providing possibilities for time-space independent interactive reasoning. Disseminating information about difficulties. Understanding difficulties and rationales of decisions.	
4. Social Encouraging conversation.	Blogs, forums, post commenting, status messages	Invest time and resources to nurture activity within product-related community. Meet and greet people. Pay attention and respond to their contributions. Recruit new contributors. Activate members.
	Understanding users, partners and co-workers, transferring requirements knowledge over time and space, making requirements and designs available in real-time.	
5. Ongoing Enabling people to be resilient in the face of interruptions.	RSS, bookmarking, tagging, customizable user profiles, recent activity lists.	Design collaboration so that it creates, and continuously updates, a shared understanding and common goals. Clear goals will guide people when unexpected events occur.
	Getting a picture of the current situation in the project. Providing immediate clues for continuing and focusing the work. Continuous checking for compatibility and required requirements changes whenever design changes are implemented.	
6. Focused on and by extracted cues Enhancing the visibility of cues.	RSS, tag clouds, providing more visibility to the most popular content, related posts, post linking, post versioning.	Promotion of <i>recently added</i> and/or <i>most discussed</i> items to the front page. Use of tag clouds to show most important items (out of many).
	Understanding the context of requirements. Understanding motives and rationales.	
7. Driven by plausibility Encouraging people to accumulate and exchange plausible accounts with an attempt to find satisfactory solutions rather than optimal ones.	Sharing bookmarks, commenting, collaborative writing, voting, post versioning and post histories, search facilities.	Brainstorming (divergent thinking) and voting (convergent thinking) that determine <i>the criteria for product's fitness to the marketplace</i> . Empowering people to make more decisions on their own, as long as agreed criteria will be fulfilled.
	Providing help in reasoning for decision-making. Enabling wider acceptance of intuitive approaches. Reducing the need to make simplifying assumptions (deliberate, conscious, subliminal and unconscious), thus opening up the solution to more possibilities as well as reducing the risk of implicit false assumptions driving the design process.	

The question still remains: What concrete actions should organizations take to release these new potentials in RE? The challenge for product organizations is how to utilize the wisdom of its organization in order to make sense of the complex problem while producing simple enough understanding for the ones needing to act on it. Even though social media is believed to be an important component in supporting sensemaking, the problem is far from being solved. The real challenge is social and political by nature rather than technical.

In proceeding towards more practical levels, we need to find ways of collaboration that implement the seven properties of sensemaking while guiding the community collectively to explore and determine the product's requirements. Potential solutions would need a process which enhances stakeholders' cognitive and information processing capabilities. It could have similarities with the EasyWinWin approach (Grünbacher, Köszegi & Biffl 2006), a groupware-supported negotiation method for reconciling stakeholder value propositions, but it would rather seek to help product managers to understand the big picture than attempt to support the negotiation of a solution that satisfies everyone. It could adopt ideas from collaborative engineering (De Vreede & Briggs 2005; Nunamaker, Reinig & Briggs 2009), utilizing a series of collaborative sessions, each designed for a particular purpose, and tying these sessions together within the product's online community. If stakeholders' virtual participation is guided and recorded wisely, it can result in a historical trace helping others to understand the rationale behind each requirement. Possible solution could also include adopting ideas from the Creative Problem Solving Process (CPS) that contains a series of design steps, each beginning with divergent thinking (a broad search for many alternatives), followed by convergent thinking (the process of evaluating and selecting) (Couger 1996). As an example, stakeholders could, firstly, begin by exploring the possible types of a product's users and the preferred quality attributes (divergent thinking). This could be followed by discussing and determining the importance of each identified possibility (convergent thinking) resulting in a shared understanding of which users are to be favored and according to which attributes design decisions are to be optimized in the next product release. Secondly, the shared understanding of a product release's goals could be utilized by first inventing features that support the targeted users and quality attributes (divergent thinking). Then, the importance of the suggested features could be discussed and determined (convergent thinking). It is important to notice that traditional release planning approaches and sensemaking approaches are likely to be woven together. The shared goals created in the first step could also help to identify the existing requirements that are important in achieving the objectives of a product's next release.

As one practical and comprehensive example, Gause (2008) suggests a design process which supports sensemaking and requirements management during the full life cycle of a product development project. The process starts from product initialization in marketing and proceeds eventually to a product release through product planning, requirements elicitation and development, product development and testing. This process includes carefully managed stakeholder expectations, well-structured post release reviews and periodically scheduled pre and post-release user satisfaction surveys. The proposed process provides better visibility to product needs and preferences as well as improved context information from the field concerning the nature of problems to be solved instead of the more superficial statement of solutions in the absence of statements providing the underlying reasons.

The implications of the proposed theory are numerous for both research and practice. The possibilities of bringing sensemaking and decision making together, not as an integration or a synthesis, but in a combination of interplay, is an exciting new horizon for organizational research (Boland 2008) and also for RE research and practice.

EPILOGUE

Writing this thesis has not been easy. Choosing grounded theory as a research approach is full of risks. As my final contribution of this thesis, I wish to share some of my experiences of following grounded theory approach so that a researcher considering a similar research path compared to mine has a better opportunity to understand where he or she may be heading to and what kind of risks are to be anticipated.

First of all, upon considering conducting a grounded theory research, one needs to be confident in one's own abilities to conceptualize data. Furthermore, it is important that the research area is one that has room for new insights. Otherwise the researcher is taking the greatest risk of all – the risk *not* resulting with a theory that is novel, conceptually dense, general, controllable and understandable.

Following grounded theory research approach is all about the 'discovery' through direct contact with the social world studied coupled with a rejection of *a priori* theorizing. The natural course of discovery has caused challenges of documenting the study. It has proved to be difficult simultaneously to 1) meet the expectations of a reader who is used to the conventional structure that has long been familiar to quantitative researchers, and 2) document a grounded theory study as it proceeded in reality. I have chosen to write the thesis with an organization that follows the course of a grounded theory study. It follows from this decision that I have needed to pay particular attention to addressing the reader's expectations. In practice, I have needed to show that the deviations from the expected style of reporting are not mere accidents, but deliberate choices. In doing so, I have tried to be careful in comparing my choices with the literature on grounded theory research approach. It has been

important to me to demonstrate how my thinking has evolved from the beginning towards the proposal of a theory and its integration with existing literature. The organization I have chosen for my thesis have served my purposes well.

Generating grounded theory *takes time*. It is above all a *delayed action* phenomenon (Glaser, B. G. 1978, p. 18). Significant theoretical realizations come with growth and maturity in the data, and much of this is outside the analyst's awareness until it happens (Glaser, B. G. 1978, p. 18). It is therefore vital that that the analyst learn to take the quality and time it takes to complete the discovery process, and that he learn to take this time in a manner consistent with his own temporal nature as an analyst (Glaser, B. G. 1978, p. 18).

Another temporal property is that theoretical pacing does not take *all* of the time of the analyst. On the contrary, the analyst cannot work continuously on research; that could stultify his or her creativity. Crash programs or unreasonable deadlines do not work. In taking the time it takes, to grow with the data and its analysis, to increase theoretical sensitivity, to allow the out-of-awareness processing to go untrampled, the analyst must focus on other matters; other work and solid recreation (Glaser, B. G. 1978, p. 18).

As the analyst watches his or her own temporal pacing emerge during a research project, the analyst begins to develop a personal recipe for pacing the research so as to be consistent with his or her temperament and energizing of the project. This recipe is crucial for many reasons. It helps to establish realistic deadlines and to avoid imposed, paralyzing ones. It insures to a great degree that the analyst will finish the theory before he or she becomes fatigued, disaffected or grabbed and derailed by another "more" interesting project. It becomes a self-pacing mechanism that prevents (or reduces) susceptibility to being paced by others, especially superiors and supervisors, who can easily be inimical to generating (Glaser, B. G. 1978, p. 19). We will always be paced by others unless we know our own pacing. Therefore, with a recipe we can *tell* others (when necessary) where we are at, where we are going and where we will probably arrive. The personal recipe is a claim to professional autonomy which other colleagues should generally respect, and most do. Without this claim, the analyst is himself claimed by others, usually then aborting part of the discovery process for reasons extraneous to research (Glaser, B. G. 1978, p. 19). When the discovery method is paced well, it works with life, not against it. This is of course vital to keeping the research energized to its conclusion in a writing (Glaser, B. G. 1978, p. 19).

If time is an issue, the only way to speed up the research is collaboration. A working culture filled with curiosity and patience for the theory to emerge will help significantly. With a collaborator, an analyst can move considerably faster (Glaser, B. G. 1978, p. 59). Collaboration is, of course, a dangerous game. Incompatibility is typical and its brutality is often discovered too late to revise the project and its

fundings. In contrast, when it works, its energizing potential is fantastic (Glaser, B. G. 1978, p. 29). Each usually stimulates the others' thinking faster, keeps the others on their toes and can encourage them during periods of depression, decompression and stagnation. A project can be completed better, faster and more easily, since good collaborators contribute to the solution of each others' problems during research, such as writer's block, the inability to finish the work or conduct interviews with certain people, difficulties in facing certain aspects of the research, and so forth. One can conceptualize while the other talks about data, thus working at two levels simultaneously with maximum energy. The researchers can continually sensitize each other to the theory in the data. They can keep each other moving through the self-pacing stages, as they develop their mutually integrated recipes for the research (Glaser, B. G. 1978, p. 29).

Grounded theory method has always been open for others to take it into new directions (Glaser, B. G. 1978, p. 158). Already in the first published book on grounded theory, Glaser and Strauss stated their principal aim as to "stimulate other theorists to codify and publish their *own* methods for generating theory" (Glaser, B. & Strauss 1967, p. 5). Over the years, the founders of grounded theory have evolved the method along separate paths. Studying the differences between these two approaches is important in order to make well-founded decisions on one's own research. In this thesis, I have made an effort to examine such differences and document my decisions on the path I have taken. Generally speaking, my approach of following grounded theory method has been closer to Glaser's approach with a tendency towards more openness and flexibility. I have not taken the advice of Strauss and Corbin (1990, p. 99) and scrutinized the data in terms existing coding paradigms. Rather, I have conceptualized the data only to the point I have felt relevant for the theory development. This decision has worked for me.

In following Glaser's grounded theory approach, I have resulted in a theory proposal that helps organizations to understand the origins of their current challenges in determining requirements to be implemented for their forthcoming product releases. These origins of perceived challenges are sometimes difficult for the organizations themselves to see because the focus of their thinking tends to be on the pragmatic level, solving product-related problems on a daily basis.

I have made an effort to derive conclusions from the data we have gathered. However, at the end of the research when I have integrated the results with existing literature, I have identified similar thinking from other studies. These sources have largely been new to the discipline of this thesis (requirements engineering). Nevertheless, parts of my conclusions are not new. They are, to a certain extent, introduced to a new context and assembled in a new way. My attitude towards this finding is similar to what Glaser has advised:

"The proper attitude is simply to accept having discovered ideas. And if the analyst discovers that one of his many ideas has already been used elsewhere, the proper attitude is "he (the other author) discovered it too". The essential point to remember is that the discovered idea is relevant because of its connections to other variables which make up a theory which accounts for variation in a pattern of behaviour" (Glaser, B. G. 1978, p. 137).

Although full of risks, grounded theory approach also holds a promise for high rewards. For me, it has offered an opportunity to systematically know more about the challenges I have experienced while I was working in industry. The theory that resulted from this study has helped me to understand my past experiences conceptually. I now know better what was happening and where to look for remedies.

REFERENCES

- Aalto, J-M & Jaaksi, A 1994, 'Object-Oriented Development of Interactive Systems with OMT++', in R Ege, M Singh & B Meyer (eds), *TOOLS 14, Technology of Object-Oriented Languages & Systems*, Prentice Hall 1994, pp. 205-218.
- Ackoff, R 1974, *Redesigning the Future: Sustems Approach to Societal Problems*, Wiley, New York/London.
- Anderson, E & Gatignon, H 1986, 'Modes of foreign entry: A transaction cost analysis and propositions', *Journal of International Business Studies*, vol. 17, no. 3, pp. 1-26.
- Aranda, J, Easterbrook, S & Wilson, G 2007, 'Requirements in the wild: How small companies do it', paper presented to 15th IEEE International Requirements Engineering Conference, New Delhi, India, October 15-19, 2007.
- Arias, E, Eden, H, Fischer, G, Gorman, A & Eric, S 2000, 'Transcending the Individual Human Mind - Creating Shared Understanding through Collaborative Design', *ACM Transactions on Computer-Human Interaction*, vol. 7, no. 1, pp. 84-113.

- Aurum, A & Wohlin, C 2005, 'Requirements Engineering: Setting the Context', in A Aurum & C Wohlin (eds), *Engineering and Managing Software Requirements*, Springer.
- Avison, D & Fitzgerald, G 2003, *Information Systems Development - methodologies, techniques and tools*, McGraw-Hill Publishing Company.
- Avison, DE & Guy, F 2003, 'Where Now for Development Methodologies?' *Communications of the ACM*, vol. 46, no. 1, pp. 79-82.
- Bacharach, SB 1989, 'Organizational Theories: Some Criteria for Evaluation', *Academy of Management Review*, vol. 14, no. 4, pp. 496-515.
- Bagnall, AJ, Rayward-Smith, VJ & Whittle, IM 2001, 'The next release problem', *Information and Software Technology*, vol. 43, pp. 883-890.
- Barker, JA 1992, *The Future Edge*, William Morrow and Co., New York.
- Bell, J 1995, 'The internationalization of small computer software firms: A further challenge to "stage" theories', *European Journal of Marketing*, vol. 29, no. 8, pp. 60-75.
- Benkler, Y 2006, *The wealth of networks: how social production transforms markets and freedom*, Yale University Press, New Haven.
- Berander, P & Andrews, A 2005, 'Requirements Prioritization', in A Aurum & C Wohlin (eds), *Engineering and Managing Software Requirements*, Springer, Berlin, pp. 69-94.
- Berander, P, Khan, KA & Lehtola, L 2006, 'Towards a Research Framework on Requirements Prioritization', paper presented to Sixth Conference on Software Engineering Research and Practice in Sweden (SERPS'06), Umeå, Sweden, October 2006.
- Berenbach, B 2006, 'Impact of Organizational Structure on Distributed Requirements Engineering Processes: Lessons Learned', paper presented to First International Workshop on Global Software Development for the Practitioner, Shanghai, China, 23.5.2006.
- Bergman, M, King, J & Lyytinen, K 2002, 'Large-Scale Requirements Analysis Revisited: The Need for Understanding the Political Ecology of Requirements Engineering', *Requirements Engineering*, vol. 7, no. 3, pp. 152-171.

- Bierly, PEI, Kessler, EH & Christensen, EW 2000, 'Organizational learning, knowledge and wisdom', *Journal of Organizational Change*, vol. 13, no. 6, pp. 595-618.
- Bogner, WC & Barr, PS 2000, 'Making Sense in Hypercompetitive Environments: A Cognitive Explanation for the Persistence of High Velocity Competition', *Organization Science*, vol. 11, no. 2, pp. 212-226.
- Boland, RJ 2008, 'Decision Making and Sensemaking', in F Burstein & CW HGolsapple (eds), *Handbook on Decision Support Systems 1*, Springer, Berlin Heidelberg, pp. 55-63.
- Burrell, G & Morgan, G 1979, *Sociological Paradigms and Organizational Analysis*, Heinemann, London.
- Carlshamre, P 2001, 'A Usability Perspective on Requirements Engineering: From Methodology to Product Development', Doctoral thesis, Linköping University.
- 2002, 'Release Planning in Market-Driven Software Product Development: Provoking an Understanding', *Requirements Engineering*, vol. 7, pp. 139-151.
- Carlshamre, P, Sandahl, K, Lindvall, M, Regnell, B & Natt och Dag, J 2001, 'An Industrial Survey of Requirements Interdependencies in Software Product Release Planning', paper presented to Fifth IEEE International Symposium on Requirements Engineering (RE'01), Toronto, Canada.
- Carmel, E & Sawyer, S 1998, 'Packaged software development teams: what makes them different?' *Information Technology & People*, vol. 11, no. 1, pp. 7-19.
- Checkland, P 2000, 'Soft Systems Methodology: A Thirty Year Retrospective', *Systems Research and Behavioral Science*, vol. 15, pp. 11-58.
- Checkland, PB 1981, *Systems Thinking. Systems Practice*, Jowh Wiley & Sons, Chichester, England.
- Cheng, BHC & Atlee, JM 2007, 'Research Directions in Requirements Engineering', paper presented to Future of Software Engineering (FOSE'07), Minneapolis, Minnesota, May 23-May 25.
- Choo, CW 2002, 'Sensemaking, Knowledge Creation, and Decision Making', in CW Choo & N Bontis (eds), *The Strategic Management of Intellectual Capital and Organizational Knowledge*, Oxford University Press, Oxford, pp. 79-88.

- Christensen, K 2009, 'Building Shared Understanding of Wicked Problems -Interview of Jeff Conklin', *Rotman Magazine*, vol. Winter 2009, pp. 16-20.
- Colquitt, JA & Zapata-Phelan, CP 2007, 'Trends in theory building and theory testing: A five-decade study of the Academy of Management Journal', *Academy of Management Journal*, vol. 50, no. 6, pp. 1281-1303.
- Conklin, J 2005, 'Chapter 1: Wicked Problems & Social Complexity', in *Dialogue Mapping: Building Shared Understanding of Wicked Problems*, Wiley.
- Cooper, RG 1990, 'Stage-Gate Systems: A New Tool for Managing New Products', *Business Horizons*, vol. May-June 1990.
- Cormen, TH, Leiserson, CE & Rivest, RL 2006, *Introduction to Algorithms*, McGraw Hill, New York.
- Coronado, J & Livermore, C 2001, 'Going Global with the Product Design Process: Does It Make Business Sense?' *Interactions*, vol. 8, no. 6, pp. 21-26.
- Couger, JD 1996, *Creativity & Innovation*, Contemporary Issues in Information Systems, boyd&fraser publishing company, Danvers, Massachusetts.
- Coughlan, J & Macredie, RD 2002, 'Effective Communication in Requirements Elicitation: A Comparison of Methodologies', *Requirements Engineering*, vol. 7, no. 2, pp. 47-60.
- Creswell, JW 1998, *Qualitative Inquirey and Research Design - Choosing Among Five Traditions*, SAGE Publications.
- Crowston, K & Kammerer, EE 1998, 'Coordination and collective mind in software requirements development', *IBM Systems Journal*, vol. 37, no. 2.
- Dahlstedt, ÅG & Persson, A 2005, 'Requirements Interdependencies: State of the Art and Future Challenges', in A Aurum & C Wohlin (eds), *Engineering and Managing Software Requirements*, Springer-Verlag, Berlin, pp. 95-116.
- Damian, D 2007, 'Stakeholders in Global Requirements Engineering: Lessons Learned from Practice', *IEEE Software*, vol. 24, no. 2, pp. 21-27.
- Damian, DE & Zowghi, D 2003, 'RE challenges in multi-site software development organisations', *Requirements Engineering*, vol. 8, pp. 149-160.

- Davis, A & Hickey, A 2002, 'Requirements Researchers: Do We Practice What We Preach?' *Requirements Engineering*, vol. 7, pp. 107-111.
- Davis, AM & Hickey, AM 2004, 'A New Paradigm for Planning and Evaluating Requirements Engineering Research', paper presented to The Second International Workshop on Comparative Evaluation in Requirements Engineering (CERE'04) In conjunction with the 12th IEEE International Conference on Requirements Engineering (RE'04). Kyoto, Japan.
- Day, GS 1999, *The Market Driven Organization-Understanding, Attracting, and Keeping Valuable Customers*, The Free Press, New York.
- De Vreede, G-J & Briggs, RO 2005, 'Collaboration Engineering: Designing Repeatable Processes for High-Value Collaborative Tasks', paper presented to 38th Hawaii International Conference on Systems Sciences.
- Deetz, S 1996, 'Describing Differences in Approaches to Organization Science: Rethinking Burrell and Morgan and Their Legacy', *Organization Science*, vol. 7, no. 2, pp. 191-207.
- Denne, M & Cleland-Huang, J 2004, 'The incremental funding method: Data-driven software development', *IEEE Software*, vol. 21, pp. 39-47.
- Denzin, NK & Lincoln, YS 2000, 'The Discipline and Practice of qualitative Research', in NK Denzin & YS Lincoln (eds), *Handbook of Qualitative Research*, Sage Publications, Thousand Oaks, pp. 1-28.
- Drummond, H 1998, 'Riding A Tiger: Some Lessons of Taurus', *Management Decision*, vol. 36, no. 3, pp. 141-146.
- Dumdum, UR 1993, 'An Approach to Problem Formulation in Ill-Structured Situations in Information Systems Development', State University of New York at Binghamton.
- Easterbrook, S, Singer, J, Storey, M-A & Damian, DE 2007, *Selecting Empirical Methods for Software Engineering Research*, Guide to Advanced Empirical Software Engineering, Springer.
- Ebert, C 2005, 'Requirements BEFORE the Requirements: Understanding the Upstream Impacts', paper presented to 13th IEEE International Conference on Requirements Engineering (RE'05), Paris, France, 29 Aug. -2 Sept. 2005.

- 2007, 'The impacts of software product management', *Journal of Systems and Software*, vol. 80, pp. 850-861.
- Ebert, C & De Neve, P 2001, 'Surviving Global Software Development', *IEEE Software*, vol. 18, no. 2, pp. 62-69.
- Edmondson, AC & McManus, SE 2007, 'Methodological Fit in Management Field Research', *Academy of Management Review*, vol. 32, no. 4, pp. 1155-1179.
- Egbu, C & Suresh, S 2008, 'Knowledge Mapping Techniques within The Construction Industry: An Exploratory Study', paper presented to CIB 2008 Performance and Knowledge Management, Helsinki, Finland.
- Eppler, MJ 2001, 'Making Knowledge Visible Through Intranet Knowledge Maps, Concepts, Elements, Cases', paper presented to 34th Hawaii International Conference on Systems Sciences, Hawaii, USA.
- Fernández, WD, Lehman, H & Underwood, A 2002, 'Rigorour and Relevance in Studies of IS innovation: A Grounded Theory Methodology Approach', paper presented to European Conference on Information Systems (ECIS), Gdansk, Poland.
- Gause, DC 2004, *Comparative Evaluation in Requirements Engineering: Is it Too Much Too Soon, Too Little Too Late, or Just the Right Amount at Just the Right Time?*, Comparative Evaluation in Requirements Engineering (CERE), IEEE Computer Society Press, Kyoto, Japan.
- 2005, *The more things change, the more things stay the same: A Look at the last 50 years of software engineering*, Keynote Address. TEKES Annual Software Engineering Conference. Tampere, Finland, May 24, 2005.
- 2008, *Requirements Management: A Full Life-Cycle Perspective for Global Markets*, Full-Day Invited Tutorial at 16th IEEE International Requirements Engineering Conference (slides available on request). Barcelona, Spain, September 9, 2008.
- Gebhardt, GF, Carpenter, GS & Sherry, JFJ 2006, 'Creating a Market Orientation: A Longitudinal, Multifirm, Grounded Analysis of Cultural Transformation', *Journal of Marketing*, vol. 70, no. October 2006, pp. 37-55.
- Glaser, B & Strauss, AL 1967, *The Discovery of Grounded Theory: Strategies for Qualitative Research*, Aldine, Chigago.
- Glaser, BG 1978, *Theoretical Sensitivity*, The Sociology Press, Mill Valley.

- 1992, *Basics of grounded theory analysis: emergence vs forcing*, Sociology Press, Mill Valley.
- GNM project 2006, *Global Network Management*, viewed 7.2.2006
<<http://www.tbrc.fi/gnm/>>.
- Goede, R & de Villiers, C 2003, 'The Applicability of Grounded Theory as Research Methodology in studies on the use of Methodologies in IS Practices', paper presented to SAICSIT.
- Goguen, JA 1993, 'Social issues in requirements engineering', paper presented to IEEE international symposium on requirements engineering.
- Goulding, C 2001, 'Grounded Theory: A Magical Formula or a Potential Nightmare', *The Marketing Review*, vol. 2, pp. 21-34.
- Granovetter, MS 1973, 'The Strength of Weak Ties', *American Journal of Sociology*, vol. 78, no. 6, pp. 1360-1380.
- Greer, D & Ruhe, G 2004, 'Software release planning: An evolutionary and iterative approach', *Information and Software Technology*, vol. 46, pp. 243-253.
- Gregor, S 2006, 'The Nature of Theory in Information Systems', *MIS Quarterly*, vol. 30, no. 3, pp. 611-642.
- Greiner, LE 1972, 'Evolution and revolution as organizations grow', *Harvard Business Review*, vol. July-August.
- Grünbacher, P, Köszegi, S & Biffel, S 2006, 'Stakeholder Value Proposition Elicitation and Reconciliation', in S Biffel, A Aurum, B Boehm, H Erdogmus & P Grünbacher (eds), *Value-Based Software Engineering*, Springer, Berlin, pp. 133-154.
- Harrison, JC 1994, *Do you suffer from paradigm paralysis?*, viewed September 7th, 2010
<<http://www.mnsu.edu/comdis/kuster/Infostuttering/Paradigmparalysis.html>>.
- Hinds, C 2008, 'The case against a positivist philosophy of requirements engineering', *Requirements Engineering*, vol. 13, no. 4, pp. 315-328.
- Hirschheim, R & Klein, HK 1989, 'Four Paradigms of Information Systems Development', *Communications of the ACM*, vol. 32, no. 10, pp. 1199-1215.
- Hirschheim, RA & Klein, HK 1992, 'A Research Agenda for Future Information Systems Development Methodologies', in WW Cotterman & JA Senn (eds),

Challenges and Strategies for Research in Systems Development, John Wiley & Sons, West Sussex, England.

- Höst, M, Regnell, B, Natt och Dag, J, Nedstam, J & Nyberg, C 2000, 'Exploring Bottlenecks in Market-Driven Requirements Management Processes with Discrete Event Simulation', paper presented to Software Process Simulation Modeling Workshop (PROSIM)2000, London, July, 2000.
- Janis, IL 1982, *Groupthink: Psychological Studies of Policy Decisions and Fiascoes*, Houghton Mifflin, Boston.
- Jantunen, S 2010a, 'The Benefit of Being Small: Exploring Market-Driven Requirements Engineering Practices in Five Organizations', paper presented to 16th International Working Conference on Requirements Engineering: Foundation for Software Quality. RE in Small Companies Workshop (RESC), Essen, Germany, June 29th, 2010.
- 2010b, 'Exploring Software Engineering Practices in Small and Medium-Sized Organization', paper presented to ACM/IEEE 32nd International Conference on Software Engineering. Cooperative and Human Aspects of Software Engineering Workshop (CHASE2010), Cape Town, South Africa.
- Jantunen, S, Gause, DC & Wessman, R 2010, 'Making Sense of Product Requirements', paper presented to 18th IEEE International Requirements Engineering Conference (RE'10), Sydney, Australia, September 27th, 2010.
- Jantunen, S, Lehtola, L, Gause, DC, Dumdum, UR & Barnes, RJ 2011, 'The Challenge of Release Planning: Visible But Not Seen?' paper presented to 5th International Workshop on Software Product Management (IWSPM 2011) in conjunction with 19th IEEE International Requirements Engineering Conference 2011, Trento, Italy, August 30th, 2011.
- Jantunen, S & Saarenketo, S 2007, 'Exploring the Modes of Foreign Entry from the Product Development Viewpoint', paper presented to The R&D Management Conference, Bremen, Germany, 4-6 July, 2007.
- Jantunen, S & Smolander, K 2006a, 'Challenges of Knowledge and Collaboration in Roadmapping', paper presented to International Workshop on Software Product Management (IWSPM'06 - RE'06 Workshop), Minneapolis/St.Paul, USA.
- 2006b, 'Towards Global Market-Driven Software Development Processes: An Industrial Case Study', paper presented to 28th International Conference on

Software Engineering & Co-Located Workshops. The first International Workshop on Global Software Development for the Practitioner (GSD 2006), Shanghai, China, 23 May, 2006.

Jantunen, S, Smolander, K & Gause, DC 2007, 'How Internationalization of a Product Changes Requirements Engineering Activities: An Exploratory Study', paper presented to 15th IEEE International Requirements Engineering Conference (RE 2007), New Delhi, India, October 15-19th, 2007.

Jarke, M & Pohl, K 1994, 'Requirements engineering in 2001: (virtually) managing a changing reality', *Software Engineering Journal*, vol. 9, no. 6, pp. 257-266.

Jaworski, BJ & Kohli, AK 1996, 'Market Orientation: Review, Refinement, and Roadmap', *Journal of Market Focused Management*, vol. 1, pp. 119-135.

Jayaratra, N 1994, *Understanding and evaluating methodologies - NIMSAD: A Systemic Framework*, McGraw-Hill, London.

Jehn, KA 1995, 'A multimethod examination of the benefits and detriments of intragroup conflict', *Administrative Science Quarterly*, vol. 40, pp. 256-282.

Jung, HW 1998, 'Optimizing value and cost in requirements analysis', *IEEE Software*, vol. 15, pp. 74-78.

Järvinen, P 1999, *On research methods*, Tampereen Yliopistopaino, Tampere.

---- 2008, 'Mapping Research Questions to Research Methods', in *Advances in Information Systems Research, Education and Practice*, Springer Boston, pp. 29-41.

Kamsties, E, Hörmann, K & Schlich, M 1998, 'Requirements engineering in small and medium enterprises', *Requirements Engineering*, vol. 3, pp. 84-90.

Karlsson, J & Ryan, K 1997, 'A cost-value approach for prioritizing requirements', *IEEE Software*, vol. 14, no. 5, pp. 67-74.

Karlsson, L, Berander, P, Regnell, B & Wohlin, C 2004, 'Requirements Prioritisation: An Experiment on Exhaustive Pair-Wise Comparisons versus Planning Game Partitioning', paper presented to 8th Conference on Empirical Assessment in Software Engineering, Edinburgh, UK.

Karlsson, L, Dahlstedt, ÅG, Regnell, B, Natt och Dag, J & Persson, A 2007, 'Requirements engineering challenges in market-driven software development -

- An interview study with practitioners', *Information and Software Technology*, vol. 49, pp. 588-604.
- Karlsson, L, Wohlin, C & Regnell, B 1998, 'An evaluation of methods for prioritizing software requirements', *Information and Software Technology*, vol. 39, no. 14-15, pp. 939-947.
- Katapultti project 2005, *Software Engineering Skills and Processes of Information and Communication Technology (ICT) companies in South-East Finland. (The KATAPULTTI project)*, viewed 13.6.2006 <<http://www.it.lut.fi/katapultti/>>.
- Keil, M & Carmel, E 1995, 'Customer-developer links in software development', *Communications of the ACM*, vol. 38, no. 5, pp. 33-44.
- Kellerer, H, Ulrich, P & Pisinger, D 2004, *Knapsack problems*, Springer.
- Kendall, J 1999, 'Axial Coding and the Grounded Theory Controversy', *Western Journal of Nursing Research*, vol. 21, no. 6, pp. 743-757.
- Kerlinger, FN 1979, *Behavioral Research: A Conceptual Approach*.
- Klein, HK & Myers, MD 1999, 'A Set of Principles for Conducting and Evaluating Interpretive Field Studies in Information Systems', *MIS Quarterly*, vol. 23, no. 1, pp. 67-94.
- Kling, R 1980, 'Social Analyses of Computing: Theoretical Perspectives in Recent Empirical Research', *ACM Computing Surveys (CSUR)*, vol. 12, no. 1, pp. 61-110.
- Kotonya, G & Sommerville, I 1996, 'Requirements engineering with viewpoints', *Software Engineering Journal*.
- 2000, *Requirements engineering: processes and techniques*, John Wiles & Sons Ltd, Chichester.
- Lafferty, BA & Hult, GTM 1999, 'A synthesis of contemporary market orientation perspectives', *European Journal of Marketing*, vol. 35, no. 1/2, pp. 92-109.
- Lauesen, S 2002, *Software requirements - styles and techniques*, Pearson Education, Essex.
- Lee, AS & Baskerville, RL 2003, 'Generalizing Generalizability in Information Systems Research', *Information Systems Research*, vol. 14, no. 3.

- Leffingwell, D & Widrig, D 2000, *Managing software requirements - A unified approach*, Addison-Wesley, Upper Saddle River.
- Lehtola, L & Kauppinen, M 2006, 'Suitability of Requirements Prioritization Methods for Market-driven Software Product Development', *Software Process Improvement and Practice*, vol. 11, pp. 7-19.
- Lehtola, L, Kauppinen, M & Kujala, S 2004, 'Requirements prioritization challenges in practice', paper presented to 5th International Conference on Product Focused Software Process Improvement, Kansai Science City, Japan.
- Lietsala, K & Sirkkunen, E 2008, *Social Media - Introduction to the tools and processes of participatory economy*, University of Tampere, Tampere.
- Lincoln, YS & Guba, EG 1985, *Naturalistic Inquiry*, Sage Publications.
- 2000, 'Paradigmatic Controversies, Contradictions, and Emerging Confluences', in NK Denzin & YS Lincoln (eds), *Handbook of Qualitative Research*, Sage Publications.
- Locke, K 2001, *Grounded Theory in Management Research*, SAGE Publications.
- Lubars, M, Potts, C & Richter, C 1993, 'A Review of the State of the Practice in Requirements Modelling', paper presented to IEEE International Symposium on Requirements Engineering, RE'93, San Diego, California, January 1993.
- Mahemoff, MJ & Johnston, LJ 1998, 'Software Internationalisation: Implications for Requirements Engineering', paper presented to 3rd Australian Workshop on Requirements Engineering, Geelong, Australia.
- Mason, RO & Mitroff, II 1981, *Challenging Strategic Planning Assumptions: Theory, Cases and Techniques*, John Wiley & Sons.
- Mathiassen, L, Saarinen, T, Tuunanen, T & Rossi, M 2007, 'A Contingency Model for Requirements Development', *Journal of the Association for Information Systems*, vol. 8, no. 11, pp. 569-597.
- McCaskey, MB 1982, *The executive challenge: Managing change and ambiguity*, MA: Pitman, Marsfield.
- McWhinney, W 1997, *Paths of Change: Strategic Choices for Organizations and Society*, Sage, Newbury Park, NJ.

- Miles, MB & Huberman, AM 1994, *Qualitative Data Analysis: an expanded sourcebook*, 2nd edition edn, SAGE Publications.
- Miller, WL 2001, 'Innovation for Business Growth', *Research Technology Management*, vol. 44, no. 5, pp. 26-41.
- Mills, HD, Dyer, M & Linger, RC 1987, 'Cleanroom Software Engineering', *IEEE Software*, vol. 4, no. 5, pp. 19-25.
- Mitroff, II, Mason, RO & Barabba, VP 1982, 'Policy as Argument - A Logic for Ill-Structured Decision Problems', *Management Science*, vol. 28, no. 12.
- Mitroff, II & Turoff, M 1973, 'Tecnological Forecasting and Assessment: Science and/or Mythology?' *Technological Forecasting and Social change*, vol. 5, pp. 113-134.
- Morgan, G 1996, *Images of Organization*, 2nd edn, SAGE Publications, Thousand Oaks, California.
- Natt och Dag, J & Gervasi, V 2005, 'Managing Large Repositories of Natural Language Requirements', in A Aurum & C Wohlin (eds), *Engineering and Managing Software Requirements*, Springer, Berlin, pp. 219-244.
- Natt och Dag, J, Regnell, B, Carlshamre, P, Andersson, M & Karlsson, J 2001, 'Evaluating Automated Support for Requirements Similarity Analysis in Market-Driven Development', paper presented to 7th International Workshop on Requirements Engineering, REFSQ'2001, Interlaken, Switzerland.
- Neisser, U 1976, *Cognition and Reality: Principles and Implications of Cognitive Psychology*, A Series of Books in Psychology, W.H. Freeman and Company, San Francisco.
- Nemiro, J, Beyerlein, MM, Bradley, L & Beyerlein, S 2008, *The Handbook of High Performance Virtual Teams: A Toolkit for Collaborating Across Boundaries*, Jossey-Bass.
- Nickerson, RS 1998, 'Confirmation bias: A Ubiquitous Phenomenon in Many Guises', *Review of General Psychology*, vol. 2, no. 2, pp. 175-220.
- Nonaka, I 1994, 'A Dynamic Theory of Organizational Knowledge Creation', *Organization Science*, vol. 5, no. 1, pp. 14-37.

- Nonaka, I & Toyama, R 2003, 'The knowledge-creating theory revisited: knowledge creation as a synthesizing process', *Knowledge Management Research & Practice*, vol. 1, pp. 2-10.
- Novorita, RJ & Grube, G 1996, 'Benefits of structured requirements methods for market-based enterprises', paper presented to International Council on Systems Engineering Sixth Annual International Symposium on Systems Engineering: Practice and Tools (INCOSE96), Boston, USA.
- Nunamaker, JFJ, Reinig, BA & Briggs, RO 2009, 'Principles for Effective Virtual Teamwork', *Communications of the ACM*, vol. 52, no. 4, pp. 113-117.
- Nuseibeh, B & Easterbrook, S 2000, 'Requirements engineering: a roadmap', paper presented to International Conference on Software Engineering, Limerick, Ireland.
- O'Donnell, AM, Danserau, DF & Hall, RH 2002, 'Knowledge Maps as Scaffolds for Cognitive Processing', *Educational Psychology Review*, vol. 14, no. 1, pp. 71-86.
- Orlikowski, WJ 1993, 'CASE Tools as Organizational Change: Investigating Incremental and Radical Changes in Systems Development', *MIS Quarterly*, vol. 17, no. 3, pp. 309-340.
- Ovaska, P & Stapleton, L 2009, 'Requirements Engineering During Complex ISD: A Sensemaking Approach', in W Wojtkowski, G Wojtkowski, M Lang, K Conboy & C Barry (eds), *Information Systems Development: Challenges in Practice, Theory, and Education*, Springer Science + Business Media, New York, vol. 1, pp. 159-209.
- Parayitam, S & Dooley, R 2009, 'The Interplay Between Cognitive and Affective Conflict and Cognition- and Affect-Based Trust in Influencing Decision Outcomes', *Journal of Business REsearch*, vol. 62, pp. 789-796.
- Parnas, DL 2010, 'Really Rethinking "Formal Methods"', *Computer*, vol. 43, no. 1, pp. 28-34.
- Penny, DA 2002, 'An Estimation-Based Management Framework for Enhance Maintenance in Commercial Software Products', paper presented to International Conference on Software Maintenance (ICSM'02), 3-6 Oct. 2002.
- Polanyi, M 1966, *Tacit Dimension*, The University of Chicago Press, London.
- Popper, KR 1979, *Objective Knowledge: An Evolutionary Approach*, Oxford University Press, Oxford.

- Potts, C 1995, 'Invented requirements and imagined customers: Requirements engineering for off-the-shelf software', paper presented to 2nd IEEE International Symposium on Requirements Engineering.
- Potts, C & Newstetter, W 1997, 'Naturalistic Inquiry and Requirements Engineering: Reconciling Their Theoretical Foundations', paper presented to third IEEE international symposium on requirements engineering.
- Punch, KF 1998, *Introduction to Social Research - Quantitative and Qualitative Approaches*, SAGE Publications.
- Regnell, B & Brinkkemper, S 2005, 'Market-Driven Requirements Engineering for Software Products', in A Aurum & C Wohlin (eds), *Engineering and Managing Software Requirements*, Springer.
- Regnell, B, Höst, M, Natt och Dag, J, Beremark, P & Thomas, H 2001, 'An Industrial Case Study on Distributed Prioritisation in Market-Driven Requirements Engineering for Packaged Software', *Requirements Engineering*, pp. 51-62.
- Regnell, B, Paech, B, Aurum, A, Wohlin, C, Dutoit, A & Natt och Dag, J 2001, 'Requirements Mean Decisions! – Research issues for understanding and supporting decision-making in Requirements Engineering', paper presented to First Conference on Software Engineering Research and Practise (SERPS'01), Ronneby, Sweden.
- Rittel, HWJ & Weber, MM 1973, 'Dilemmas in a General Theory of Planning', *Policy Sciences*, vol. 4, pp. 155-169.
- Roberts, N 2000, 'Wicked Problems and Network Approaches to Resolution', *The International Public Management Review*, vol. 1, no. 1.
- Robson, C 2002, *Real World Research: A Resource for Social Scientists and Practitioner-Researchers*, 2 edn, Blackwell Publishing.
- Royce, WW 1970, 'Managing the development of large software systems: Concepts and techniques', paper presented to IEEE WESCON, August.
- Ruhe, G 2010, *Product Release Planning: Methods, Tools and Applications*, Auerbach Publications, Boca Raton, FL.
- Ruhe, G, Eberlein, A & Pfahl, D 2002, 'Quantitative WinWin-a new method for decision support in requirements negotiation', paper presented to 14th

- International Conference on Software Engineering and Knowledge Engineering (SEKE'02), Ischia Island, Italy.
- Ruhe, G & Saliu, MO 2005, 'The Art and Science of Software Release Planning', *IEEE Software*, vol. 2, no. 6, pp. 47-53.
- 2006, 'The Science and Practice of Software Release Planning', *IEEE Software* (Submitted).
- Saaty, T 1980, *The analytic hierarchy process*, McGraw-Hill, New York.
- Sawyer, P, Sommerville, I & Kotonya, G 1999, 'Improving Market-Driven RE Processes', paper presented to International Conference on Product Focused Software Process Improvement (PROFES'99), Oulu, Finland.
- Sawyer, S 2000, 'Packaged software: implications of the differences from custom approaches to software development', *European Journal of Information Systems*, vol. 9, pp. 47-58.
- 2001, 'A Market-Based Perspective on Information Systems Development', *Communications of the ACM*, vol. 44, no. 11, pp. 97-102.
- Schön, DA 1983, *The reflective practitioner*, Basic Books, New York.
- Seaman, CB 1999, 'Qualitative Methods in Empirical Studies of Software Engineering', *IEEE Transactions on Software Engineering*, vol. 25, no. 4, pp. 557-572.
- Seldén, L 2005, 'On Grounded Theory - with some malice', *Journal of Documentation*, vol. 61, no. 1, pp. 114-129.
- Selvin, AM & Buckingham Shum, SJ 1999, 'Repurposing Requirements: Improving Collaborative Sense-Making over the Lifecycle', paper presented to International Conference on Product Focused Software Process Improvement, Oulu, Finland.
- Shrader, RC, Oviatt, BM & McDougall, PP 1997, 'Overcoming foreign market risks: The case of new ventures', paper presented to Annual Academy of Management Conference, Boston.
- Smit, J 1999, 'Grounded Theory Methodology in IS research: Glaser vs. Strauss', *South African Computer Journal*, vol. 24, pp. 219-222.

- Software, S 2004, *Atlas.ti*, WIN 5.0 edn, Scientific Software Developmen GmbH,
<<http://www.atlasti.com/>>.
- Sommerville, I & Sawyer, S 1997, *Requirements Engineering: A Good Practice Guide*, John Wiley & Sons.
- Strauss, AL & Corbin, J 1990, *Basics of Qualitative Research - Grounded Theory Procedures and Applications*, Sage Publications, Newbury Park, CA.
- Stähle, P & Grönroos, M 2000, *Dynamic Intellectual Capital*, Tummavuoren kirjapaino Oy, Vantaa.
- Suddaby, R 2006, 'What Grounded Theory is Not', *Academy of Management Journal*, vol. 49, no. 4, pp. 633-642.
- Sutton, RI & Staw, BM 1995, 'What theory is not', *Administrative Science Quarterly*, vol. 40, pp. 371-384.
- Tamminen, S 2006, *From punch cards to product modeling - 40 years of Tekla software*.
- Tekla 2009a, *Tekla Milestones* (<http://www.tekla.com/international/about-us/history/milestones/>), viewed March 5th, 2009 2009,
<<http://www.tekla.com/international/about-us/history/milestones/Pages/Default.aspx>>.
- 2009b, *Tekla's homepage* (<http://www.tekla.com/>), viewed May 19 2008,
<<http://www.tekla.com/>>.
- Wagner, SM, Lukassen, P & Mahlendorf, M 2010, 'Misused and missed use - Grounded Theory and Objective Hermeneutics as methods for resaerch in industrial marketing', *Inudstrial Marketing Management*, vol. 39, pp. 5-15.
- Vail, EFI 1999, 'Knowledge Mapping: Getting Strated With Knowledge Management', *Information Systems Management*, vol. 16, no. 4, pp. 16-23.
- Walsh, JP 1995, 'Managerial and Organizational Cognition: Notes from a Trip Down Memory Lane', *Organization Science*, vol. 6, no. 3, pp. 280-321.
- van de Weerd, I, Brinkkemper, S, Nieuwenhuis, R, Versendaal, J & Bijlsma, L 2006, 'Towards a Reference Framework for Software Product Management', paper presented to 14th IEEE International Requirements Engineering Conference, Minneapolis/St. Paul, Minnesota, USA.

- Van den Akker, M, Brinkkemper, S, Diepen, G & Versendaal, J 2008, 'Software product release planning through optimization and what-if analysis', *Information and softwareTechnology*, vol. 50, pp. 101-111.
- Wegner, DM 1986, 'Transactive Memory: A Contemporary Analysis of the Group Mind', in B Mullen & GR Goethals (eds), *Theories of group behavior*, Springer-Verlag, New York, pp. 185-208.
- Weick, KE 1986, 'Theoretical assumptions and research methodology selection', in Me al (ed.), *Research Issues in IS Research*.
- 1995a, 'Definition of "theory"', in N Nicholson (ed.), *Blackwell Dictionary of Organizational Behavior*, Oxford.
- 1995b, *Sensemaking in Organizations*, Foundations for Organizational Science, Sage Publications, Thousand Oaks, California.
- 1995c, 'What Theory is Not, Theorizing Is', *Administrative Science Quarterly*, vol. 40, pp. 385-390.
- 2001, *Making Sense of the Organization*, Blackwell Publishers, Oxford.
- Weick, KE & Roberts, KH 1993, 'Collective Mind in Organizations: Heedful Interrelating on Flight Decks', *Administrative Science Quarterly*, vol. 38, pp. 357-381.
- Wexler, MN 2001, 'The who, what and why of knowledge mapping', *Journal of Knowledge Management*, vol. 5, no. 3, p. 249.
- Wieringa, R 2005, 'Requirements researchers: are we really doing research?' *Requirements Engineering*, vol. 10, pp. 304-306.
- Vitalari, NP 1992, 'Structuring the Requirements Analysis Process for Information systems: A Proposition Viewpoint', in WW Cotterman & JA Senn (eds), *Challenges and Strategies for Research in Systems Development*, John Wiley & Sons, West Sussex, England.
- Wolcott, HF 1982, 'Differing styles of on-site research, or, "If it isn't ethnography, what is it?"', *The Review Journal of Philosophy and Social Science*, vol. 7, no. 1&2, pp. 154-169.
- www.softwareproductmanagement.org 2010, *IT and Software Product Management*, 2010, <<http://www.softwareproductmanagement.org/>>.

- Yeh, A 1992, 'Requirements engineering support technique (REQUEST); a market driven requirements management process', paper presented to Second Symposium of Quality Software Development Tools.
- Yin, RK 1994, *Case Study Research: Design and Methods*, 2nd edn, Sage Publications.
- Yoo, Y & Kanawattanachai, P 2001, 'Developments of Transactive Memory Systems and Collective Mind in Virtual Teams', *The International Journal of Organizational Analysis*, vol. 9, no. 2, pp. 187-208.
- Ågerfalk, PJ, Fitzgerald, B, Holmström, H, Lings, B, Lundell, B & Conchúir, EÓ 2005, 'A Framework for Considering Opportunities and Threats in Distributed Software Development', paper presented to International Workshop on Distributed Software Engineering, Paris, August 29, 2005.

APPENDIX 1:

INTERVIEW QUESTIONS

BEGINING OF THE INTERVIEW

1. Please describe the nature of your work in your company.
2. Please describe your company's / business unit's core capabilities.
3. Why do customers buy from you and not from the competitor?
4. Please draw the organizational structure of your company.
 - a) What responsibilities and duties do different departments or units have?
 - b) What kinds of skills and knowledge are needed in each department?
 - c) What kind of interaction occurs between departments?
 - d) In which department do you work?

COMPANY'S BUSINESS ACTIVITIES

5. Please describe the business models you use.
 - a) Product strategy
 - b) Service and implementations model
 - c) Distribution model
 - d) Why?
6. Please describe the revenue logic in your company.
 - a) Of which elements does the income consist?
 - b) Revenue logic with partners?
 - c) Revenue logic in direct customer sales?
 - d) Why?

PARTNER NETWORKS DESCRIPTION

7. Please describe the partner strategy in your company.
8. Please complete the organization figure by drawing down the partnerships in each unit/department.
 - a) What matters led into these partnerships?
 - b) What objectives were set to the partnership?
 - c) Where do the partners physically exist?
 - d) What is the size of the partners?
 - e) For what activities are the partners used? Why?
 - f) How well has the partnership met your expectations?
 - g) What positive do you see in the partnership?
 - h) What would you wish to improve in the partnership?
 - i) How long did it take to gain any financial benefits for the company?
 - j) Please set the partners in order of importance. Why so?
9. Please give an example of one successful and one unsuccessful partnership.
10. What changes are you planning to make in your partner network and why?
11. In general, what do you consider important regarding the partnerships?

PARTNER SEARCH AND EVALUATION

12. How do you search for partners?
 - a) What activities are involved?
 - b) Who is responsible for the search?
 - c) How continuous are these activities?
 - d) How much time is devoted to these activities?

- e) How much financial resources are allocated to the search?
- f) What advantages do you see in the current practice?
- g) What should still be developed in current practices?

13. Please give one example of searching for a partner.

14. How do you evaluate partners?

- a) What activities are involved?
- b) Who is responsible?
- c) How continuous are these activities?
- d) How much time is devoted to these activities?
- e) What advantages do you see in the current procedures?
- f) What should still be developed in current practices?

PARTNER SELECTION AND ESTABLISHING THE PARTNERSHIP

15. Which factors have an effect on partner selection?

- a) Technical reasons
- b) Commercial reasons
- c) Human resource reasons (organization, key persons)
- d) Strategic reasons
- e) Risks related to the partner

16. How are the partners chosen?

- a) Who is responsible for the selection?
- b) In which time-frame is the decision made?
- c) What advantages do you see in the current practices?
- d) What should still be developed in current practices?

17. Please give an example of successful and failed partner selection or evaluation.
18. How do you start a new partnership?
- a) What activities are involved (setting objectives and sharing responsibilities, resources, contacting informing)?
 - b) Who is responsible?
 - c) How well planned is the partnership formation?
 - d) How much time is devoted to these activities?
 - e) How much financial resources are allocated to these activities?
 - e) What advantages do you see in the current practices?
 - f) What should still be developed in current practices?
 - g) To which level do you tend to establish the partnership (operative level, corporate management, owners)?
19. Please give an example of one successful and one failed partnership formation.

COMMITTING PARTNERS INTO CO-OPERATION AND TRUST

20. In your opinion, what influences the commitment of the partner?
- a) The economic advantage to the company
 - b) The economic advantage to key personnel
 - c) The partner's dependence on your company
 - d) Your company's dependence on the partner
 - e) The strategic advantages (extension of product range, etc.)
21. How is the commitment of the partner secured at the moment?
- a) Activities involved (Investment objectives, rewards, etc.)?
 - b) Do you make an effort to secure the commitment of all partners? Why?

- c) Who is responsible for securing partners' commitment?
 - d) What advantages do you see in current practice?
 - e) What would you wish to improve in current practice?
 - f) What other means do you see for securing partner commitment?
22. How trustworthy do you consider your partners?
- a) What builds trust between partners?
 - b) What decreases or dilutes trust?
23. Please give a practical example of an occasion when *commitment and trust* have been in a special role.

PARNERSHIPS IN PRACTICE

24. Please describe how information is shared with your partners.
- a) What information do you need from the partners?
 - b) What information is available from the partners?
 - c) What information, in your opinion, do the partners need?
 - d) In practice, what information do you give to the partner?
 - e) In which phase is the co-operation most active?
 - f) What advantages to you see in the current co-operation?
 - g) What would you like to improve regarding the current practices?
 - h) How do you interact with the end customer?
25. How is information shared within your company? (concerning software development)
- a) What kind of information do you need from other departments?
 - b) What information is provided from other departments?
 - c) What information is needed in the departments?
 - d) What information do you give to the different departments?

- e) In which stage of the software development is the co-operation most active?
 - f) What advantages do you see in co-operation?
 - g) What would you develop in the co-operation?
26. Please give a practical example of successful and failed partner co-operation.
27. Please give a practical example of successful and failed internal co-operation in your organization.
28. How important is co-operation with partners to your work?
29. How important for your work is the internal co-operation in the company?
30. How can the co-operation with partners be seen in your everyday work?
31. How has the co-operation with partners affected your work?
- a) What new skills have been required?
 - b) What new stages has the co-operation brought to your work? (Contract procedures, extra co-ordination)?
 - c) What new tools have been required?
 - d) What new roles has the co-operation introduced?
32. In practice, how do you control the actions of partners?
- a) Objectives/results?
 - b) Active following of contacts' actions
 - c) Contacts' knowledge and skills, education

PARTNERSHIP DISSOLUTION

33. How are partnerships ended?
- a) What functions are involved?
 - b) What advantages do you see in current practices?
 - c) What would you wish to improve in current practice?
 - d) How many partnerships has your company ended?
 - e) How do you inform parties about the ending of co-operation?
 - f) How have juridical services been used?
 - g) How have the consequences of the partnership dissolution on the partner's future business been taken into consideration?
34. Which factors influence the decision of ending a partnership?
- a) Investments made
 - b) Personal relations
 - c) Why?
35. Please give one example of ending a partnership that you particularly remember.

FINALLY

36. From your point of view, which important aspects involving partnerships and co-operation were not dealt with?
37. In your opinion, who else should be interviewed?
38. Is there any material in your company available for us to see concerning this topic?
39. What did you think of this interview?

APPENDIX 2:

CONTACT SUMMARY FORM

CONTACT SUMMARY FORM

Company:

Topic:

Interviewees:

Interviewers:

Time & place:

1. What were the main issues or themes that struck you in this contact?
2. Summarize the information you received (or failed to receive) on following key questions.

Question	Information
Product related interaction to gain understanding regarding the markets (who, how, challenges)	
Product related interaction to make decisions regarding the product (who, how, challenges)	
Product related interaction to act upon decisions made (who, how, challenges)	

3. Anything else that struck you as salient, interesting, illuminating or important in this contact?
4. What new (or remaining) key questions do you have in considering the next contact with this site?

ACTA UNIVERSITATIS LAPPEENRANTAENSIS

427. AHONEN, TERO. Monitoring of centrifugal pump operation by a frequency converter. 2011. Diss.
428. MARKELOV, DENIS. Dynamical and structural properties of dendrimer macromolecules. 2011. Diss.
429. HÄMÄLÄINEN, SANNA. The effect of institutional settings on accounting conservatism – empirical evidence from the Nordic countries and the transitional economies of Europe. 2011. Diss.
430. ALAOUTINEN, SATU. Enabling constructive alignment in programming instruction. 2011. Diss.
431. ÅMAN, RAFAEL. Methods and models for accelerating dynamic simulation of fluid power circuits. 2011. Diss.
432. IMMONEN, MIKA. Public-private partnerships: managing organizational change for acquiring value creative capabilities. 2011. Diss.
433. EDELMANN, JAN. Experiences in using a structured method in finding and defining new innovations: the strategic options approach. 2011. Diss.
434. KAH, PAUL. Usability of laser - arc hybrid welding processes in industrial applications. 2011. Diss.
435. OLANDER, HEIDI. Formal and informal mechanisms for knowledge protection and sharing. 2011. Diss.
436. MINAV, TATIANA. Electric drive based control and electric energy regeneration in a hydraulic system. 2011. Diss.
437. REPO, EVELIINA. EDTA- and DTPA-functionalized silica gel and chitosan adsorbents for the removal of heavy metals from aqueous solutions. 2011. Diss.
438. PODMETINA, DARIA. Innovation and internationalization in Russian companies: challenges and opportunities of open innovation and cooperation. 2011. Diss.
439. SAVITSKAYA, IRINA. Environmental influences on the adoption of open innovation: analysis of structural, institutional and cultural impacts. 2011. Diss.
440. BALANDIN, SERGEY, KOUCHERYAVY, YEVGENI, JÄPPINEN, PEKKA, eds. Selected Papers from FRUCT 8 .2011.
441. LAHTI, MATTI. Atomic level phenomena on transition metal surfaces. 2011. Diss.
442. PAKARINEN, JOUNI. Recovery and refining of manganese as by-product from hydrometallurgical processes. 2011. Diss.
443. KASURINEN, JUSSI. Software test process development. 2011. Diss.
444. PEKKANEN, PETRA. Delay reduction in courts of justice – possibilities and challenges of process improvement in professional public organizations. 2011. Diss.
445. VANHALA, MIKA. Impersonal trust within the organization: what, how, and why? 2011. Diss.
446. HYYNEN, KATJA. Broadband excitation in the system identification of active magnetic bearing rotor systems. 2011. Diss.
447. SOLONEN, ANTTI. Bayesian methods for estimation, optimization and experimental design. 2011. Diss.

448. JABLONSKA, MATYLDA. From fluid dynamics to human psychology. What drives financial markets towards extreme events. 2011. Diss.
449. MYÖHÄNEN, KARI. Modelling of combustion and sorbent reactions in three-dimensional flow environment of a circulating fluidized bed furnace. 2011. Diss.
450. LAATIKAINEN, MARKKU. Modeling of electrolyte sorption – from phase equilibria to dynamic separation systems. 2011. Diss.
451. MIELONEN, JARI. Making Sense of Shared Leadership. A case study of leadership processes and practices without formal leadership structure in the team context. 2011. Diss.
452. PHAM, ANH TUAN. Sewage sludge electro-dewatering. 2011. Diss.
453. HENNALA, LEA. Kuulla vai kuunnella – käyttäjää osallistavan palveluinnovoinnin lähestymistavan haasteet julkisella sektorilla. 2011. Diss.
454. HEINIMÖ, JUSSI. Developing markets of energy biomass – local and global perspectives. 2011. Diss.
455. HUJALA, MAIJA. Structural dynamics in global pulp and paper industry. 2011. Diss.
456. KARVONEN, MATTI. Convergence in industry evolution. 2011. Diss.
457. KINNUNEN, TEEMU. Bag-of-features approach to unsupervised visual object categorisation. 2011. Diss.
458. RUUSKANEN, VESA. Design aspects of megawatt-range direct-driven permanent magnet wind generators. 2011. Diss.
459. WINTER, SUSANNA. Network effects: scale development and implications for new product performance. 2011. Diss.
460. JÄÄSKELÄINEN, ANSSI. Integrating user experience into early phases of software development. 2011. Diss.
461. KÄÄRIÄINEN, TOMMI. Polymer surface modification by atomic layer deposition. 2011. Diss.
462. KOCHURA, ALEKSEY. Growth, magnetic and transport properties of InSb and II-IV-As₂ semiconductors doped with manganese. 2011. Diss.
463. PUTKIRANTA, ANTERO. Possibilities and challenges of longitudinal studies in operations management. 2011. Diss.
464. HAPPONEN, ARI. Muuttuvaan kysyntään sopeutuva varastonohjausmalli. 2011. Diss.
465. VASAVA, PARITOSH. Application of computational fluid dynamics in modelling blood flow in human thoracic aorta. 2011. Diss.
466. PURO, LIISA. Identification of extractives and polysaccharides as foulants in membrane filtration of pulp and paper mill effluents. 2011. Diss.
467. LAPPALAINEN, PIA. Socially Competent Leadership – predictors, impacts and skilling in engineering. 2012. Diss.
468. PLAMTHOTTATHIL, ANSHY OONNITTAN. Application of electrokinetic Fenton process for the remediation of soil contaminated with HCB. 2012. Diss.
469. EBRAHIMI, FATEMEH. Synthesis of percarboxylic acids in microreactor. 2012. Diss.

