Tuure Tuunanen

REQUIREMENTS ELICITATION FOR WIDE AUDIENCE END-USERS

HELSINKI SCHOOL OF ECONOMICS

ACTA UNIVERSITATIS OECONOMICAE HELSINGIENSIS

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Abstract

In this dissertation, we focused on gaining an understanding of what new problems arise in relation to eliciting the requirements of diverse and distributed end-users who are usually not within the reach of development team. This target group was defined as wide audience end-users (WAEUs).

We applied design research as a research agenda for our study and our findings are derived from three distinct research phases. *First*, we recognized that it was important to reach the end-users, who are often left outside the development process. It was also acknowledged that these end-users were often not experts in the context of the technology or firm. Furthermore, in an attempt to facilitate communication between the different stakeholders, we proposed that considering end-user preferences was a key issue in the modeling of requirements. We should also be able to easily aggregate the requirements in order to support the presentation of requirements, which would facilitate the consensus making process. As a final point, an attempt should be made to integrate the technique into design practice.

Second, we constructed a requirements elicitation technique to meet the presented requirements. The information systems (IS) planning technique was extended so as to facilitate the eliciting of WAEU requirements. We propose that by using the wide audience requirements elicitation (WARE) technique we can adequately understand the needs and desires of end users and thus support the decision making process. To support this claim, we present preliminary results from two case studies: Digia, Inc. and Helsingin Sanomat.

Third, to rationalize the use of WARE, we have to understand in what situations we should consider using it. For this purpose, we suggest a theoretical model for managing requirements engineering risks. The model provides means for choosing resolution tactics for each project situation, prioritizing the use of techniques, while it also suggests how the compensation of techniques may affect project dynamics. The model distinguishes four specific situations in which we should consider using the WARE technique.

In conclusion, we have theorized the problems faced by practitioners when developing information systems for wide audience end-users and constructed a technique to meet this challenge. Our theoretical model provides guidelines for selecting and using the different techniques. Finally, the research agenda offers guidance and direction for conducting further research.

Key words: wide audience end-users, requirements elicitation, requirements engineering, information systems development, risk management, contingency models.

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Article II – Ken Peffers and Tuure Tuunanen, “Planning for IS Applications: a Practical, Information Theoretical Method and Case Study in Mobile Financial Services.”, Information & Management, Vol. 43, Issue 3, pp. 483-501, March 2005.
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Part I: Overview of the dissertation

1. Introduction

Understanding what to build is, and has been, one of the most difficult issues in information systems development (Lyytinen 1987). No other part of the work so cripples the resulting system if done wrong. No other part is as difficult to rectify later" (Brooks 1975). Since programmers became developers of information systems (IS) and were not the sole users any more, we have been seeking answers for understanding end-users. Researchers in information systems and software engineering (SE) have tried to resolve the problem by developing an almost unlimited number of different techniques for eliciting end-user needs and for facilitating communication between different stakeholders (e.g. Byrd, Cossick and Zmud 1992;Keil and Carmel 1995;Nuseibeh and Easterbrook 2000). A whole new discipline, requirements engineering (RE), has evolved to tackle these issues within software engineering (Neill and Laplante 2003). Some authors even argue that the constant stream of techniques has developed into a methodology jungle (Jayaratna 1994).

Researchers have responded to this development by developing contingency models (e.g. Davis 1982;McFarlan 1982), which can be used by practitioners for navigating in the RE technique landscape. Many of these models are based on risk management ideas (Lyytinen, Mathiassen and Ropponen 1998). Alter et al. (1978) were among of the first, introducing a model to help develop software for decision support. Later, McFarlan (1981;1982) made an effort to help organize IS development by trying to achieve appropriate integration internally amongst developers and externally between developers and end-users. Davis (1982), in turn, developed a contingency framework to reduce the uncertainty of the development task. According to him, we can reduce uncertainty by using different requirements elicitation techniques. Davis's model remains the only contingency framework to have approached the issue from the risk management point of view since the 1980s (Hickey and Davis 2004).

The relevance of requirements engineering to IS success has hardly diminished. It is rather quite the opposite, a growing number of end-users are outside the developing organization. Lamb and Kling (2003) have advocated challenging the traditional user concept. According to them the traditional view still mostly derives from Herbert Simon and his ideas of bounded rationality (1955). The authors claim that this view might be too narrowly defined and offer a broader concept of end-users as social actors in the IS development process. Our approach builds on this idea.

We present a new category of end-users who do not fit the traditional concept of end-users. We label them as **wide audience end-users**. Typical contemporary examples of related products are 3rd generation mobile software applications (Peffers, Gengler and Tuunanen 2003). We can see that wide audience end-users differ in four ways. First, the number of users can be very large and they can be widely dispersed physically and geographically. This may emphasize the problems in reaching the end-users. Second, the lack of control and poor incentives may result in volatility of information. Finally, the end-users have a low level of integration to service or it can be of secondary nature. The volatility of information and the lack of interest in developing the firm may, in turn, negatively affect the communication of requirements between developers and end-users (Salaway 1987). This is further highlighted by the fact that many of end-users do not even know how to express their needs (Walz, Elam and Curtis 1993;Watson and Frolick 1993). Thus, it remains open what the key ingredients are for understanding the needs of these external end-users and how they could eventually help the organizations developing software for them.

We revealed two gaps in related literature. First, a lack of understanding for the needs of requirements elicitation techniques suitable for new tasks with the external and diverse set of end-users. The literature fails to recognize what features are important for these kinds of techniques. Second, there is an urgent need to revise how requirements eliciting techniques should be selected for a particular IS Development project. There are hundreds of techniques available to us (Chatzoglou and Macaulay 1996). What kind of techniques should we use for dealing with WAEU projects and when should we use these techniques? These gaps led us to the main research question of the thesis: *How should requirements elicitation be handled when the developed system is targeted to wide audience end-users?*

We apply the design research methodology (Hevner, March and Park 2004) to answer this question. Our research is divided into three phases aiming to answer specific research questions, which elaborate the main research question. We initially seek to define the problem domain area and the key features for a requirements elicitation technique designed to be used with WAEUs. Next, we aim to construct the technique and then to rationalize its use by forming a theoretical model for selecting techniques.

The structure of the thesis is following. We first position the study within the information systems development discipline. Second, we review relevant literature to raise specific research questions so as to address the presented gaps in the literature. Then, we present the research methodology that has driven the research to provide answers to the specific research questions. Next, we review the findings, going through them according to the specific research questions. We recap with a discussion of how we have been able find answers and how well we have been able to meet methodology requirements. Last, we present the contributions of the thesis, its limitations and propose some areas for future research.

2. Positioning the study

In this section, a literature review is presented to position the study. First, we briefly review literature in the information systems development discipline to understand the process nature of design work. Then we position and elaborate requirements engineering within IS development. Finally, we focus our scope on requirements elicitation.

2.1. Information systems development

Hirschheim et al. (1995) have defined IS development as an "organized collection of concepts, methods, beliefs, values and normative principles supported by material resources". They summarize this as a methodology for IS development. We focus on one of these areas, IS development methods. IS development methods can be described as approaches to perform a systems development project. Brinkkemper (1996) has suggested that IS development methods include two Meta level concepts. First, it should contain directions and rules to guide development work. Second, it should be structured in a systematic way to support development activities with corresponding development products. Lyytinen (1987) has also incorporated tools that support the development activities in the definition. The history of IS development can be characterized as a venture to find solutions for raising the productivity of programmers, making systems less defective or developing systems by techniques that pay more attention to the end-users and their needs (Brooks 1975).

The story of process improvement in IS development methods began with the 'code-and-fix' approach (Boehm 1988). This method has been blamed for containing many problems, starting with poorly understood requirements and problematical structure of coding and resulting in great expenses when fixes are needed later on (Boehm 1988). The 'waterfall model' emerged as a systematic, sequential solution to software development problems (Brooks 1975;Hirschheim, Klein and Lyytinen 2003). With it, the IS product was not delivered until the whole linear sequence had been completed. With waterfall, researchers also became more focused on requirements. Determining requirements was considered to be essential and it was suggested to collect them in the start of the development process.

As projects became larger and more complex, such problems as stagnant requirements and badly structured programming started to emerge. Through an overlapping of the development phases (Fairley 1985;Pressman 2000;Sommerville 2001) and through the introduction of the more incremental spiral model (Boehm 1988;Iivari 1990a;Iivari 1990b) it was possible to tackle many of the difficulties mentioned above. The spiral model presented the software process as a spiral, where each of the loops would be considered to represent one fundamental step of the software process. Thus, the innermost loop might be concerned with requirements engineering, the next with design and so on. The spiral model assumed a risk-driven approach to software development rather than a primarily document-driven (waterfall) or code-driven (prototyping) one (Boehm 1988). Each cycle incrementally increased the system's degree of definition and simultaneously decreased its degree of risk (Boehm, et al. 1998).

Parallel to the IS development organization changes, the design craft itself has been evolving. It has been argued (McKeen, Guimaraes and Wetherbe 1994) that user participation improves the quality of the system in several ways, such as by

> "… providing a more accurate and complete assessment of user information requirements … providing expertise about the organization the system is to support … avoiding development of unacceptable or unimportant features, and improving user understanding of the system …"

However, there is no common definition of how users should be involved in the development process (Carmel, Whitaker and George 1993). Participatory design

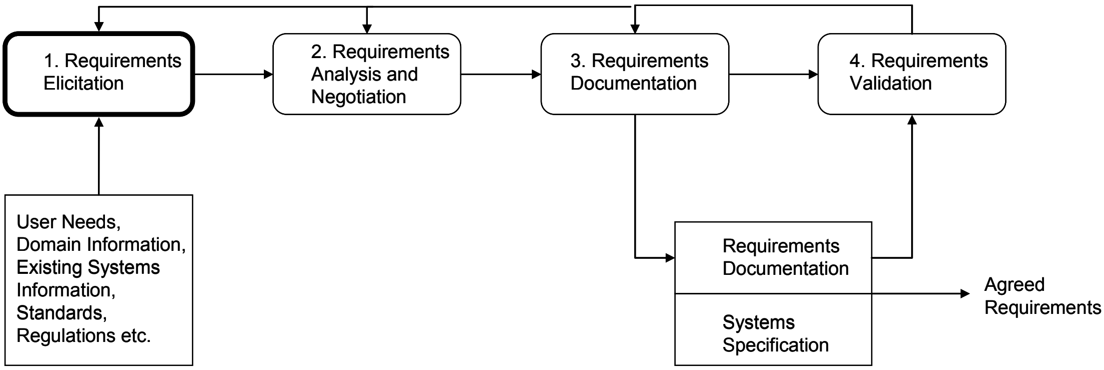
(Clemont and Besselaar 1993;Greenbaum and Kyng 1991;Smart and Whiting 2001;Vredenburg, Mao, Smith and Carey 2002) and the Scandinavian IS development approach (Bansler and Kraft 1994;Bjerknes and Bratteteig 1995;Grudin 1991;Iivari and Lyytinen 1999;Kautz 2001;Kyng 1994) have been seen as answers. One of the key arguments has been the emphasis on reconnecting the designer and user again (Grudin 1991).

2.2. Requirements engineering

Many disciplines have been dealing with the various issues surrounding the problem of recognizing the needs of end-users of information systems services and products. In IS the usual way of trying to solve these problems has been to determine the needs of the organizational end-user and then to analyze the data in order to achieve requirements specification of feasible quality (Byrd, Cossick and Zmud 1992;Davis 1982;Keil and Carmel 1995;Saarinen 1990). In marketing science, a specific discussion has emerged regarding the issues of developing new products. In this field, the problems have been approached more from a customer's point of view, and the new product development discipline has been strongly arguing for involving the customers (Thomke and von Hippel 2002), i.e. end-users, in the development process and listening to the voice of the customer (Griffin and Hauser 1993). Within the software engineering discipline, requirements engineering has been focusing on the issues surrounding the problems in eliciting and managing the changing requirements (Dubois and Pohl 2003;Jarke and Pohl 1994;Kotonya and Sommerville 2002).

Requirements engineering is generally seen as a linear process. One of the traditional descriptions has been the four step activity model (Kotonya and Sommerville 2002). This model is presented in Figure 1. In *the first phase*, requirements elicitation, the technical software developers work with customers and system end-users to specify the system requirements. One of the most important goals of the elicitation phase is to find out what problems need to be solved. Several different techniques can be used for elicitation (Nuseibeh and Easterbrook 2000). This phase is the focus of our study.

Figure 1 Coarse-grain activity model of the RE process modified from (Kotonya and Sommerville 2002)



In *the second phase*, requirements analysis and negotiation, the different stakeholders analyze the data and negotiate which requirements should be accepted. This is necessary as there are always conflicts between the requirements of different sources or the requirements suggested are not possible to implement because of budget constraints, for example (Kotonya and Sommerville 2002). Several strategies have been suggested to overcome these problems, such as 'group support systems' (Nunamaker, et al. 1991) and 'quality function deployment for software' (Elboushi and Sherif 1997;Herzwurm, Schockert and Weinberger 1997).

The third phase, requirements documentation, aims at creating a software requirements document at an appropriate level of detail. Requirements can be documented using formal techniques like mathematical specifications (van Lamsweerde, Darimont and Letier 1998), graphical notations or design description languages, but in practice informal or semi-informal techniques like natural language or data-flow diagrams are used for communication (Neill and Laplante 2003). IEEE has also provided a standard for documenting requirements (1999).

The fourth, and last, *phase* is requirements validation. This step is concerned with making sure that the collected requirements actually define the system desired by the customer. The requirements are systematically checked for consistency, completeness and validity. The techniques for requirements validation include, but are not limited to, requirement reviews, prototyping, test-case generation and automated consistency analysis (Kotonya and Sommerville 2002). There are also more novel ways, like the scenery technique (Haumer, Pohl and Weidenhaupt 1998) or conjoint analysis (Laaksonen, Tuunanen and Rossi 2004).

2.3. Requirements elicitation

We center our attention to the first phase of requirements engineering: requirements elicitation. Within software engineering, requirements elicitation has traditionally been regarded as a phase of requirements engineering that uses different techniques to capture end-user requirements (cf. section 2.2.). However, researchers have started to disagree with this view. Jirotka and Goguen (1994) have recommended using the term “elicitation” over “capture” so as to avoid the suggestion that requirements are out there to be collected simply by asking the right questions. Furthermore, Bergman et al. (2002) have presented a view that requirements are defined in a political process between the stakeholders. While building on the two last views, we give a slightly different definition. We regard requirements elicitation as a voyage to discovering end-users’ needs, modeling them using suitable techniques, and finally finding consensus among stakeholders in their prioritization.

The literature offers many techniques for handling the problems associated with requirements elicitation. Textbooks often mention interviews, use-cases, soft systems techniques, scenario analysis, observation and social analysis, ethnographic analysis, requirements reuse and prototyping. A recent review by Nuseibeh and Easterbrook (2000) provides a classification of techniques according to the needs of the project. They divided the techniques into six metagroups: 1) traditional techniques, 2) prototyping, 3) group elicitation, 4) contextual techniques, 5) cognitive techniques, and 6) model-driven techniques. These are described in Table 1 and reviewed below to elaborate the focus of the study.

Traditional Techniques. Over the years, projects have become more and more complex, giving rise to a need to reorganize the development work. Consequently, the “waterfall” process was adapted, and development work was thought of as a process; when one phase is concluded, the next one begins in a linear timeline (Sommerville 2001). With the waterfall, we also started to see more actual attempts to structurally elicit the requirements. Nuseibeh and Easterbrook (2000) call these early elicitation techniques *traditional techniques*. These include a broad range of generic data-gathering techniques such as questionnaires and surveys, interviews, and analyses of existing documentation such as organizational charts, process models or standards, and user or other manuals of existing systems.

Prototyping. Requirements elicitation techniques started to evolve towards answering the new needs, and one of the early adaptations was *prototyping*. Prototyping has been referred to by many researchers as a good way of getting feedback from end-users (Mathiassen, Seewaldt and Stage 1995). Davis (1982) has promoted using prototyping when end-users are not able to express their requirements and when they need help in visualizing the new possibilities for a system.

Table 1 Six categories of elicitation techniques, modified from (Nuseibeh and Easterbrook 2000;Tuunanen 2003)

Technique Category	Technique Examples
1.Traditional techniques	Questionnaires and surveys, interviews, and analysis of existing documentation
2.Prototyping	Prototyping the early versions of user interface
3.Group elicitation techniques	Group techniques: brainstorming, focus groups, and RAD/JAD workshops
4.Contextual techniques	Ethnographic techniques such as participant observation
5.Cognitive techniques	Protocol analysis, laddering, card sorting, and repertory grids
6.Model-driven techniques	Goal-based techniques and scenario-based techniques

Group elicitation techniques contain a wide range of methods, the purpose of all of which is to elicit requirements from groups of end-users. Group elicitation practices aim to foster stakeholder agreement and buy-in, while exploiting team dynamics to bring out a better understanding of the needs. Group procedures include, for example, brainstorming and focus groups, rapid application development (RAD) / Joint Application Development (JAD) workshops (Liou and Minder 1994) and group support systems (GSS) workshops (McGoff, Hunt, Vogel and Nunamaker 1990). Several researchers (e.g. Herlea 1998 and Davison and Briggs 2000) have been applying the GSS method to requirements elicitation.

Contextual Techniques. Contextual techniques emerged in the 1990s as an alternative to both traditional and cognitive techniques (Goguen and Linde 1993). These include the use of ethnographic techniques, and ethnomethodology and conversation analysis, both of which apply fine-grained analysis to identify patterns in conversation and interaction (Viller and Sommerville 1999). As an example of the genre, the reader is referred to contextual design (Holtzblatt and Beyer 1993). It draws a lot from both American JAD/RAD and Scandinavian participatory design (Bjerknes and Bratteteig 1995) literature. Holtzblatt and Beyer (1993) have suggested three general guidelines to be used as general goals of the contextual techniques: 1) the best product designs happen when the product designers are involved in collecting and interpreting customer data and 2) they can really understand what users and customers in fact need, and 3) desire and see themselves as apprentices of the customer and not as teachers.

Cognitive Techniques. These are techniques originally developed for knowledge acquisition (Shaw and Gaines 1996). They include protocol analysis (in which an expert thinks aloud while performing a task to provide the observer with insights into the cognitive processes used to perform the task), laddering (using probes to elicit the structure and content of stakeholder knowledge), card sorting (asking stakeholders to sort cards into groups, each of which has a name of some domain entity), repertory grids (constructing an attribute matrix for entities, by asking stakeholders for attributes applicable to entities and values for cells in each entity). The cognitive techniques have traditionally been used in marketing (e.g. Reynolds and Gutman 1988; Gengler, Howard and Zolner 1995). Lately, IS researchers have begun to take interest in these techniques. Browne et al. (Browne and Ramesh 2002;Browne and Rogich 2001) have claimed that by using laddering analysts are enabled to produce a richer set of requirements compared to other techniques.

Model-driven Techniques usually provide a specific model of the type of information to be gathered, and use this model to drive the elicitation process. Examples of Model-driven approaches are, according to Nuseibeh and Easterbrook (2000), goal-based techniques (e.g. van Lamsweerde, Darimont and Letier 1998; van Lamsweerde and Letier 2000), scenario-based techniques (Maiden et al. 1999 and Maiden 1998) and KAOS (van Lamsweerde, Darimont and Letier 1998). These techniques usually require a thorough knowledge of the system domain area or a high level of knowledge of related work practices.

3. Raising research questions

The thesis focuses on the elicitation of requirements from wide audience end-users (Tuunanen 2003;Tuunanen, Peffers and Gengler 2004;Tuunanen and Rossi 2004). In the following, three specific research questions are raised to elaborate the main research question: "*How should requirements elicitation be handled when the developed system is targeted to wide audience end-users*?" The first specific question focuses on the key characteristics of a requirements elicitation technique designed for this purpose. The second one addresses how this should be done and the third focuses on when these techniques should be used.

3.1. What are the key characteristics of requirements elicitation techniques for wide audience end-users?

As mentioned above, various techniques have been used for eliciting requirements from end-users. Several categorizations of such techniques have been put forward. Byrd et al. (1992) suggested categorizing methods according to how they resolve communication obstacles. Another notable review was conducted by Keil et al. (1995), who paid special attention to what the target of systems were (custom or package software). Finally, one of the most recent reviews is that by Nuseibeh and Easterbrook (2000), who have developed a classification of techniques according to the needs of the project. They have divided the spectrum into six metagroups, defining a total of 19 individual techniques (cf. section 2.2. and Table 1).

However, these categorizations provide little help for analysts in understanding what the essential characteristics are that they should look for in the case of eliciting the requirements of wide audience end-users. The literature points us towards two issues: *reach* and *communication*. Researchers (Dean, et al. 1998;Hickey and Davis 2003) have suggested using three dimensions of reach : 1) user representation, 2) user groups, and 3) user community, with the analyst-developer team being the heart of the enlarging circles of user dimensions. Pohl (1994), in turn, has provided a conceptual framework for the requirements engineering process. His three dimensions of requirements engineering include specification, presentation and agreement. If we simplify his view to a higher level of abstraction and regard presentation and agreement as our tools we can say that these three dimensions are, essentially, only forms of communication. Similarly, in IS literature, there is an extensive demand for improving communication between designers and end-users to improve design (e.g. Bostrom 1989;Grudin 1991;Hepworth, Vidgen, Griffin and Woodward 1992;Herzwurm, Schockert and Pietsch 2003;Holtzblatt and Beyer 1998;Nakakoji and Fischer 1995;Salaway 1987).

Even though the literature is rich with associated problems and resolution techniques for them, we remain uncertain about what is important in the case of external and diverse end-users. Through this we arrive at our first specific research question.

Research Question 1: What are the key characteristics of requirements elicitation technique for discovering the requirements of wide audience end-users?

3.2. How to incorporate wide audience end-users and communicate requirements between stakeholders?

IS research has suggested that end-user participation is essential for achieving the right development portfolio (Kujala 2003;McKeen, Guimaraes and Wetherbe 1994). This is one of the key arguments in the Scandinavian participatory design discussion (Bansler and Kraft 1994;Bjerknes and Bratteteig 1995;Iivari and Lyytinen 1999;Kautz 2001;Kyng 1994) has been how to reconnect the designer and user again (Grudin 1991). Hence, an exclusive use of top-down planning may effectively shut the firm off from an effective use of this grass-roots knowledge (Premkumar and King 1994). However, no consensus has been reached as to how end-users should be involved (Carmel, Whitaker and George 1993). Successful communication between stakeholders has been argued to be one of most important factors for a successful IS project (Holtzblatt and Beyer 1998), along with competent requirements specification (Davis 1990).

Within IS, the communication between different stakeholders and its influence on the results of the process has been a major research theme (Curtis, Kellner and Over 1992;Curtis, Krasner and Iscoe 1988;Davidson 2002;Keil and Carmel 1995). Daft and Lengel (1986) suggest characterizing information with two terms: *media richness* and *synchronicity*. Media richness refers to the capability of the media to carry complex, multidimensional information and cues that help message recipients to better understand the intended message (Daft and Lengel 1986). Information helps to manage uncertainty and equivocality in the decision environment. Dennis and Valacich (1999) have presented an extension of the media richness theory which is referred to as “media synchronicity.” According to the authors, a meaningful action requires communication that supports both conveyance of data and convergence of shared understanding. The conveyance of sufficient information is essential for individuals in order to reach the correct conclusions, while convergence is necessary for the group to be able to act together (with synchronicity and) with a common understanding (Dennis, Valacich and Fuller 2002).

Our interest lies in trying to understand how the different theories could best be used in benefit of understanding the needs of wide audience end-users. Hence, we come to the second specific research question probing the presented area:

Research Question 2: How can we incorporate wide audience end-users into the requirements elicitation process and facilitate communication between the stakeholders of an IS project?

3.3. When to use different requirements elicitation techniques?

It has been widely studied how information systems development should be managed (e.g. Barki, Rivard and Talbot 1993;Boehm 1991;Iversen, Mathiassen and Nielsen 2004;Keil, Cule, Lyytinen and Schmidt 1998;Lyytinen, Mathiassen and Ropponen 1996;Lyytinen, Mathiassen and Ropponen 1998;Nidumolu 1995;Ropponen and Lyytinen 1997;Ropponen and Lyytinen 2000;Willcocks and Margetts 1994). Risk based approaches, such as contingency models, have been considered to be a good way of handling the risks involved in development (Alter and Ginzberg 1978;Davis 1982;Iversen, Mathiassen and Nielsen 2004;Mathiassen, Seewaldt and Stage 1995;McFarlan 1981;McFarlan 1982). In general, contingency models offer three elements: an understanding of the situations involved, an understanding of the portfolio of available techniques, and a set of heuristics linking available techniques to different types of situations (Iivari 1992;Kickert 1983). These models are based on basic risk management concepts: the profile of the situation is analyzed in terms of risks, approaches are seen as risk resolution tactics, and these tactics are linked to situations based on their capacity to resolve certain types of risks (Lyytinen, Mathiassen and Ropponen 1998).

Davis's (1982) contingency model has been promoted to be a good framework for selecting techniques for requirements elicitation (Saarinen 1990). Fazlollahi and Tanniru (1991) have revisited the model and claimed that emphasis should be given also to information presentation, while they also emphasized the importance of information richness in requirements elicitation techniques (cf. section 3.2.) However, there seem to be no contemporary contingency models that would take account of the new problems organizations are facing with external and diverse end-users (Hickey and Davis 2004;Tuunanen 2003). Thus, it remains open how contingency models could be updated to include the emerged new techniques and to address the problems faced by contemporary organizations. The advances of IS development practices, such as the spiral model (Boehm 1988), also put pressure on the well established models. This sets the basis for the final specific research question.

Research Question 3: When should we use the different requirements elicitation techniques, including the wide audience requirements elicitation techniques given the contingencies of the project profile?

We address the above three specific research questions to find out what features are important for a requirements elicitation technique, how we can satisfy these demands, and when we should use the different techniques in order to answer our main research question. In following section, the research methodology used for this task is described.

4. Research methodology

The constructive research agenda in information systems development has been drawing more and more attention recently. IS researchers have presented a concept of design research (Hevner, March and Park 2004). Design research is said to be yet another "lens" or set of analytical techniques and perspectives for performing IS research. Moreover, the researchers claim that design research addresses important unsolved problems (Hevner, March and Park 2004). When compared to traditional ways of conducting research, design research can be considered to complement the positivist and interpretive perspectives. It involves analyzing the use and performance of designed artifacts in order to understand, explain and very frequently to improve the behavior of the various IS aspects (Orlikowski and Iacono 2001). Five general outputs have been proposed for design research: constructs, models, methods, instantiations[1], and better theories (ISWorld 2004;March and Smith 1995;Purao 2002;Rossi and Sein 2003).

The thesis employs the design research approach. We have used different research methods during the research process in order to to triangulate the research

[1] Instantiation operationalizes constructs, models and methods. 111. March, S. and G. Smith, "Design and Natural Science Research on Information Technology," *Decision Support Systems*, 1995, 15, pp. 251-266.

process. Thus, our research can be also described as a multimethod study (Mingers 2001). However, we feel that our study largely follows Nunamaker and Chen's (1991) research agenda for information systems development and Hevner et al.'s guidelines for design science in IS (Hevner, March and Park 2004). These are summarized in Table 2. These views are further elaborated below.

Table 2 Design research requirements and acronyms

Reference	Acronym	Description
Nunamaker and Chen (1991)	A1	Theory building
	A2	Systems development
	A3	Experiments
	A4	Observations
Hevner et al. (2004)	R1	Creation of an innovative and purposeful artifact
	R2	A specified domain
	R3	Evaluation of the constructed artifact
	R4	The problem must be solved in an innovative or more efficient or effective way.
	R5	The artifact must be rigorously defined, formally represented, coherent, and internally consistent
	R6	The research process must be iterative
	R7	Results should be efficiently communicated both to academia and practitioners

Nunamaker and Chen (1991) have claimed that the nature of the research in IS development demands a multi-methodical research approach. The method is divided into four approaches: (A1) theory building, (A2) systems development, (A3) experiments and (A4) observations. According to the authors, these approaches should be interconnected , thus providing feedback to each other. Using Mingers' (2001) terminology, we could say that the study should be conducted in a parallel manner, and use different research methods feed other streams with the results. Hevner et al. (2004), in turn, have presented a more specific framework for conducting design research. In their view, design research requires creating innovative and purposeful artifacts (R1). Second, research should be conducted in a clearly specified domain (R2). To support purposefulness, evaluation of constructed artifacts is also emphasized (R3). Further, the way of solving problems should be innovative or more efficient or effective than previously (R4). The artifact should be rigorously defined, formally represented, coherent, and internally consistent (R5). The research process itself should be iterative, within which a problem space is constructed and a mechanism posed or enacted to find an effective solution (R6). Finally, the results should be efficiently communicated both to academia and practitioners (R7).

We have used a combination these two views to conduct our research. The selected research methodology of the study is elaborated below. After forming overall and research phase specific research requirements, we present our choices of research methods in particular studies. These are further explained in the summary of the findings. In the discussion section of the thesis, we return to the methodology of the study and reflect how well we have been able to follow the research guidelines of Nunamaker and Chen (1991) and Hevner et al. (2004).

Reference	Acronym	Description
Nunamaker and Chen (1991)	A1	Theory building
	A2	Systems development
	A3	Experiments
	A4	Observations
Hevner et al. (2004)	R6	The research process must be iterative
	R7	Results should be efficiently communicated both to Academia and practitioners

Table 3 Overall research requirements for the study

Figure 2 and tables 3 and 4 demonstrate the overlap of the two research approaches. To begin with, we can see that Nunamaker and Chen's (1991) concept applies more to the general way of conducting research. Their classification is presented in table 3. Theory building (A1) is considered to happen throughout the research process. In our research endeavor, we consider research systems development (A2) to be substituted with the construct of requirements elicitation technique. For this construct, we use experiments (A3) and observations (A4) as suggested by Nunamaker and Chen (1991). We also use two of Hevner et al.'s (2004) requirements in a more abstract way. First, the authors have suggested communicating the results to both academia and practitioners alike (R7). We regard this as an overall requirement for our research. Second, the authors claim that the research process should be iterative in its nature (R6). This study was designed to follow the high level methodology presented above.

Figure 2 Research phases

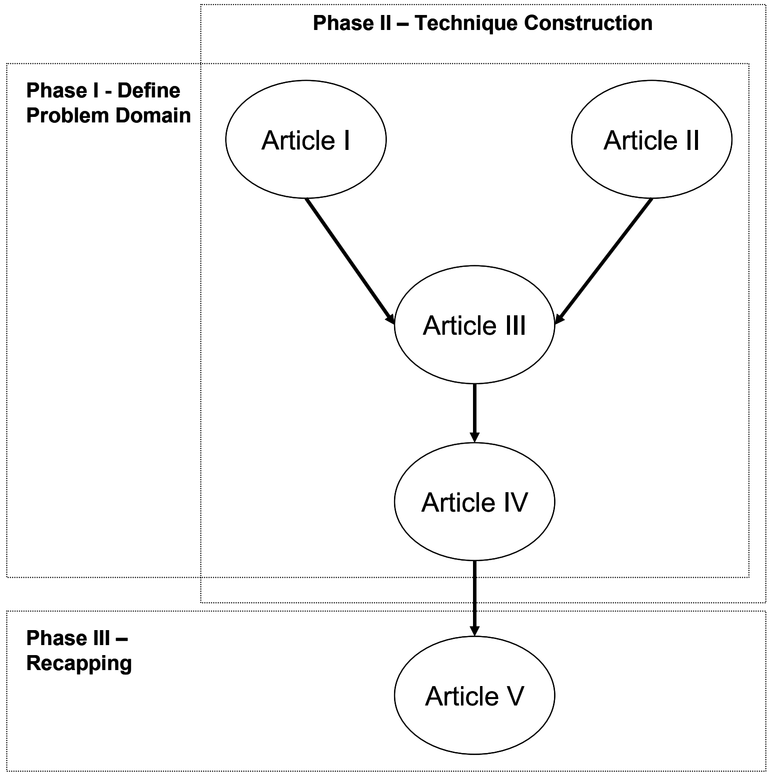


Figure 2 illustrates the flow of research. The iterative research process is divided into three phases, with the two first overlapping with each other. **Phase I** starts by striving to recognize possible needs for performing requirements elicitation for wide audience end-users. In Articles I and II, two main needs for the task are recognized: *reach* and *communication*. These two are explicitly defined in Article III, where requirements elicitation literature is reviewed and the issue further elaborated. Finally, in Article IV we provide a cumulated list of characteristics to satisfy the needs of a WAEU requirements elicitation technique. This process defines the problem area (R2) and set us forward towards the construction of an innovative requirements elicitation technique.

Phase II describes the construction of the technique (R1). This effort involved two independent case studies. We first constructed a technique for IS planning (Articles I and II), which was then extended to meet the needs of the new problem domain, i.e. requirements elicitation, in Articles III and IV. We applied Hevner et al's (2004) more specific requirements to this and the final phase of the research. These phases and requirements are listed in Table 4 below. We were aiming to provide solutions in a novel and innovative way (R4). The evaluation of the results (R3) was planned to be done by using client feedback to provide preliminary feasibility results of the technique. Furthermore, we were aiming to formally define each individual study with great emphasis on rigor (R5). All this should provide us the means to recap the study.

Phase III focuses on providing ideas for and recapping how and when the constructed requirements elicitation technique, and also other techniques, should be used given the contingencies of the project profile. In this phase, the same four requirements (R1, R3, R4 and R5) were used as for the second phase. In the end, we constructed a structured literature review method and used it for reviewing a total of 4320 articles in the relevant literature. The review method helped us to find 91 relevant articles. These provided the means for synthesizing the cumulated knowledge in IS and SE.

Research phase	Creation of Artifact (R1)	Define Problem Domain (R2)	Evaluation of Artifact (R3)	Efficient or Innovative (R4)	Rigorously defined / presented (R5)
Phase I	n/a	√	n/a	n/a	n/a
Phase II	√	n/a	√	√	√
Phase III	√	n/a	√	√	√

Table 4 Methodology requirements for individual research phases

The individual research methods are listed in Table 5. As illustrated above, Articles III and V are conceptual works, which derive from a literature review and provide a synthesis as a research outcome. In our empirical work, i.e. in Articles I, II and IV, we used the laddering technique (Browne and Ramesh 2002;Browne and Rogich 2001;Gengler, Klenosky and Mulvey 1995;Gengler and Reynolds 1995;Reynolds and Gutman 1988) to gather data from a total of 80 interviews. The technique was incorporated in the constructed requirements elicitation method. Clustering was used as an analysis method to aggregate data into requirements. In articles I and II, we used a quantitative approach and Ward's method (Aldenderfer and Blashfield 1984) to cluster the data automatically with statistical software. In article IV, we relied on a more qualitative approach and used three analysts to manually create the clusters of requirements. In article IV a web survey was also used for collecting feedback data in order to validate the results of our analysis (n=24).

Table 5 Data gathering and analysis methods

Article	Data Gathering	Data Analysis
Article I (Peffers, Gengler and Tuunanen 2003)	Case study 1: 18 In-depth interviews using the laddering technique. Case study 2: 32 In-depth interviews with laddering technique (Reynolds and Gutman 1988). Workshops: Case study 1 had two workshops with four participants; Case study 2 had one workshop with five participants.	Aggregating data with clustering, Ward's method (Aldenderfer and Blashfield 1984)
Article II (Peffers and Tuunanen 2005)	32 In-depth interviews with laddering technique (Reynolds and Gutman 1988). Workshop with five participants (Case study 2 in Article II).	Aggregating data with clustering, Ward's method (Aldenderfer and Blashfield 1984)
Article III (Tuunanen 2003)	Literature review.	Synthesis of the literature
Article IV (Tuunanen, Peffers and Gengler 2004)	30 In-depth interviews with laddering technique (Reynolds and Gutman 1988). Workshop with seven participants. Internet based survey of 33 participants. 24 answers with one uncompleted answer (73% response rate).	Aggregating data with manual clustering. Survey was analyzed with a descriptive technique.
Article V (Mathiassen, Saarinen, Tuunanen and Rossi 2004)	A structured literature review with a constructed review method. The reviewed literature comprises 4320 articles. The review resulted in choosing 91 articles for analysis.	Synthesis of the literature.

The selection of the cases for the PhD research was based on the suitability of the cases for our view of the wide audience information systems project and the accessibility of the client. Initially, we sought to co-operate with clients developing information systems that would be characterized with the three qualities stated earlier: 1) the number of users can be very large and they can be widely dispersed physically and geographically, 2) a lack of control of the external end-users, and 3) the end-users showing a low level of integration to service or the service being of secondary nature. With Digia, our task was to provide knowledge of potential 3rd generation mobile applications for the financial sector whereas in the case of Helsingin Sanomat the purpose was to develop an e-commerce system to support the entire business advertisement clientele. Both cases comply with the three basic requirements stated above. The potential number of end-users in both cases is in the order of hundreds of thousands and these were suggested to be geographically widely distributed over the whole of Finland. Secondly, most of the potential end-users in both cases were external and had loose ties with the developing company, which created a lack of control and a low level of integration to the offered end-user service. A further reason for selecting these cases was to be found in the accessibility of the clients. After pinpointing a few prospective candidates, the author started negotiations with the most potential clients. The negotiations were carried out in two phases. The first phase was conducted in the year 2000 and the second in 2003. For the university case reported in Article I, no such selection process was necessary due to the high level of accessibility of the organization.

The sampling of the interviewees for the first case was different from the last two ones. In the first case, the subjects were selected by the researchers from key positions, from several layers of the case study organization (university). In the other two case studies, the author worked with the clients (Digia, Inc. and Helsingin Sanomat) in order to find potential lead users (Rogers 1976;von Hippel 1986) for the system[2] to be designed. In summary, the process involved a market segmenting of would-be-users and then used snowballing (e.g. Olson and Bakke 2001) to recruit the participants. In the second case study the use of snowballing was similar to Olson and Bakke. In the third case study, we were experimenting with a modified version and it was the client that carried out the selection of the potential participants. The client's staff was asked to pinpoint potential lead-users from their customer base. The survey participants in the final case study were also recruited according to the same principle. The workshop participants were always selected by the client from their own organization.

With the selected research methodology and methods, we claim to have attempted to address the specific research questions. In research phase I, we set the theoretical background for understanding what kind of needs arise for a requirements elicitation technique as regards wide audience end-users. This was followed by the

[2] This process is further explained in the section 5.2.1.

construction of the technique (phase II). The construction can be described as an iterative process culminating in Article IV. Finally, with phase III, we recap the study by positioning the constructed requirements elicitation techniques, i.e. wide audience requirements elicitation, within the spectrum of RE techniques (Article V). Thus, we seek to provide an initial understanding of how to select RE techniques paying attention to the specific project characteristics and the risks involved On the basis of the outcome of these phases, we finally intend to address the main research question of the thesis.

5. Review of findings

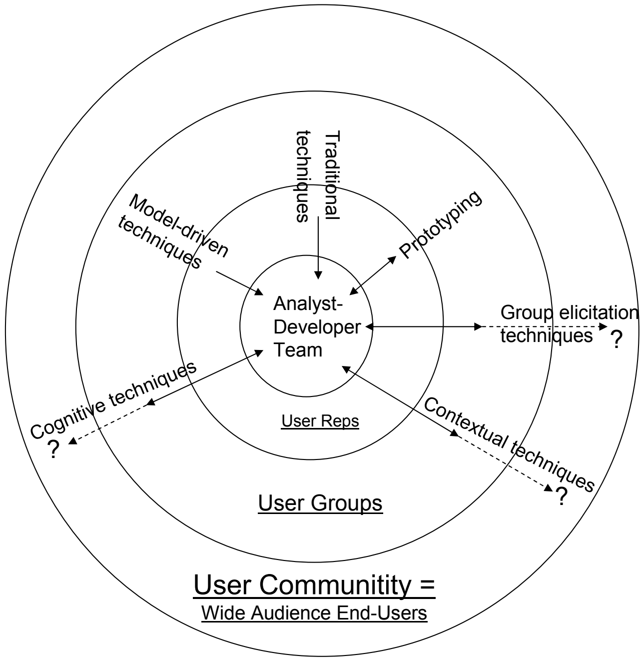
In the following, we go through the findings by using the specific research questions as a structure for the summary. This illustrates the research methodology of the study. First, we define the problem domain area and determine what kind of features may be essential for eliciting requirements of wide audience end-users, deriving from the results of iterative theory building. Second, we construct the technique rigorously by using experiments and observations in an innovative way. The results of the evaluation of the technique are also presented. Finally, we return to theorizing and present the results of the final research effort, which endeavors to position the constructed technique among other techniques and to rationalize its use. This was accomplished by creating a novel and rigorously constructed artifact, a model that aims to provide a new efficient solution for selecting techniques.

5.1. Key features of the WAEU requirements elicitation technique

The number of firms developing IS services and products for non-traditional end-users has been increasing throughout the 1990s and 2000s. Likewise, there are also more and more information systems products and services the primary users of which are not within easy reach for the organization developing these. Although researchers have been putting more emphasis on the development of market oriented package software (e.g. Keil and Carmel 1995;Regnell, et al. 2001), we would like to especially emphasize the specific nature of widely dispersed use of embedded systems. Examples of such systems are the case of 3rd generation mobile applications (Peffers and Tuunanen 2005) and that of an e-commerce system serving a highly diverse set of end-users (Tuunanen, Peffers and Gengler 2004). In these cases, the users usually remained unknown and mostly external to the developing organization, with only few of them being internal users. We suggest that this is not an uncommon situation for contemporary application providers, like Microsoft. However, we could say that until now most of the package software has been developed for business users, with perhaps the exception of computer games (e.g. Rajala, Rossi, Tuunainen and Vihinen 2003). Let us think about office applications, for example. Although it is true that these applications are used in homes and offices alike, they are, essentially, tools and derive their usage habits from the work context. There are only minor differences in how a word processor is used at the office compared to its use at home or regarding what kind of features are required. The requirements of the user for the application are essentially the same regardless of the location of use. In this study, the emphasis is on the change that is happening today in how information systems are created for personal use.

A good example of the failure to recognize the new needs of understanding the changing markets (Barwise and Meehan 2004) is to be found in the trouble telecommunication industry had with wireless internet at the turn of the millennium. The wireless system nearly choked to death after its launch. Similar problems with 3rd generation networks are still haunting telecom carriers struggling to cope with their high investments (Bickers 2001;Hadden 2001;Quotient Communications 2001). The change from productivity tools to services and even entertainment has created the problems that we are trying to describe here. These systems include systems that are intended for use by customers and vendors and in which substantial value for external users is embedded in system features. We are referring to such systems as wide-audience information systems (WAIS) (Tuunanen, Peffers and Gengler 2004) and to users such as wide audience end-users. Our view is that this situation presents several problems not completely addressed in prior IS development literature. Consequently, the traditional methods of requirements gathering and analysis may no longer adequately support the development of these systems and new methods may be necessary to support requirements engineering for wide audience end-users (Tuunanen 2003;Tuunanen and Rossi 2004).

Figure 3 Elicitation methods for use with wide audience end-users (Tuunanen 2003)



The first phase of our study defined the research problem domain, more specifically, the key characteristics for the WAEU requirements elicitation technique. We found that the proposed two dimensions (reach and communication) did provide a useful starting point. During the research, it became evident that to meet our needs we had to consider a number of specific factors affecting the capabilities of the requirements elicitation technique. First of all, we should be able support multiple information sources with an economical data gathering technique. This would allow us to incorporate the views of a great number of people into the development process (Peffers, Gengler and Tuunanen 2003). We should also be able to support conveying the results of the data gathering to practitioners in a meaningful way (Peffers and Tuunanen 2005). In addition, the needs of data aggregation necessary for facilitating decision making should be paid attention to (Peffers, Gengler and Tuunanen 2003). According to the related literature, a solution can be found in consensus making between stakeholders. This in turn is linked to the presentation of requirements (Peffers and Tuunanen 2005). Daft and Lengel (1986) opened our eyes to using rich information to facilitate understanding of needs among different stakeholders, such as developers, project managers, end-users etc. Finally, when reviewing the contemporary RE literature, it was found that practitioners for some reason did not take advantage of the novel techniques (e.g. Chatzoglou and Macaulay 1996;Kujala 2003).

The ideas presented above culminated in Article III. By reviewing the literature, we extended Hickey and Davis's framework (2003) to include the categorization of requirements elicitation techniques by Nuseibeh and Easterbrook (2000). Secondly, we followed the recommendations of literature to include the communication aspect in the framework. This conceptual work is presented in Figure 3. First, it combines the three levels of reach: user representative, user groups, and user community (WAEU), with the analyst-developer team in the middle. Second, we have included the communication capabilities of the technique categories by using single and two-directional arrows. A single arrow depicts one-way communication and a double arrow two-way communication. As a result of the analysis, three possible technique categories were identified: group elicitation techniques, contextual techniques and cognitive techniques. We concentrated on gaining an understanding of the potential of one of the emerging techniques in the cognitive category[3]. These ideas were accumulated into a list of problem areas with Article IV. Based on the research done with Articles I, II, III and IV, we propose seven distinct problems associated with RE for WAEUs to be addressed by the techniques:

Context. The potential end-users may have little or no historical relationship with the firm, the product line, or the technology and hence may have little context in which to have views about desirable functionalities (Salaway 1987). This is particularly true when developers wish to design new applications with features hitherto unavailable (Peffers, Gengler and Tuunanen 2003). In such as situation, technology typically offers new possibilities to be exploited.

Reach. WAEUs are more costly to access for data collection than in-house users and are also likely to be unavailable for iterative or interactive consultation about their needs. Most of the techniques, well over hundred of them, that were reviewed during the research (Mathiassen, Saarinen, Tuunanen and Rossi 2004;Peffers, Gengler and Tuunanen 2003;Peffers and Tuunanen 2005;Tuunanen 2003;Tuunanen, Peffers and Gengler 2004) take it as granted that end-users are available and you have control over them.

[3] This research is reported in Articles II, III and IV (cf. section 5.2.)

Modeling. The character of the knowledge of end-users may differ from that of developers to such an extent that it is not easy for decision-makers to understand what end-users want or need, why they need these things, and what the importance of their preferences is (Watson and Frolick 1993). Although this not a new thing for practitioners or researchers, it must be emphasized due to the specific context and reach problems.

Model aggregation. The character of knowledge among the WAEU group may differ so much that it becomes difficult to aggregate their preferences to present a meaningful, combined view for decision-makers. When trying to understand the needs of a consumer segment, researchers usually conduct studies involving tens or hundreds individuals, e.g. within the marketing science (Kotler 1994). Researchers have argued for looking more specifically at what could be offered by the marketing science in this respect (Ravichandran and Rai 1999;Ravichandran and Rai 2000;Zultner 1993).

Presentation. Differences in perspective and culture between WAEUs and managers may make it difficult for managers to understand and evaluate WAEU data for making decisions about which features to incorporate and how to do it. According to the traditional view, top-down management can provide a solution for this (Shank, Boynton and Zmud 1985). However, Scandinavian IS researchers have taken another view (e.g. Bjerknes and Bratteteig 1995) and recommend involving and incorporating end-users into the development process to increase the success rates of projects. This creates a demand for presenting the information and communicating it to different stakeholders. Again, although this is not an uncommon problem to IS researchers (Barki, Rivard and Talbot 1993;Dennis, et al. 1988;Nunamaker, et al. 1991), it is highlighted by the physical, conceptual, and cultural distance between the developers and the would-be users.

Consensus making. Managers may lack the concepts and tools necessary for making the best decisions about features and attributes, the source of which, i.e. WAEUs, is external to the organization. The research literature offers various ways of reaching consensus (e.g. Davison and Briggs 2000;Herlea and Greenberg 1998;Linstone and Turoff 1975;Nunamaker, et al. 1991) and prioritizing requirements (e.g. Green and Krieger 2001;Herzwurm, Schockert and Pietsch 2003;Herzwurm, Schockert and Weinberger 1997;Johnson 1987;Laaksonen, Tuunanen and Rossi

2004;Ravichandran and Rai 1999;Ravichandran and Rai 2000;Zultner 1993). However, for the time being there is little literature available that connects this to a comprehensive approach (Tuunanen 2003).

Requirements-design interface. It may be hard to model the results of the requirements elicitation process in a form that permits WAEU views to be used effectively in the design process. In general, the requirements elicitation techniques are not widely used by practitioners (Chatzoglou and Macaulay 1996;Kujala 2003). To resolve this, RE researchers have been attempting to integrate the complex requirements elicitation techniques (Briggs and Gruenbacher 2002) into the traditional RE process and to create the RE documentation following the standards such as (IEEE 1999). Additionally, researchers have argued that users prefer tools that are embedded within the development environment (Ramesh and Jarke 2001). Hence, this is a problem not only related to the development of WAIS, but also to all complex RE techniques.

5.2. Constructing technique

The findings of research phase I suggest three potential requirements elicitation tactics for studying wide audience end-users. These findings are employed in the technique construction phase of the study. Our methodology suggested for us to seek creating an innovative artifact, a requirements elicitation technique, to evaluate if we have provided a feasible solution and to rigorous define our work. To accomplish this, we used an iterative theory building method, along with experiments and observations.

Cognitive techniques (cf. table 1) were chosen as the focus area, and, more specifically, critical success chains, which is one of the emerging techniques in this category (Peffers and Gengler 2003;Peffers, Gengler and Tuunanen 2003). The technique originates from IS planning and it has been further developed also to serve as a requirements elicitation technique. With Article I (Peffers, Gengler and Tuunanen 2003) we extended a well know IS planning technique, critical success factors (Rockart 1979), with laddering originating from marketing science (Gengler, Howard and Zolner 1995;Gengler, Mulvey and Oglethorpe 1999;Gengler and Reynolds 1995;Reynolds and Gutman 1988).

The second suggested dimension, communication, was addressed in Article II. As a result of a review of information richness literature, the concept of “rich enough” information for every stakeholder was found promising. Rich enough information would aim to deliver just the right amount of information for each of the stakeholders. For example, managers should not be overwhelmed with too detailed information about the requirements whereas developers would need a deeper understanding. These results were strengthened by an extensive review done in software engineering and requirements engineering in Article V (cf. Table 5). The review emphasized using three categories of requirements elicitation techniques (cognitive, contextual and group), which is in line with what was also suggested in Article III.

In total three empiric papers (Articles I, II and IV) resulted from the iterative process of trying to understand and develop a way to incorporate the external and diverse set of end-users into the development process, more specifically into requirements elicitation. Three further studies extended our understanding of how rich enough information could be used to facilitate communication between stakeholders.

5.2.1. Incorporating wide audience end-users

The research began in 2001 with a case study, reported in Article I, where the critical success chains (CSC) technique was used for planning innovative new 3rd generation mobile applications for the financial sector. This was the third time the critical success chains technique was used and the first time when an external researcher was used (the author).

The study used laddering (Browne, Curley and Benson 1997;Browne and Ramesh 2002;Browne and Rogich 2001;Reynolds and Gutman 1988) to elicit requirements from the participants like in the other two studies[4] conducted previously. Laddering is based on Kelly’s work in the 1930s and 1940s when he was working as a practicing psychologist (Kelly 1955) when he developed the Personal Construct Theory (PCT). He argued that by understanding how people see and understand the surrounding world, one can predict their behavior. He modeled how people saw the relationships between the different states of the universe, the consequences of those

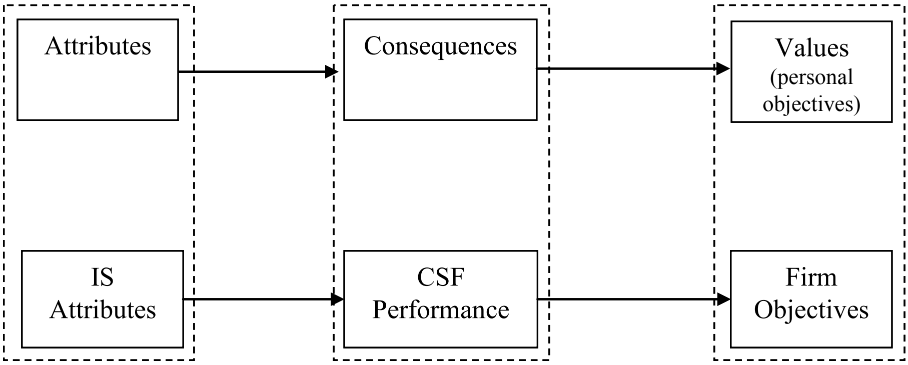
[4] The other two studies are reported in 131. Peffers, K. and C. Gengler, "How to Identify New High-Payoff Information Systems for the Organization," *Communications of the ACM*, 2003: 1, , 132. Peffers, K., C. Gengler and T. Tuunanen, "Extending Critical Success Factors Methodology to Facilitate Broadly Participative Information Systems Planning," *Journal of Management Information Systems*, 2003, 20: 1, pp. 51-85.

states, and the impact of those consequences on their individual values. Hence, by using laddering we can make implicit requirements more explicit and understand what the end-users essentially need (Tuunanen and Rossi 2004). This would make it possible to avoid context related problems. Later, a lot of work has been done within the marketing science to transform the elicited ladders to meaningful information for managers by using semantic maps and data clustering as a means of aggregating the information (Gengler, Klenosky and Mulvey 1995;Gengler, Howard and Zolner 1995;Gengler, Mulvey and Oglethorpe 1999;Gengler and Reynolds 1995).

To facilitate wide participation across the organization, critical success chains, as the name of technique indicates, adopted critical success factors (CSF) (Rockart 1979) as a way to insure that strategic needs were met. The objective was to extend the CSF model by studying the views of personnel at various levels in the organization (Peffers, Gengler and Tuunanen 2003). "Grass-roots level" users are viewed as an untapped reservoir of potential creativity that can be harnessed to support IT innovation in the firm. This is something that also Scandinavian IS researchers would agree on (Bansler and Kraft 1994;Bjerknes and Bratteteig 1995;Iivari and Lyytinen 1999;Kautz 2001;Kyng 1994).

Critical success factors are, by definition, expressed as performance consequences that are related to firm objectives (Rockart 1979). When managers use CSFs for planning, they implicitly use a three-element model of consequence that is similar to Personal Construct Theory. They assume that, if the firm develops a system with appropriate attributes, the use of this system will result in outcomes that are observable as changed CSF performance, which is, in turn, required to achieve important firm goals. The critical success chain refers to this linkage of IS attributes to CSF and to specific firm goals , as illustrated in Figure 4. It is an extension of the CSF model to incorporate the implicit importance relationships between attributes, CSFs, and firm goals.

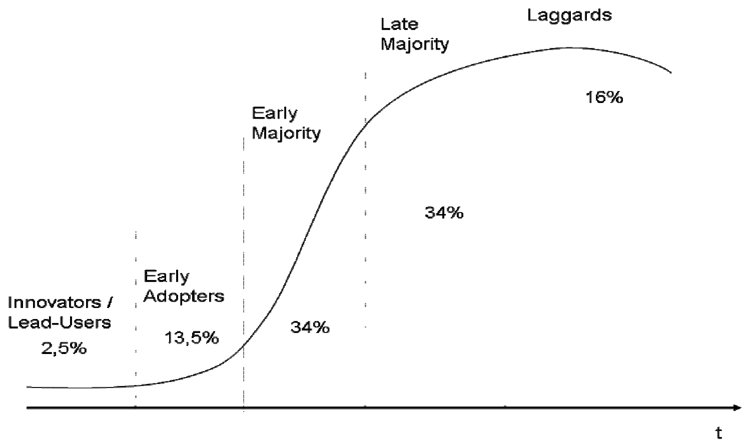
Figure 4 Personal constructs and critical success chains items



In Articles I, II and IV the author contributed to the process of extending the reach of critical success chains by using the lead users concept (Rogers 1976;Rogers 1995;von Hippel 1986;von Hippel 1998;von Hippel 2001;von Hippel and Katz 2002;von Hippel, Thomke and Sonnack 1999). The lead user concept is considered an appealing one in the current marketing science literature (Lüthje and Cornelius 2004;Morrison, Roberts and Midgley 2004). Researchers have presented that using lead users can lead to higher performance in product development (Lilien, et al. 2002). Originally, Rogers (1976;1995) has claimed that diffusion of innovation follows a pattern, which can be used to forecast the entire diffusion (cf. Figure 5). The key argument is that by recognizing what lead users demand from innovative products can lead to forecasts of what the masses desire. According to von Hippel (1986), lead users are users whose present strong needs are likely to become general in a marketplace in months or years in the future. Since lead users are familiar with the conditions, which lie in the future for most others, they can used as a need-forecasting laboratory.

However, how to choose the lead users for a study is rather a different problem and so far it has remained not completely answered (Lilien, et al. 2002). One approach has been using the so-called snowball-selection technique to recruit participants according to their knowledge (Olson and Bakke 2001). It is assumed that if we can initially find some lead users they can refer others. We found that some of our results were in line with those of Olson and Bakke (2001). These Norwegian researchers had found that recruiting works very well for one time occasions, but becomes more difficult later as it is not easy find new people. With our financial mobile application case we managed to achieve a 100% participation rate from the would-be-users. Later, with the newspaper case (Article IV) when the client did the recruiting, we run into similar problems as those reported by Olson and Bakke earlier.

Figure 5 Adopter categories (Tuunanen, Nielsen and Mallat 2003), modified from (Rogers 1995)



The selection technique of the participants provided us development opportunities. The practical results from the two cases strengthened our belief in using lead users as a tool to extend the *reach* of requirements elicitation techniques. In both case studies with real clients, the development requirements were met and even exceeded (Peffers and Tuunanen 2005;Tuunanen, Peffers and Gengler 2004). Similarly to this, the use of laddering to understand the voice of the customer (Griffin and Hauser 1993) seemed to prevent *context* oriented problems. The clients appeared to greatly value the provided requirements. In the first case, the CEO of the firm was highly satisfied with the results. However, what convinced us more of the value of our approach was the surprise given by the client company in the newspaper case. As the client went on to develop a 3-year product road map for their strategic e-commerce system based on our business report, it was apparent that we had made some progress with resolving the issues of *reach* and *context* (see Table 6) in the requirements elicitation of wide audience end-users.

5.2.2. Facilitating communication between stakeholders

In Articles II and IV, we mainly concentrated on facilitating communication, which is related to the issues of *modeling*, *model aggregation* and *presentation*, but also *consensus making* (cf. section 5.1.). With Article IV we also provide some initial findings on how the *requirements-design interface* problem could be approached. First, we summarize the theory development done in Article II, for which the author was acting as an equal co-author, with the first author leading the writing process. The author provided the basis for the theoretical work, also actively participating and contributing to the theory development. He was also the main contributor for reporting the empiric work, which had been conducted by him previously. The analysis was a joint effort.

We approach the issue of facilitating communication though information theory. Information can be characterized by two characteristics, *media richness* and *synchronicity,* as discussed earlier (cf. section 5.2.) (Daft and Lengel 1986;Dennis and Valacich 1999;Dennis, Valacich and Fuller 2002). These characteristics help managers to manage uncertainty and equivocality in the decision environment. The argument for using the concept of rich media has been that rich media helps managers to overcome equivocality through providing sufficient multidimensional clues to help them understand the essential meaning of complex and ambiguous messages. In Article II, we applied information richness to understand how we could enhance communication between different stakeholders. This process is described in Figure 4. Our framework is divided into three individual sections: *information theory, information processing needs for IS planning* and *how well critical success chains meet these demands*.

Dennis and Valacich (1999) have argued for an extension of the media richness theory, which they refer to as “media synchronicity.” The authors suggest that the use of information for any task can be characterized by two processes, *conveyance* and *convergence*. Conveyance refers to the process of transferring required information to the intended recipients as well as thinking about the meaning of messages. Information conveyance can result in divergent understanding as different actors independently interpret the incoming data about a problem. Convergence, in turn, refers to the process of developing shared understanding among actors about the meaning of the message. Meaningful action in any group requires that communication supports both conveyance of data and convergence of shared understanding. The conveyance of sufficient information is essential for individuals to reach correct conclusions and convergence is necessary for the group to act together (with synchronicity) and with a common understanding (Dennis, Valacich and Fuller 2002;Peffers and Tuunanen 2005).

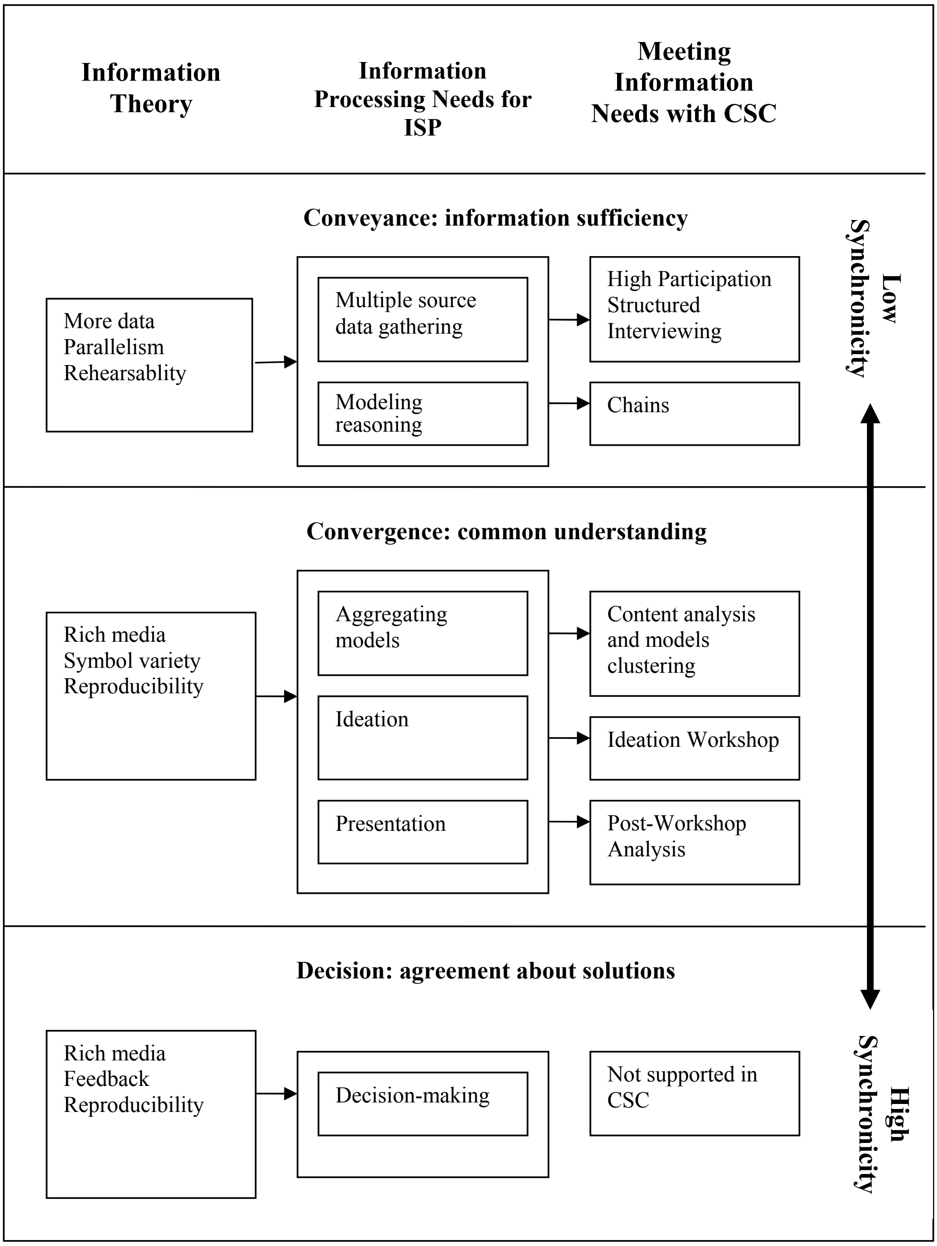
According to Dennis et al. (Dennis, et al. 1988;Dennis and Valacich 1999), media is characterized by five characteristics: 1) immediacy of feedback, 2) symbol variety, 3) parallelism, 4) rehearsability, and 5) reprocessability. First, immediacy of feedback affects the level of interaction among the participants in communication to the extent that bi-directional communication is fast. Second, symbol variety refers to the number of ways in which a given message may be coded. Greater symbol variety can help message recipients to better understand the meaning of the message because some information can better be coded in one format or another. It can also facilitate the process of coming to a common understanding about the meaning of the message. Third, parallelism refers to the ability of the media to carry multiple conversations simultaneously. Greater parallelism provides better support for the conveyance of sufficient information to support the decision tasks. Fourth, rehearsability refers to the extent to which an author can take time to prepare and edit a communication before sending it. Greater rehearsability slows down the communication but may make it more precise. Finally, reprocessability refers to the extent to which a communication sequence in the media can be observed multiple times and be stored for future reference. Higher levels of reprocessability may assist in convergence by acting as a memory for the group (Dennis, Valacich and Fuller 2002;Peffers and Tuunanen 2005).

In Figure 6, i.e. our framework, these five characteristics are connected for information processing needs for IS planning, as derived through the literature review and synthesis in Article II. We suggest that more data, parallelism and rehearsability should be linked to multiple information sources. Our technique supports this with an economical and structured interviewing technique, laddering and through modeling reasoning by expressing the results of the interviews as a series of feature-performance value chains (Peffers and Tuunanen 2005). Rich media, symbol variety and reproducibility, in turn, are connected to model aggregation, ideation and presentation. Model aggregation is supported by a clustering process resulting from aggregating individual chains to form case-specific semantic maps (Peffers, Gengler and Tuunanen 2003;Peffers and Tuunanen 2005;Tuunanen, Peffers and Gengler 2004). Feasible idea generation is supported by ideation workshops (Peffers, Gengler and Tuunanen 2003;Peffers and Tuunanen 2005). Idea presentation is catalyzed by ideation workshops that create the basis for transforming selected ideas into documents intended for decision makers and developers (post-workshop analysis). The requirements associated with decision making, involving the link to rich media, feedback and reproducibility, were not explicitly supported with the IS planning version of the technique (Articles II and III). This handicap was one of the focuses in our second case study (Article IV).

In Article IV, we collected the experiences with previous studies and constructed and field tested a new requirements elicitation technique, called wide audience requirements elicitation (WARE). The author contributed to the work by running the project, solely conducting the empiric work, playing a key role in the analysis and reporting the results to practitioners and academia. The focus was on extending the IS planning technique to requirements elicitation and providing preliminary results of its feasibility for the task. Secondly, as stated above, we sought to include features that would support *consensus making*, i.e. decision making, and the *requirements-design interface* (cf. section 5.1.) The constructed technique is presented in Table 6.

Table 6 illustrates the connections between the information processing needs for IS planning and the WAEU requirements elicitation characteristics outlined in section 5.1. These are then linked to the features of the WARE technique. From the table we can see that the extended critical success chains (Peffers and Tuunanen 2005) served as a basis for the new technique. Major theoretical work was done to improve the *consensus making* features and to provide an elementary way of feeding the requirements to design with a *requirements-design interface*. In the following, these two features are elaborated along with the reasons for not including ideation.

Figure 6 Study framework for meeting the needs of IS planning for rich information with critical success chains. (Peffers and Tuunanen 2005)



We advanced towards consensus making with three sub-features of the technique: workshop, ranking of requirements, and business report. These three contributed to the creation of a product road map for the e-commerce system. In the previous studies, the purpose of the workshop was to refine gathered ideas for post-workshop needs with the purpose of transforming these to firm-specific goals. In our second case with Helsingin Sanomat, the second biggest newspaper in the Nordic countries, we faced a situation were the potential user base was calculated not by thousands but by hundreds of thousands users in at least six different customer segments. This potential was revealed by the results of the data gathering. A total of 2566 distinct requirements were determined. The second reason for altering this feature was the fact that the software tool used for presenting and managing the requirements had been initially designed for data gathering, not for communicating of requirements. Hence, we felt that this opportunity should be used for familiarizing the project staff with the tool. The feedback from the workshop and later from the project management proved that this had been a good decision. With the workshop we were able to provide the means for the project staff to use our tool, which included three layers of information. However, we do not feel that ideation should be completely removed from information processing requirements for IS planning. Although we do not consider ideation a crucial factor for WAEU requirements elicitation, it is an important topic for future research.

The ranking of requirements had previously provided problems to us. The semantic maps do show any indication of the value of the different features by size or by the number of cases (Peffers, Gengler and Tuunanen 2003;Peffers and Tuunanen 2005), and this leaves the researcher with no means to suggest which features would be the most important from the perspective of the end-users. It was reasoned that by using a second set of would-be end-users and a web based survey we would be able to rank the requirements. This would, in turn, give us the means to prioritize the requirements according to the needs of the end-users. We used the so far unused lead users from the interview recruiting. We asked the survey participants to rank the requirements within each theme map. More specifically, the guideline was to rank the requirements within each feature subtheme. The themes included several subthemes of features, consequences and values/goals. We received 24 complete answers. These were analyzed by using descriptive statistics methods. We considered this as satisfactory for our needs. This pragmatic process gave us the tools to create a business report for our client. In our report, we provided the top 10 requirements with more specific details and also more generic lists of other requirements and ranking of the semantic maps (themes of requirements). The report also included our analysis of the situation along with our recommendations.

Table 6 Summary of information processing needs for ISP (Peffers and Tuunanen 2005), RE method requirements for features and attributes of value to WAEUs and the WARE technique (Tuunanen, Peffers and Gengler 2004).

Information Processing Needs for IS planning	Wide Audience End-User Requirements Elicitation Characteristics	WARE technique
Multiple source data gathering.	*Context.* Data gathering method that does not require users to understand firm or technology.	Laddering technique
	Reach. Data sufficiently rich so that interaction is not required. Data gathering economical	Wide participation of potential end-users
Modeling reasoning.	*Modeling.* Modeling user preferences and values flexibly.	Flexible modeling based on laddering
Model aggregation.	*Model aggregation.* Aggregating user ideas quickly and flexibly	Iterative clustering process to aggregate user models
Presentation.	*Presentation.* Enabling developers to easily examine data at different levels of aggregation.	Various levels of aggregation of information
Ideation.	n/a	n/a
Decision-making.	*Consensus making.* Supporting consensus reaching behavior.	Workshop, ranking of requirements, business report and roadmap generation.
	Requirements-design interface. Present models of new features and attributes in a semi-structured form useful for systems design.	Limited support by the presentation tool

The report proved to be a key element in client's communication between different stakeholders. The client's project manager used it for rationalizing the needs of the would-be-users to upper management and also down to developers. The report was widely used throughout the organization, carrying the name "Tuunanen's paper". Based on this document the client created a product road map for their strategic information system. The roadmap contains 59 features that are used for the three major versions of the system. 42 of the 59 features originate from our study. The time frame of the road map is 2003-2006 and the first version that we helped to build was put to production use in January 2004.

The *requirements-design interface* was supported by the constructed tool. The tool was implemented within a spreadsheet application to gather, present and manage requirements. It includes three layers of information designed as an initial means to provide rich enough information for each of the stakeholders. First, it includes a semantic maps of requirements themes to give an aggregated view. Second, the chains contain all the requirements in a feature-consequence-value/goal chain format. Third, the actual interviews are included in compressed audio format (MP3). With the developed tool, stakeholders are able to navigate with hyperlinks between these layers. This creates an elementary means to resolve the final problem of how to integrate novel state-of-the-art techniques into design work. Even though our tool still leaves a lot to be desired, it was widely used by the client's developers. As presumed, the developers were not interested in the abstract semantic maps, but mainly used the chain information and the interviews. Later, they complemented us for providing the DVD version of the tool that included all the data, including the interviews. Hence, in the end, our tool proved useful in facilitating the communication between the stakeholders.

5.2.3. The WARE technique

The process model of the constructed WARE technique is presented in Figure 7. In the following, the specific phases are described in more detail.

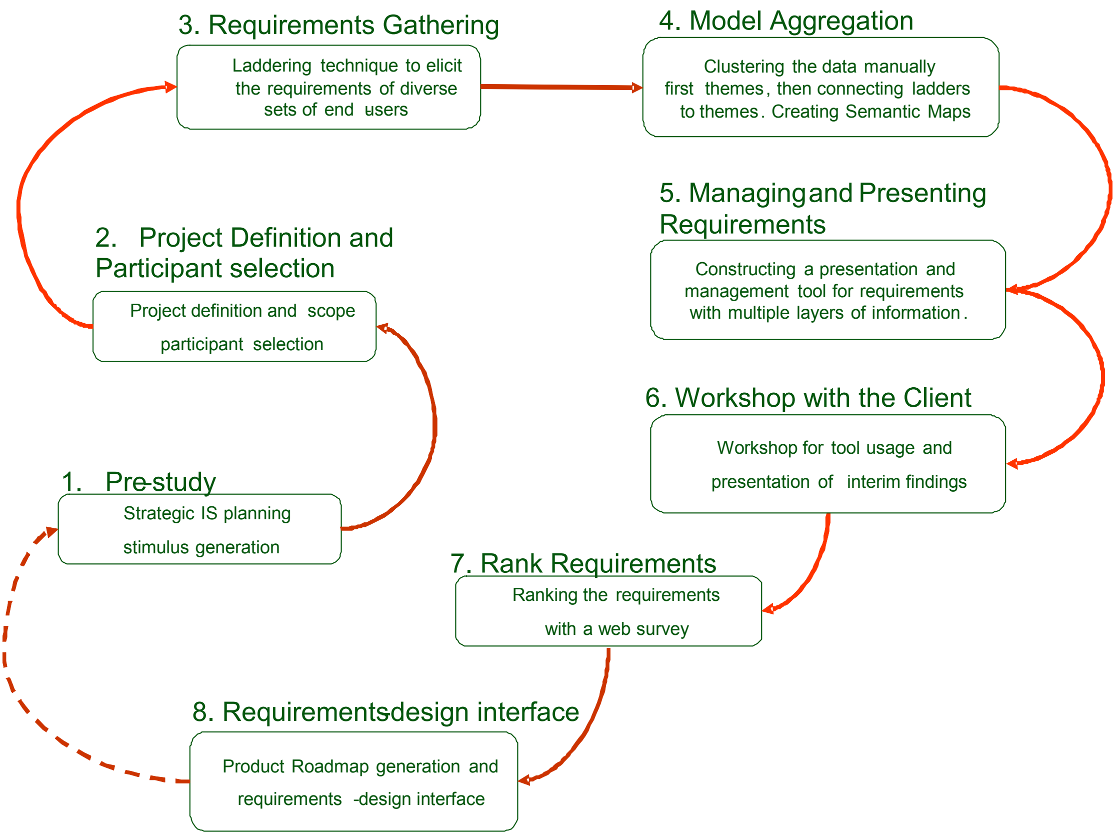
Phase 1 – pre-study. This phase should define the scope of the project and provide stimuli for the actual requirements gathering. WARE is a tactical method for requirements elicitation. Hence, it requires an initial input for the strategic planning level of the company. There are various methods that have been used for enhancing participation in IS planning and requirements analysis. Peffers and Tuunanen (2005) list a few of these as representatives for such methods: Delphi, focus groups, ETHICS, multiple criteria decision-making, and total quality management/quality function deployment.

Phase 2 - **Project definition and selection of participants**. We recommend beginning the data gathering process by identifying project participants. You will wish to interview approximately 30 people for this kind of project. Earlier research has suggested that a sample of such size is sufficient for gathering 90% or more of the potential ideas about a concept from a population (Griffin and Hauser 1993). The literature further recommends that the sample be representative of the end-user segments. We suggest that "lead users" should be included in the sample (cf. section 5.2.1.)

Phase 3 - Requirements gathering. We advise interviewing each of the participants individually and in-person. During the interviews, the interviewer should make digital audio recordings and take notes with an electronic spreadsheet application or using pen and paper. The use of a spreadsheet may decrease the time spent in rewriting, while the pen and paper approach can be more flexible. The interviews should be done by using the laddering method (cf. section 5.2.1.). Participants are presented with a list of the stimuli provided by the phase 1 and asked to rank order them in terms of their importance to them. Then, one at a time, for the two highest ranked stimuli, the interviewer asks the participant to describe a feature that would be important to him/her. This is followed by asking the subject to explain why that particular feature is important, so as to elicit the consequences that the participant expects from the feature. The interviewing process continues with a series of further "why would that be important?" questions to elicit what the subject expects as an end result from the features and consequences, i.e. as values or objectives for the chain. To elicit more concrete system attributes, we recommend asking a series of questions in the lines of "what would there be about the system that would make you think that it would do that?" This data is recorded in the notes as a series of chains directly to spreadsheet or first as paper sketches and then on a spreadsheet, depending on the preference of the analyst. Examples of ladders can be found in Articles III and IV.

Phase 4 - Model aggregation. The data may easily contain hundreds or even thousands of distinct statements, requirements, and it would be difficult, if not impossible, for decision makers and designers to interpret these directly. The data has to be aggregated to produce a meaningful, and smaller, set of rich, unified and aggregated models, which makes it easier for managers and designers to comprehend the data. It is , however, important to preserve the integrity of the individual chains because they represented the reasoning of each individual or "the voice of the customer" (Griffin and Hauser 1993) . To accomplish this we recommend the following procedure. Cluster the chains qualitatively into *themes* without breaking them up, i.e., without clustering any of the individual statements from a particular chain into different clusters. The objective is to create an aggregated top layer representation of participant models, i.e. theme maps (cf. Article IV). The analysts – it is recommended to use two or more persons to avoid analyst bias – should then discuss the elicited chains and determine a limited set of conceptual themes that would capture all of the chains. The themes should represent different kinds of user needs. The next step is to arrange the individual chains into the themes. To avoid analyst bias, it is recommended that analysts work independently and then go through the chains together to resolve any differences by consensus.

Figure 7 The WARE process model



Phase 5 - Presentation and management of requirements. The aggregated data can be used for creating network maps. This is done by transforming the clustered chains in each theme into a network map. These maps contain features (attributes) and reasons for which these were deemed necessary or interesting by the interviewees (consequences) along with goals or values driving the customers. Next, the chains should be examined in each of the themes to determine, iteratively, what subthemes could be found in them. Subthemes should be determined by consensus. The process should finish with developing graphical network maps through rounds of sketches. The network maps can implemented as the first level in an electronic spreadsheet-based presentation tool. Our tool links network maps to individual chains to allow the user to drill down from a map to the individual chains from which it has been constructed. From the chains you can further drill down and listen to the original interviews, i.e., recorded segments of the original participant statements. The high level network models, individual chains, and audio recordings can be implemented together in an electronic spreadsheet and packaged on a DVD for use by decision makers and designers.

Phase 6 - workshop. We use the presentation tool to facilitate consensus reaching activities by a manager/developer workshop and a post-elicitation user survey (phase 7). The objective of the workshop is to familiarize the development team with the presentation tool so they can learn how to use it to obtain rich information of user needs along with the consequences and values or goals driving these needs.

Phase 7 - Ranking requirements. The data collection, analysis and presentation tool provides managers and developers rich information about customer preferences and reasoning, but not so much about the relative importance of gathered ideas. This issue can be addressed by conducting a survey of potential customers to determine the relative value of the requirements items and, secondarily, to validate the collected data. We recommend using an independent sample of about 30 people, identified using the same criteria as for the interviewees. The survey instrument can be constructed by using subthemes for each of the themes. The participants are advised to rank value each attribute in each subtheme from most important to least. This approach enables an easy generation of values for each of the themes and also individual values for the attributes by using descriptive statistics.

Phase 8 - Requirements-design interface. Based on the results of study, the analyst should be able to provide an analysis of the situation and describe the needs, requirements, in a business report. The report can, for example, give recommendations for focusing resources on developing features mentioned in the top ten features list and among the top ranked themes. The analyst(s) should point out the features and themes that are most valued by the customers. This information should then be used independently by the client or with the help of the analyst(s) to create a roadmap for the system. The roadmap should contain feature release milestones, which describe features, priorities, and development schedules for a defined period of time. Furthermore, the use of the presentation tool should be encouraged across the project team to facilitate communication across different stakeholders.

The technique construction phase of the study was rounded off by the presentation of the constructed artifact. For the final phase, we return to theorizing and try to understand when to use the WARE technique among others available. In the following section, the results gained in creating an innovative model for selecting techniques are presented.

5.3. Iterative and dynamic use of requirements elicitation techniques

During the iterative process of technique development (Articles I, II, III and IV) we realized that our technique was just one tool that could be used when addressing the myriad of problems related to requirements elicitation. Furthermore, there were also a number of other techniques for reaching end users and facilitating communication available, also for reaching and understanding wide audience end-users (Mathiassen, Saarinen, Tuunanen and Rossi 2004;Tuunanen 2003). Undeniably, the plethora of available techniques is overwhelming. In all our material, we encountered well over one hundred different techniques. The review makes no claim of being complete, as is also suggested by the findings of Chatzoglou and Macaulay (1996).

In Article V, the objective was to find out if risk management literature (cf. section 3.3.) could provide assistance in how to select the most appropriate techniques for different IS development projects. The requirements for methodology were the same as in the technique construction phase. The aim was to create an innovative artifact, to evaluate it, to provide information of its efficiency or innovativeness and, finally, to rigorously define it and conduct the research. The author contributed to the research by developing a method for selecting literature, by selecting and managing the literature and by making key contributions to the analysis and synthesis of the literature.

The resulting artifact of Article V, a model for managing requirements engineering risks, is based on a comprehensive review of relevant literature (cf. Table 5). Through a rigorous selection process, we ended up with 91 articles in top-ranked IS and SE academic journals. The journals were selected by using two of the latest studies in the two fields of literature (Katerattanakul, Han and Hong 2003;Peffers and Tang 2003). The selected articles were analyzed and synthesized to present a theoretical model for managing requirements engineering risks. The analysis was divided into three sections elaborating *understanding risks*, *techniques* and *principles* related to the first two themes. Thus, the synthesis places our requirements elicitation technique in the pool of techniques currently available for conducting requirements engineering. In the following section, the analysis is summarized and the results of the synthesis presented.

5.3.1. Understanding risks, techniques and principles

The reviewed literature suggests three possible sources of risks associated with requirements engineering. First, **requirements complexity,** which has been seen as a key risk in IS development and requirements engineering. It refers to the amount and structure of the information that is available for designing new software (Mathiassen, Saarinen, Tuunanen and Rossi 2004). The more information is available and the more unstructured it is, the higher the complexity (Mathiassen, Seewaldt and Stage 1995).

Requirements reliability, in turn, refers to the dynamics of information about the new information system. Such dynamics occur, e.g., when the involved stakeholders change perceptions due to them learning during the development process or when the internal or external conditions for using the software change (Mathiassen, Saarinen, Tuunanen and Rossi 2004). An additional source of reliability risks is to be found in the fact that end-user needs are seldom evident to developers (Houston, Mackulak and Collofello 2001;Kraut and Streeter 1995;Nidumolu 1995;Willcocks and Margetts 1994).

Finally, **requirements availability** refers to the communication gap between developers and end-users, which has been growing wider as more and more business applications target users are external to the organization (Barki, Rivard and Talbot 1993;Dennis, et al. 1988;Nunamaker, et al. 1991;Tuunanen 2003), like in the case of WAEUs. The related literature points out problems in how to identify and reach external users (Hirschheim and Newman 1991;Keil and Carmel 1995;Tuunanen 2003). Additionally, Salaway (1987) has presented that it is often more problematic to communicate with external users than with internal ones. These factors increase the risks related to the availability of information about requirements and emphasize the need for communication between stakeholders (Curtis, Kellner and Over 1992;Curtis, Krasner and Iscoe 1988;Davidson 2002;Keil and Carmel 1995;Tuunanen 2003) and the involvement of different groups of users in IS development (Bostrom 1977;Bostrom 1989;Elboushi and Sherif 1997;Tuunanen 2003).

Based on these three sources of risks, we analyzed the literature to gain a better understanding of the techniques. The literature review included nearly one hundred different techniques (cf. Article V). The analysis of the literature pointed towards using specific tactics for addressing the recognized risks. The analysis is presented in Table 7 with example techniques. The analysis suggests that complexity could be resolved with requirements specification tactics, reliability with experimentation, and availability with discovery tactics. In the following, a more detailed account of these is given.

Specification tactics are characterized by *formal* techniques, like CREWS (Haumer, Pohl and Weidenhaupt 1998), KAOS (van Lamsweerde and Letier 2000) and Z (Liu, et al. 1998). These techniques are highly syntax oriented and provide rigorous ways of specifying requirements. The second subgroup of specification is *pragmatic* techniques. These can be defined as techniques focusing on acquiring information from end-users, studying existing systems, and developing graphical representations of requirements. Pragmatic techniques adopt natural language as the basic means for defining semantics (Mathiassen, Saarinen, Tuunanen and Rossi 2004). Prominent examples of such techniques are to be found in entity-relationship modeling (Haumer, Pohl and Weidenhaupt 1998;Pedersen, Jensen and Dyreson 2001) and data flow diagramming (Larsen and Naumann 1992;Marakas and Elam 1998;Ramesh and Browne 1999). The third is group of specification tactics is *combined* techniques. These combine the techniques of the first two groups. Atypical example is scenario-based requirements elicitation (Haumer, Pohl and Weidenhaupt 1998).

The second distinct category of tactics is **requirements experimentation**. According to our analysis, these techniques can efficiently be used for resolving reliability risks. We found two types of requirements experimentation techniques in the selected literature. First, there are *iteration* techniques that facilitate learning based on specifications, prototypes, and preliminary versions of software modules. Prototyping is a prime example for this. Prototyping can help developers receive direct feedback from users (Davis 1982;Keil and Carmel 1995;Lyytinen 1987;Watson and Frolick 1993). The second type of requirements experimentation comprises *collaboration* techniques that involve end-users in the development process (Kujala 2003). The objective of these techniques is to make end-user knowledge and experience directly influence requirements engineering activities (Duggan and Thachenkary 2004;Kujala 2003). Joint Application Design (Andrews 1991;Wetherbe 1991) exemplifies this technique.

Table 7 Classifications of requirements engineering techniques with examples

Tactics	Technique Examples
Requirements Specification	Formal techniques, e.g. CREWS (Haumer, Pohl and Weidenhaupt 1998), KAOS (van Lamsweerde and Letier 2000) and Z (Liu, et al. 1998)
	Combined techniques, e.g. scenario-based requirements elicitation (Haumer, Pohl and Weidenhaupt 1998)
	Pragmatic techniques, e.g. entity-relationship modeling (Haumer, Pohl and Weidenhaupt 1998;Pedersen, Jensen and Dyreson 2001) and data flow diagramming (Larsen and Naumann 1992;Marakas and Elam 1998;Ramesh and Browne 1999)
Requirements Experimentation	Iteration techniques, e.g. Prototyping (Davis 1982;Keil and Carmel 1995;Lyytinen 1987;Watson and Frolick 1993).
	Collaboration techniques, e.g. Joint Application Design (Andrews 1991;Wetherbe 1991)
Requirements Discovery	Cognitive techniques, e.g. quality function deployment (Pai 2002;Ravichandran and Rai 1999;Ravichandran and Rai 2000;Zultner 1993), laddering (Browne and Ramesh 2002;Browne and Rogich 2001;Davidson 2002), and **WARE** (Tuunanen, Peffers and Gengler 2004)
	Group techniques, e.g. focus group interviews (Leifera, Leeb and Durgeea 1994;Telem 1988) and Group Support Systems (Chen and Nunamaker 1991;Duggan 2003;Duggan and Thachenkary 2004;Liou and Chen 1993)
	Observation techniques, e.g. Contextual Design (Holtzblatt 1995;Jones, Candy and Edmonds 1993)

The third group of tactics is **requirements discovery**. Our analysis shows that this group includes three distinct types of technique for connecting internal and external end-users, i.e. wide audience end-users, to the development team to help discover requirements. First, *cognitive* techniques focus on listening to and understanding the voice of the customer or other user groups. These are inspired by various approaches in marketing science, like quality function deployment (Pai 2002;Ravichandran and Rai 1999;Ravichandran and Rai 2000;Zultner 1993) and laddering (Browne and Ramesh 2002;Browne and Rogich 2001;Davidson 2002). Hence, the WARE technique could be categorized as a cognitive technique as well. Second, *group* techniques, like focus group interviews (Leifera, Leeb and Durgeea 1994;Telem 1988) and Group Support Systems (Chen and Nunamaker 1991;Duggan 2003;Duggan and Thachenkary 2004;Liou and Chen 1993), have been suggested to take advantage of group dynamics in discovering requirements. Third, *observation* techniques help discover requirements by having end-users explain or demonstrate their work process in the specific context. Contextual design (Holtzblatt 1995;Jones, Candy and Edmonds 1993) is a contemporary example of discovering requirements by observing end-users while they work on a day-to-day basis. This technique simultaneously addresses the problem of reaching individual users and understanding the context of use. The discovery tactics reflect the findings of Article I, which suggest these three types as potential tactics for meeting the needs of wide audience requirements elicitation. The three resolution tactics described above are summarized under *resolution principle* in Table 8.

Understanding how to resolve specific risks does not, however, automatically provide us with an adequate understanding of how to combine the different techniques in response to the overall risk profile or on how to adjust tactics during requirements engineering practices. As a solution for this, the reviewed literature offered contingency models (Alter and Ginzberg 1978;Davis 1982;Mathiassen, Seewaldt and Stage 1995;Mathiassen and Stage 1992;McFarlan 1982). These provide suggestions for how to address different levels of risks by using specific resolution tactics. The findings of the literature analysis were used as a basis for the *prioritizing principle*, which is generalized in the following. We advocate that discovery tactics should generally be first used to emphasize reach and communication. Experimentation tactics should then be used to resolve reliability issues concerning requirements. Finally, when the requirements have been established, specification tactics should be used (Mathiassen, Saarinen, Tuunanen and Rossi 2004).

Table 8 Principles for managing requirements engineering risks

Resolution Principle	Prioritizing Principle	Interaction Principle
The tactics of requirements engineering resolve risks as follows: 1. Requirements complexity is resolved by specification tactics including formal, combined, and pragmatic techniques. 2. Requirements reliability is resolved by experimentation tactics including iteration and collaboration techniques. 3. Requirements availability is resolved by discovery tactics that connect relevant stakeholders through cognitive, group, and observation techniques.	The primary focus on requirements engineering risks and tactics should gradually change as follows: 1. Requirements availability through discovery 2. Requirements reliability through experimentation 3. Requirements complexity through specification	Adoption of a requirements engineering tactic may require adoption of compensating tactics to offset any adverse effect on other risks than the ones targeted by the tactic.

Finally, it was recommended in the literature that the risk profiles should be continuously assessed to monitor how different risks interact as they are addressed and as the project evolves (Chen and Chou 1999;Lyytinen, Mathiassen and Ropponen 1996;McFarlan 1982;Quintas 1994). Therefore, we should include continuous sense-and-respond activities in which risk profiles are updated and the portfolio of adopted techniques is modified or changed (Lyytinen, Mathiassen and Ropponen 1996). Mathiassen et al. (1995) claim that we often cannot reduce one source of risk without affecting other sources. In addition, they argue that reducing uncertainty risks through experimentation generates additional information and hence increases complexity related risks (and visa versa with respect to specification tactics for reducing complexity risks)[5]. The consequence of this is that risks should be addressed systemically as adoption of certain tactics might require adoption of complementary tactics to address adverse effects. For this reason, we put forward as an *interaction principle* that the adoption of a requirements engineering tactic may require adoption

[5] The Principline of Limited Reduction, 114. Mathiassen, L. and J. Stage, "The Principle of Limited Reduction in Software Design," *Information, Technology and People*, 1992, 6: 2,

of compensating tactics to offset any adverse effects on other risks than the ones targeted by the tactic.

5.3.2. Synthesis - model for managing requirements engineering risks

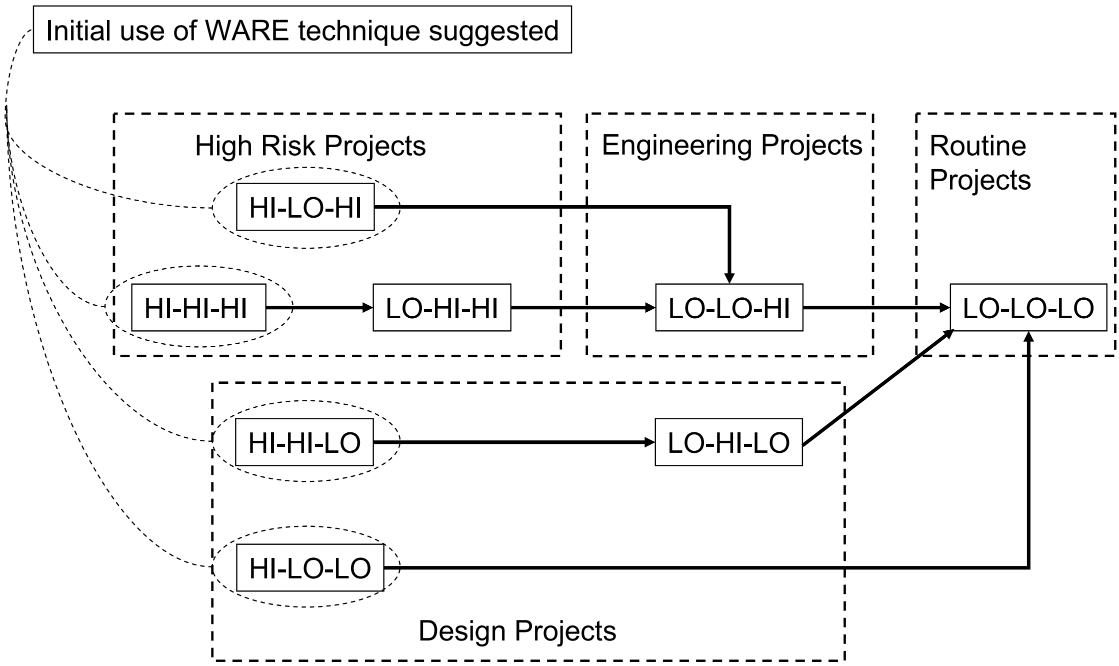
After the analysis we followed Iivari's (1992) framework for building contingency models based on insights from organization theory (Kickert 1983;Van de Ven and Drazin 1985). Furthermore, the current contingency models for managing software risks (Alter and Ginzberg 1978;Davis 1982;Mathiassen and Stage 1992;McFarlan 1981;McFarlan 1982) provided additional support for synthesizing the findings from the literature analysis. Iversen et al. (2004) provided us with further assistance, in form of the four types of contingency models identified by the authors. First, there are risk lists (e.g. Barki, Rivard and Talbot 1993) that contain generic risk items (often prioritized) to help managers focus on possible sources of risk. Second, there are risk-action lists (e.g. Boehm 1991). These models contain generic risk items, each with one or more related risk resolution techniques. Third, there are risk-strategy models (e.g. McFarlan 1982) that relate to an overall strategy for addressing the project risk profile. These models combine broad lists of risks and resolution techniques with abstract categories of risks and abstract techniques. The risk profile is assessed along the risk categories (e.g., into high or low), making it possible to classify the project as being in one of a few possible situations (Mathiassen, Saarinen, Tuunanen and Rossi 2004). For each situation, the model offers a dedicated risk strategy that combines several abstract techniques. Finally, there are risk-strategy analysis approaches (e.g. Davis 1982). These approaches are similar to risk-strategy models as they offer both detailed and aggregated view to risk identification and resolution techniques, while applying different heuristics. We found that there is no contingency model available that would link aggregate risks to aggregate resolution techniques (Hickey and Davis 2004). Instead, these approaches offer a stepwise process in which risks are identified and linked to techniques to form an overall risk management strategy (Mathiassen, Saarinen, Tuunanen and Rossi 2004).

Our synthesis adopted McFarlan's (1982) risk-strategy model as a basic template for our model. McFarlan's model (1982) distinguishes between three types of software development risks: 1) size of project, 2) experience with technology, 3) understanding of task. In addition, it suggests assessing each risk using a high-low scale, and it presents four basic tactics to resolve risks. The model leads to 2^3=8 distinct project situations and provides recommendations for each of them with a specific combination of tactics to effectively resolve risks. The model can be used repeatedly over the project life-cycle as the risk profile of a project changes.

We implemented a high-low scale for assessing complexity, reliability, and availability risks. This led to 2^3=8 different types of requirements engineering situations. Figure 8 illustrates the resulting archetypical situations and how they relate to each other as risks are resolved according to the prioritizing principle. Each situation is characterized by availability-reliability-complexity risks (HI=high; LO=low). Based on the characteristics of the eight situations and the relationships between them, we propose to distinguish between four types of projects: *high-risk projects*, *engineering projects*, *design projects*, and *routine projects* (cf. Figure 8) (Mathiassen, Saarinen, Tuunanen and Rossi 2004). In the following, each of these is briefly reviewed, along with the risk profiles characterizing them, and recommendations are presented for requirements engineering tactics for addressing risks. Furthermore, we suggest four situations in which the WARE technique may provide aid in understanding the needs and desires of wide audience end-users. Finally, the resulting contingency model is summarized in Table 9.

High risk projects. These projects face complex requirements while at the same time having to deal with difficult issues related to the availability and reliability of relevant information. In our view, this is a typical situation for wide audience information system and includes two of the suggested situations. *First*, there are the projects characterized as HI-HI-HI (type 1 in Table 9). They should mainly focus on requirements discovery tactics to ensure strong connections to would-be-users, and on the context in which they operate. At the same time, these projects should employ moderate levels of experimentation and specification tactics from the outset, so as to help capture and assess information about requirements as it is discovered. The *second* suggested target for using WARE, and discovery tactics in general, are projects that are assessed as HI-LO-HI (type 2 in Table 9). These differ from the previous group in that the requirements can be highly reliable. Therefore, they only need complementary specification tactics (iteration and collaboration techniques) to help capture information as it is discovered. Finally, projects that are assessed as LO-HI-HI (type 3 in Table 9) have requirements available and they should mainly focus on experimentation tactics to ensure reliable requirements. In addition, we recommend that they should adopt complementary specification tactics for document requirements as these are suggested and validated.

Figure 8 Four situations where initial use of WARE is suggested, modified from (Mathiassen, Saarinen, Tuunanen and Rossi 2004)



Engineering projects. These projects are characterized by a complex set of reliable requirements. The available requirements reflect end-user needs and they are relatively stable. These are typically projects assessed as LO-LO-HI (type 4 in Table 9). We present that these projects can afford to focus mainly on specification tactics.

Design projects. These projects face relatively simple requirements, but there are serious risks involved that are related to the availability and reliability of information about requirements. The key challenge in these projects is to design a viable solution. Such projects should identify and validate requirements through interaction with would-be-users and the context area. Two of the situations may require the use of the WARE technique or some other discovery technique. There is also a *third* group of projects that can be assessed as HI-HI-LO (type 5 in Table 9). These projects should also adopt complementary experimentation tactics to help validate requirements. The *fourth* and final situations for using discovery tactics are projects assessed as HI-LO-LO (type 6 in Table 9). They should proceed in a similar fashion, except that they need not concentrate on the reliability of requirements. Lastly, there are projects that are assessed as LO-HI-LO (type 7 in Table 9), having access to relevant information about requirements, while the information is highly unreliable. These projects should emphasize experimentation tactics in order to stabilize the requirements.

Routine projects. Routine projects are assessed as LO-LO-LO (type 8 in Table 9). Requirements are available and stable, and the IS development team understands them well and knows from previous experience how to design and develop IS to meet the requirements. With routine projects a straightforward approach can be adopted to develop the information systems.

The distinctions and logic in Figure 8 expresses a synthesis of the key findings of Article V. Furthermore, it suggests four specific situations in which the WARE technique could be used. This synthesis provides the rationale for the contingency model summarized in Table 9. In the model, the risk levels are expressed using the high-low scale and the degree to which individual tactics should be emphasized in designing a comprehensive strategy for risk resolution is expressed using a weak-medium-strong scale.

Table 9 Managing requirements engineering risks, slightly modified from (Mathiassen, Saarinen, Tuunanen and Rossi 2004)

	Availability	Reliability	Complexity	Discovery	Experimentation	Specification
1	High	High	High	Strong	Medium	Medium
2	High	Low	High	Strong	Weak	Medium
3	Low	High	High	Weak	Strong	Medium
4	Low	Low	High	Weak	Weak	Strong
5	High	High	Low	Strong	Medium	Weak
6	High	Low	Low	Strong	Weak	Weak
7	Low	High	Low	Weak	Strong	Weak
8	Low	Low	Low	Weak	Weak	Weak

5.4. Summary of findings

We consider our findings to be threefold. Initially, we recognize seven key characteristics for a requirements elicitation technique used for understanding the needs of wide audience end-users. First of all, there is a need to reach the external end-users who are often not experts in the context of technology or firm. Furthermore, we advocate facilitating the communication between the different stakeholders within the IS development project. We suggest that modeling requirements according to end-user preference is a key issue. We should also be able to easily aggregate requirements in order to support the presentation of requirements. The adopted strategies should also support consensus making. As a final point, we should make an attempt at integrating the technique into design practice.

The main emphasis of the empiric work done was on implementing the above requirements in practice. For this, we constructed a new requirements elicitation technique called "wide audience requirements elicitation" (WARE). We extended the IS planning technique to facilitate eliciting WAEU requirements by incorporating external end-users into IS development and facilitating communication between different stakeholders. We present that by using the WARE technique we can adequately understand the needs and desires of WAEUs and support decision making in the developing organization. To support this claim, we present the preliminary results from two case studies with real clients: Digia, Inc. and Helsingin Sanomat.

In conclusion, we recognized that there was an abundance of requirements elicitation techniques available to practitioners. To rationalize and to provide suggestions for when to use WARE, we recognized the need to understand in what kind of situations we should consider using it. For this purpose, we present a theoretical model for managing requirements engineering risks derived through analysis and synthesis of literature. The model provides means for choosing adequate resolution tactics in different project situations and for prioritizing the use of techniques, while also suggesting how the compensation of techniques may affect project dynamics. We distinguish four specific situations in which we should consider using the WARE technique. Hence, we have theorized what are the needs practitioners are likely to have to address when developing IS for WAEUs and constructed a technique to meet these demands. Finally, our model for managing requirements engineering risks provides suggestions and insight into how to use WARE and other techniques in contemporary IS development.

One of the goals set in the beginning of the fifth section was to follow the selected research methodology to present the results. In the next section, we assess how well we succeeded in meeting these requirements.

6. Discussion and conclusion

In the following, the results of the three distinct research phases are first discussed, using our methodology requirements as lenses. Then the findings are summarized. The suggested contributions of the study for academics and practitioners alike are then presented and the limitations of the study recognized. The thesis is concluded by presenting suggestions for future research.

6.1. Discussion

We found two gaps in the related literature. These gaps were the motivator for forming the main research question of thesis: *How should requirements elicitation be handled when the developed system is targeted to wide audience end-users?* We elaborated this with three specific research questions. First, we presented that there was a shortage of understanding the key characteristics of requirements elicitation for wide audience end-users, and set up specific research questions 1. Second, we questioned how we could incorporate wide audience end-users into the development process and facilitate communication between the stakeholders of the IS project. Finally, we recognized that we should gain a better understanding of when we should use the different requirements elicitation techniques, including WARE, in different IS development projects.

In the following, we discuss how we have been able to provide answers to the specific research questions. This review has been structured according to the selected research methodology (cf. section 4.) In this way, we can evaluate to which extent the whole research process can be characterized as an iterative process of theory building that aims to provide meaningful results for both academia and practitioners. For this purpose, the specific research phases are first assessed according to the selected criteria (cf. Table 10) and then the implications of findings are discussed. Finally, a summary is presented along with a review of how well we have been able meet the general methodology requirements presented above.

Table 10 Meeting specific methodology requirements within research phases

Specific Methodology Requirements / Research Phases	Creation of Artifact (R1)	Define Problem Area (R2)	Evaluation of Artifact (R3)	Efficient or/and Innovative (R4)	Rigor (R5)
Phase I – defining research problem area	n/a	√	n/a	n/a	n/a
Phase II – technique construction	√	n/a	Limited Support	Limited Support	√
Phase III – recapping	√	n/a	Not Accomplished	√	√

6.1.1. Defining research problem area

Meeting the first specific methodology requirement and defining the research problem area (R2), i.e. understanding the key characteristics WAEU elicitation technique, was not as easy a task as we had presumed. Articles I and II provided for the foundation of the study by suggesting for us to extend the reach of the techniques and to create a strategy for improving communication between stakeholders. Article III builds on these, putting forward the idea of dimensions of reach and communication in selecting requirements elicitation techniques. Extending the reach of techniques has been a topic in the IS discipline even before this endeavor (Bostrom 1977;Bostrom 1989;Elboushi and Sherif 1997;Hirschheim and Newman 1991;Keil and Carmel 1995;Salaway 1987). Improving communication within IS development work is hardly a new idea either; several researchers have argued for this issue (Curtis, Kellner and Over 1992;Curtis, Krasner and Iscoe 1988;Davidson 2002;Keil and Carmel 1995). The two issues, reach and communication, were subsequently fused together in Article V as *availability of requirements*, which, in our view, manages to define the problem slightly better.

With our empiric work (Articles I, II and IV), we focused on the issue of communication and reach and reviewed literature in an attempt to derive solutions for discovering requirements, i.e. extending participation and facilitating communication between internal and external stakeholders. We were stimulated by the participative research done in Scandinavia (e.g. Bansler and Kraft 1994;Bjerknes and Bratteteig 1995;Grudin 1991;Iivari and Lyytinen 1999;Kautz 2001;Kyng 1994). Scandinavian researchers have been promoting active participation of stakeholders for decades. This is not a very different view from what Segars and Grover (1999), arguing that for IS planning to be effective, it must be both strategic in focus and highly participative. In addition, the work done with information richness to facilitate communication (e.g. Daft and Lengel 1986;Dennis and Valacich 1999;Dennis, Valacich and Fuller 2002) proved highly valuable, also providing new ideas about how to continue. With Article IV we suggest seven problems that characterize our view of how we can approach eliciting the needs of wide audience end-users. With these seven problem areas, we suggest to define the research problem area and to meet methodology requirement R2. We endeavored to address these needs (specific research question 2) with our empiric work elaborated in the next section.

6.1.2. Technique construction

According to the methodology requirements, the construction phase of the study calls for creating an innovative artifact (R1) that should be evaluated (R3) to see if it is more efficient or innovative than previously offered solutions (R4). Furthermore, the artifact should be rigorously defined and represented (R5).

Our research was guided by the findings from the first research phase. These initially promoted tackling the *context* and *reach* related issues in order to create a competent and innovative artifact, a requirements elicitation technique for wide audience end-users. We chose the laddering technique (Browne and Ramesh 2002;Browne and Rogich 2001;Gengler, Klenosky and Mulvey 1995;Gengler and Reynolds 1995;Reynolds and Gutman 1988) and the lead-user concept (Rogers 1995;von Hippel 1986) for addressing these needs. The use of laddering to overcome the problems of end-users not understanding their needs (Walz, Elam and Curtis 1993;Watson and Frolick 1993) seems fruitful when assessed through our empiric findings. Other IS researchers have also been promoting the use of laddering in requirements elicitation recently (Chiu 2005). The use of the lead-user concept has been considered valuable (Lilien, et al. 2002), while its implementation has proven to be tiresome (Olson and Bakke 2001).

The issue of facilitating communication between stakeholders was approached with five distinct problems: *modeling*, *model aggregation* and *presentation*, *consensus making* and *requirements-design interface.* Our research was first guided by the work done in the marketing science to understand how advertisement affects people (Gengler, Klenosky and Mulvey 1995;Gengler, Howard and Zolner 1995;Gengler, Mulvey and Oglethorpe 1999;Gengler and Reynolds 1995) and later by the information richness debate within IS (e.g. Daft and Lengel 1986;Dennis and Valacich 1999;Dennis, Valacich and Fuller 2002). We suggest that the use of laddering and clustering as an aggregation method can provide answers for modeling and model aggregation (Tuunanen, Peffers and Gengler 2004). We agree with others researchers (e.g. Nunamaker, et al. 1991) that finding consensus is important. Thus, we seek ways to include this in our method with workshops and through prioritizing of requirements.

However, as our research progressed we found that the presentation of requirements can also be a vital factor for consensus making. We suggest that requirements should be presented in a rich enough way (Peffers and Tuunanen 2005;Tuunanen, Peffers and Gengler 2004) by using semi-formal presentation of requirements (Tuunanen and Rossi 2004). This in turn can be beneficial in integrating novel requirements elicitation techniques into a design that has lately been promoted by RE researchers (Briggs and Gruenbacher 2002;Fouskas, Pateli, Spinellis and Virola 2002;Jirotka and Goguen 1994). Although our modest application with WARE did yield positive feedback, we argue that more work should be done in the field.

The preliminary results from the empiric work (Article IV) suggest that our technique can be adequately used for gathering requirements for wide audience end-users and for facilitating information flows between the different stakeholders in an IS development project. Furthermore, our client used the results of the project to develop a product roadmap for their strategic e-commerce system, which can be characterized as a wide audience information system. We should, however, keep in mind that the findings are based on only one case study and that further research is needed to make more extensive generalizations on the efficiency of the technique.

The above findings allow us to suggest that we have managed to provide initial answers to the second specific research question and meet the selected methodology requirements. We have also created a new innovative (R4) requirements elicitation technique (R1) and defined it with rigor (R5). We can also regard the resulting journal articles as external validation for the rigorously conducted research. However, we do not claim that the technique we have developed would be superior to others due to the limited evaluation of the technique (R3). This also prevents us from stating anything final about the efficiency of the technique. Anecdotal evidence, however, suggests positive results. Moreover, we present that WARE technique has been iteratively developed through theory building, experiments and observations to address the seven problems described as characteristic of eliciting requirements of wide audience end-users. The analysis of literature in Article V also suggests a number of other techniques feasible for requirements discovery. Although our technique is complex and more costly than many of the others, the preliminary findings suggest that we can get good results with it. The question that remains unanswered is when we should recommend practitioners to adopt the WARE technique.

6.1.3. Recapping

Our final specific research problem called for recapping the study and understanding when techniques like WARE should be used. For this phase of the study, four methodological requirements were set forward: creation of an innovative artifact, evaluation of the created artifact, solving the research problem more efficiently or in an innovative way, and that the artifact should be rigorously defined, formally represented, coherent, and internally consistent.

When reviewing the literature, it was found that many researchers had also previously been dealing with this problem. IS researchers had promoted contingency models for resolving the risks in IS development (Alter and Ginzberg 1978;Davis 1982;Mathiassen and Stage 1992;McFarlan 1981;McFarlan 1982) and Davis's (1982) model specifically used this knowledge in helping practitioners to choose requirements elicitation techniques. However, what was a surprise to us was that there was no current literature available that would use risk management literature to help us to choose contemporary techniques or to recognize the new risks that wide audience end-users, for example, have brought us (Hickey and Davis 2004). Yet, there was a possibility to satisfy at least first one of the methodology requirements (R1). To this end, we reviewed the relevant literature (91 articles) with a six step method in Article V and elaborated the understanding of risks and techniques. Our analysis suggested some new risks involved in availability of requirements and corresponding techniques that could help discovering these. Furthermore, we derived three principles through the analysis that could be used as a basis for resolving requirements oriented problems and prioritizing the use of techniques, and that could, through our compensation principle, shed light on how the use of different techniques affects the dynamics of the whole selection problem during an IS development project.

We synthesized this knowledge into a theoretical model for managing requirements engineering risks that went beyond choosing only requirements elicitation techniques, reflecting the whole RE process (cf. section 2.2.). Hence, our opinion is that our model provides answers to our third specific research question. It presents a straightforward model for managing risks and four archetypical project types for IS development to illustrate the use of the model. Furthermore, it positions our technique, WARE, as a discovery technique and points out four specific situations suggested for using WARE. In our view, solving the availability problem of requirements justifies the costs of the technique. Of course, practitioners should also review the other techniques we have characterized as discovery tactics and see if any of them fits their IS development project needs better than our method. Our proposal could be synthesized as follows: 1) assess the risks and needs of your project, 2) use our model to understand what kind techniques can help you and how to prioritize their use, 3) choose techniques that fit your needs and those of your organization, and 4) when needs change during the project, assess what techniques can be used for resolving the current problem.

To conclude, we present that we have created an innovative (R1) and rigorously defined, formally represented, coherent and internally consistent (R4) artifact. Our model for managing requirements engineering risks was constructed by using an innovative and rigorously defined review method that was developed by the author. Hence, we can argue that we have managed to satisfy the requirement of innovativeness also regarding the way of creating the artifact. However, we do lack sufficient evaluation of the artifact, having thus not accomplished to fulfill all the set requirements.

6.1.4. Summary

With these answers to the three specific research questions we suggest to have approached answering our main research question. We provide an initial understanding of what requirements there are for eliciting requirements of wide audience end-users and we have used this knowledge for constructing a new innovative requirements elicitation technique. Finally, we have rationalized the use of the WARE technique by providing four specific situations when it is likely to provide efficient results. We present that the whole research process can be described as iterative, particularly regarding the technique construction processes (Articles I, II, III and IV). Furthermore, we suggest that the whole research reported in this paper is characterized by commitment to the theory building principles throughout the five original articles. We have also been working with real clients. The received feedback suggests that we have provided them relevant results. In addition, we have been pursuing to distribute our results to academia. Thus, we present to provide an iterative feedback loop of our research methodology and thus to fill the final methodology requirement (R7). Lastly, reflecting the research against the five required outputs of design research (ISWorld 2004;March and Smith 1995;Purao 2002;Rossi and Sein 2003) we can claim that our study also accomplishes to produce these. We have created a construct, developed a new technique, and we have applied it to practice with acceptable preliminary results. Moreover, we have extended the theoretical base within the discipline. Thus, we may state that our study is methodologically defendable both regarding the aspects of research in information systems development (Nunamaker and Chen 1991) and from the design research perspective (Hevner, March and Park 2004;Orlikowski and Iacono 2001).

6.2. Contributions

The thesis aims to make multiple contributions to academia and practitioners. For academics, our research seeks to contribute in three different ways. First, we have theorized what probable needs practitioners face when developing IS for diverse and mostly external set of end-users. This provides a start in understanding what kind of new needs and risks should be considered when developing new requirements elicitation techniques for wide audience end-users. Second, we have constructed a requirements elicitation technique to address these needs through an iterative research process. The research process demonstrates how design research methodology can be applied to assist constructing theoretically sound solutions for contemporary IS development problems. The research method should also be applicable to other problem areas than constructing RE techniques. Hence, our research methodology could be considered a guide line. Finally, we present that our theoretical model for managing requirements engineering risks recaps the knowledge in the field and provides guidance on when WARE or other techniques should be used in the contemporary world of IS development. It also provides a more general understanding of how to select among different requirements engineering techniques within and between IS projects.

For practitioners, our research offers many practical solutions, techniques, enabling them to address the difficulties they are facing in their every day work. Initially, the developed IS planning technique can be used as it is for high level planning of IS projects. In addition, we have constructed a way of eliciting the requirements of wide audience end-users. The constructed requirements elicitation technique has proven to be a success in the pilot case. Our research with the newspaper case provides a simple way of using market segmenting and lead users to find the external end-users. To facilitate communication, we suggest using workshops and feedback from internal and external end-users. In addition, we have provided an initial way of using a spreadsheet application tool for integrating the WARE technique to design work practice. Finally, we provide an easily understandable model for managing requirements engineering risks to aid practitioners to dynamically select requirements elicitation techniques during the IS development life-cycle. The model also provides help in deciding whether to use WARE or some other technique to reach and understand diverse and external end-users.

6.3. Limitations

We realize that there are several limitations in our study, originating from both empiric and theoretical work. First of all, we do not consider the WARE technique any better than any of the other techniques categorized as discovery tactics. WARE is simply a technique that has specifically been constructed with the WAEU target group in mind. We also recognize some limitations as regards the implementation of the technique. The participant selection clearly needs rethinking and improved ways should be developed. We agree with Olson and Bakke (2001) that snowballing can be a good way to do participant recruiting in single cases. However, if we aim to use lead users more systematically, we should find out if there are any other ways enabling a more orderly incorporation of them into the development process. Another major concern we have has to do with the difficulties of providing practitioners with a tool that would facilitate the communication of requirements between stakeholders. We were only partially successful in the usage of the tool. We believed, through the previous experiences, that the management would use our tool (Articles I and II). They started to use the business report produced by us as a tool instead. Developers, however, found our tool satisfactory and useful for design work. Hence, the tool created an elementary requirements-design interface. Yet, the management of requirements with the current tool is not an easy task. The management of static data points at two levels turned out to be rather tiring and resource demanding from time to time.

We have also recognized limitations originating from theoretical work. It has been found more difficult than expected to define what wide audience end-users actually are. With the thesis we hope to present an acceptable and adequate enough definition to satisfy the problem domain specification requirement arising from the research methodology. More research should be done to find out how the building of extensive e-commerce systems, like in the case of Amazon[6], differs from producing ubiquitous services for contemporary wireless networks. Furthermore, a stronger research effort seems to be worthwhile as regards firms mainly conducting business with consumers, like those specializing in computer gaming.

Assessing the entire study against the selected methodology requirements, it can be seen that the requirement concerning artifact evaluation has not been completely satisfied. We also have to recognize that our preliminary results of the feasibility of the technique are limited. We have field tested the technique with only one client and we have not yet seen the results of a feedback study to be able to assess how the process has continued after discontinuing the main study. What is more, we should continue the research by conducting laboratory tests involving different techniques that try to solve the same problems. This way we might be able to gain a better understanding of the efficiency of our technique compared to others, a requirement that was also only supported to a limited extent. Another option would be to apply action research (Iversen, Mathiassen and Nielsen 2004) and to use several

[6] http: //www.amazon.com

cases to fathom out how the technique works in different firm environments. This would most probably also lead to further improvements of the technique.

Finally, we recognize that a major limitation arises from the major contribution of this research work. The theoretical model we have derived through analysis and synthesis of the literature remains only theoretical. Our research did not evaluate the model through empiric work. Additionally, the structured review method used in this study restricts our view to only top journal outlets in the IS and SE disciplines. Hence, the review can be said to be comprehensive, but not complete. To transfer our theoretical results into practice, we should conduct further empiric research to understand how the model performs and how well it can be adjusted for different applications.

If we are able to meet or at least initially fulfill the evaluation requirements, we may hope to provide results that can be generalized further on. Of course, we should also critically study and evaluate the selected research methodology. We can see that even though the two views used in our study (Hevner, March and Park 2004;Nunamaker and Chen 1991) fit comparatively well together, we should notice that there are some issues arousing concern. We recognize that Hevner et al.'s requirements are set on two different abstraction levels. Two of the requirements (research process being iterative and results being efficiently communicated both to academia and practitioners) are clearly more on the same level as the requirements set forth by Nunamaker and Chen, whereas the five others appear to direct the construction process in a more straightforward way. We have made an effort to combine these approaches, but more research should definitely be done in the methodology area of design research.

6.4. Future Research

The recognized limitations of this work provide a basis for guiding our future research. Initially, our interests lie in the methodology issues of design research. In our research some conflicting views were detected regarding how to do design research (Hevner, March and Park 2004;Nunamaker and Chen 1991). Even though the conflicts were not found severe, they give rise to a need for further research in the area. It would be intriguing to continue the conceptual work with a formation of a repeatable research process. Furthermore, we should make an attempt at comprehending how we could validate the results internally and externally. We should also definitely aim to provide extension to the current view of just proving a *proof-of-concept*.

Secondly, the constructed technique should be further developed. We consider it essential that more constructive ways should be found to ease the burden of analysts striving to find participants for requirements elicitation. We see great potential in using virtual communities for this purpose (Füller, Bartl, Mühlbacher and Ernst 2004;von Hippel 2001;von Hippel and Katz 2002) and we have already started theoretical work based on this concept (Bragge, Marttiin and Tuunanen 2005). In particular, we believe that the limitations of the requirements-design interface should be overcome with more practical ways. We have proposed using the CASE tool for constructing a support environment for the presentation and management of requirements (Tuunanen and Rossi 2003a;Tuunanen and Rossi 2003b;Tuunanen and Rossi 2004). In addition, we see great interest in trying to produce product concepts or prototypes directly from the analyzed requirements (Laaksonen, Tuunanen and Rossi 2004). Moreover, the WARE technique should be further developed as presented in the limitations of this work and further evaluated empirically. The thoughts of internal and external validation presented above would thus be related and applied also to design research methodology.

Finally, we believe that it is essential to provide empirical evidence of how the model for managing requirements engineering risks performs in practice. Through empirical work we are likely to be able to find ways to put the model to everyday use by practitioners and thus to evaluate its practical feasibility. Finally, the selected research methodology provides opportunities for further study as regards how design research can be applied to IS development problems and how it should be further enhanced.

Using this research agenda, we may hope to improve information systems products and services that we use in our every day lives. At least we may be able to bring this goal a little closer.

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Helsingin kauppakorkeakoulu
Julkaisutoimittaja
PL 1210
00101 Helsinki
Puh. (09) 4313 8579, fax (09) 4313 8305
Sähköposti: julkaisu@hkkk.fi

All the publications can be ordered from

Helsinki School of Economics
Publications officer
P.O.Box 1210
FIN-00101 Helsinki
Phone +358-9-4313 8579, fax +358-9-4313 8305
E-mail: julkaisu@hkkk.fi