RISK, INNOVATION & CHANGE

Design Propositions for Implementing Risk Management in Organizations

Martin van Staveren

Graduation committee:

Prof. dr. F. Eising, dean	University of Twente
Prof. dr. ir. J.I.M. Halman, first promotor	University of Twente
Prof. dr. ir. J.E. van Aken, second promotor	Eindhoven University of Technology
Prof. dr. P.B. Boorsma, member	University of Twente
Prof. dr. G.P.M.R. Dewulf, member	University of Twente
Prof. dr. ir. J.J. Krabbendam, member	University of Twente
Prof. dr. ir. J.W.F. Wamelink, member	Delft University of Technology

RISK, INNOVATION & CHANGE

Design Propositions for Implementing Risk Management in Organizations

DISSERTATION

to obtain
the doctor's degree at the Universiteit of Twente
under the authority of the rector magnificus,
prof. dr. H. Brinksma
on the account of the Graduation Committee
to be publicly defended
on Friday, the 17th of April 2009, at 16.45 hours

by

Martinus Theodorus van Staveren

born on the 12th of May 1964
in Groningen, The Netherlands

This dissertation is approved by:
Prof. dr. ir. J.I.M. Halman
Prof. dr. ir. J.E. van Aken

The research for this dissertation is part of and sponsored by the research project *Implementing Risk Management* of Delft Cluster, The Netherlands.

For any questions about this publication, please contact the author by e-mail: martin.vanstaveren@xs4all.nl

ISBN: 978-90-365-2774-3

Design and lay-out: Legatron Electronic Publishing, Rotterdam, The Netherlands.
Cover concept: Annelies Mikx & Martin van Staveren.
Cover photo: Used with permission from CBS Interactive, Inc. copyright 2007.

Printed by: Ipskamp Drukkers B.V., Enschede, The Netherlands.

CONTENTS

1

INTRODUCTION

1.1 Research topic

Why and how it started

This Ph.D. research builds on the researcher's book *Uncertainty and Ground Conditions: A Risk Management Approach* (Van Staveren, 2006), which describes the application of risk management within the geotechnical industry. This book covers and integrates four aspects: inherent ground uncertainty, construction and its industry, risk management, and the people involved. It contains a synthesis of theoretical and empirical knowledge, from different perspectives. Within the researcher's organization, a geotechnical knowledge institute, free availability of the book proved to be insufficient for the routine application of geotechnical risk management. Apparently, something was still missing. First, this situation surprised the researcher. Later, this condition of surprise turned into fascination about *how* to actually implement geotechnical risk management, and risk management in general, in organizations. What should be added? This very question was the trigger for undertaking this Ph.D. research.

Research objective

After a metaphor by Schön (1983) in Van Aken (2008a), the generic *objective* of this Ph.D. research is finding firm ground in the swamp of practice. Such swamps are well known to geotechnical engineers dealing with soft soils, as well as to practitioners in other technical and organizational disciplines. These swamps include ill-defined and messy field problems, which in reality are problematic situations. One typical organizational example is implementing risk management in organizations.
The specific objective of this research is providing a scientifically designed and validated approach to implementing risk management within organizations in the construction industry. This research should generate a scientifically grounded and practically checked knowledge base for *designing* the process and required activities for effective, efficient, and persistent implementation of risk management within organizations. This designing aspect is additional to the conventional triplet of description, explanation, and prediction within the natural and social sciences (Emory, 1985). It should answer the main research question:

How to implement risk management in organizations in the construction industry?

Realizing this research objective requires academic, yet *applied*, organizational research. Applied research aims developing explicit and technical-rational input to knowledge-intensive problem solving and decision-making (Van Aken, 2008a). Therefore, the CIMO-logic of context, intervention, mechanism, and outcome (Denyer et al., 2008) has been applied. According to the heuristic causality of this logic, within an organizational *context*, executing *interventions* with underlying *mechanisms* generate appropriate conditions or *outcomes* for implementing risk management within organizations.

Risk management

Within this thesis, *risk management* has been defined as the coordinated application of risk management methodologies, including principles, processes, and tools, for effectively and efficiently dealing with risk. The term *risk* has been defined in a two-dimensional way, as the likelihood of occurrence of an undesired event *and* the consequences that event, assessed at a certain moment in time.[1] By fostering a multi-level approach, three levels of risk management have been distinguished:

1 These definitions are motivated in Chapter 3 about risk management.

1. Risk management at *discipline* level, such as geotechnical risk management;
2. Risk management at *project* level, such as project risk management;
3. Risk management at *organizational* level, such as portfolio risk management.

While geotechnical risk management at discipline level triggered the research topic, all three levels of risk management were subject of research.

Risk management implementation

The *implementation* of risk management has been defined as executing all required activities for *routinizing* the *application* of risk management within an organization.[2] Therefore, implementing *geotechnical* risk management is the routinized application of risk management during geotechnical design and construction activities. Similarly, implemented *project* risk management is the routinized application of risk management in single projects. Implemented *portfolio* risk management is the routinized application of risk management in project portfolios at organizational level in an organization. Figure 1.1 shows the relationships between *applying* and *implementing* three levels of risk management.

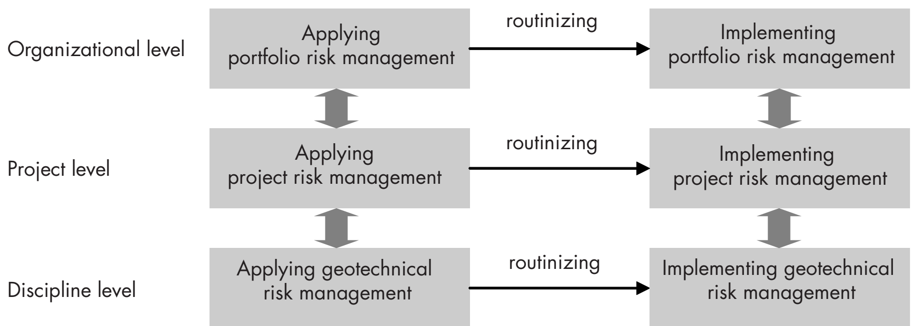

Figure 1.1 Relationships between applying and implementing three levels of risk management.

It is well possible to implement different levels of risk management in different sequences. For instance, within one organization geotechnical risk management and project risk management are implemented, while portfolio risk management has not (yet) been implemented. Applying project management without applying discipline-related risk management within the project is also possible. Moreover,

2 This definition is motivated in Chapter 4 about innovation management and implementation issues.

organizations may start with implementing risk management at discipline or project level, as a stepping-stone for implementing risk management at organizational level, at a later stage. As such, implementing discipline-related and project risk management can be considered as "*light*" and "*medium*" versions of implementing portfolio risk management, which is the "*heavy*" version. Within this Ph.D. research, the three levels of risk management have been analyzed in four case studies. Within one of these, a geotechnical institute, implementing geotechnical risk management at discipline-level has been analyzed. Two case studies, a project management consultancy and a contractor, concerned project-related risk management. In the remaining case of a public client, the topic was portfolio risk management.

Research focus and target groups

This Ph.D. research *focused* on organizations in the construction industry. The target group for *implementing* risk management consisted of all existing and potential users of risk management within an organization. These are professionals at either discipline level (such as geotechnical engineers), at project level (such as project managers), or at organizational level (such as members of staff units). These practitioners are well-educated professionals (Van Aken, 2008a), who have knowledge-intensive field problem solving as their core competence (Schön, 1983).

The three main target groups for the *results* of this research, design propositions for implementing risk management in organizations, are *risk management consultants*, *organizational consultants*, and *change management consultants*. Risk management consultants are expected to be experts in *applying* risk management. They should have knowledge and experience about why and how applying risk management, at discipline level, at project level, or at organizational level. However, risk management consultants are not necessarily also experts in *implementing* risk management, which has been defined as *routinizing* the application of risk management. This reveals the need for organizational and change management consultants. These professionals should be proficient in understanding and, when required, changing organizational conditions, in favour of the routinized application of risk management. It has been concluded from this research that for *implementing* risk management within an organization, at discipline level, at project level, or at organizational level, risk management consultants, organizational consultants, and change management consultants should share their expertise and join their forces.

Unit of analysis

The unit of analysis (Yin, 2006) is the implementation of *existing* risk management methodologies in social systems of organizations. Within this research, risk management *methodologies* are defined as sets of existing principles, concepts, processes, methods, and tools for *applying* risk management. The design and development of *new* risk management methodologies is beyond the scope of research.

An *organization* is a structured and stable set of social systems with individuals who work together for achieving common goals. *Social systems* are sets of interrelated units involved in joint problem solving to accomplish a common goal (Rogers, 2003: 476).[3] Risk management users are members of social systems. In case of well-implemented risk management, targeted users have entirely adopted risk management methodologies by routinely using these methodologies in their day-to-day activities, for reaching the common goal(s) of their social systems.

Research results

This Ph.D. research provided a scientifically grounded and practically checked knowledge base for *designing* risk management implementation within organizations, with four main conclusions, two models, and two instruments. The exploration research part on risk management, innovation management, and change management generated the following conclusions, which have been inferred from two key propositions for implementing risk management in organizations:

Conclusion 1: Form, function and meaning of risk management are largely intangible and subjective, which makes effective, efficient, and persistent implementation in organizations highly complex;

Conclusion 2: Implementing risk management in organizations requires a design approach that synthesizes risk management, innovation management, and change management concepts and practices;

Conclusion 3: Specific attention to routinize the use of risk management methodologies, defined implementation, is highly underdeveloped;

Conclusion 4: For real implementation, risk management methodologies need to be adapted to organizational social systems with their distinct risk management user groups.

3 These definitions are motivated in Chapter 4 about innovations.

Because of the objective of this research, these conclusions are about *how* to implement risk management in organizations in the construction industry. Conclusion 1 and Conclusion 3 are field problems in the professional practice of the Dutch construction industry, for which Conclusion 2 and Conclusion 4 provide solutions. In addition, the development research part generated two models and two instruments:

1. A *conceptual model* for implementing risk management in organizations with fifty indicators in three dimensions: (1) risk management users, (2) risk management methodologies, and (3) social systems within organizations;
2. A *design process model* for context-specific design of the risk management implementation process within organizations;
3. An *audit instrument* for measuring the readiness and monitoring the progress of risk management implementation within organizations;
4. An *intervention proposition* with ten specific interventions in five aspect systems for (1) providing user group-specific motivation and commitment (targeting), (2) realizing adaptation of risk management methodologies (customization), and (3) setting organization-specific conditions for social systems within organizations (contextualization).

This solution-oriented knowledge base facilitates field problem solving in conceptual, as well as in instrumental ways (Pelz, 1978, in Van Aken, 2008a). *Conceptual use* implies that the knowledge base is merely used for enlightenment about implementing risk management in organizations. The four main conclusions and the conceptual model serve this objective. *Instrumental use* means specific and direct acting by using the knowledge base. The design process model, the audit instrument, as well as the intervention proposition are typically research results for instrumental use. This research demonstrated that using these models and instruments, while acknowledging the four key conclusions, increases the effectiveness, the efficiency, and the persistence of implementing risk management in organizations in the construction industry.

1.2 Scientific and practical relevance

Scientific relevance

What is the *scientific* relevance of investigating the implementation of existing risk management methodologies in organizations at discipline level, at project level, and at organizational level? Three main reasons provided the scientific relevance of this research.

First, there is almost no scientific *risk management* research that explicitly includes *implementation* issues. Risk management research at *discipline* level, such as geotechnical risk management and presented by Clayton (2001), De Ridder (1998), Hatem (1998), Skipp (1993), and Van Staveren (2006), does not address its implementation. Research about *project* risk management, as for example provided by Boothroyd and Emmet (1996), Edwards (1995), Edwards and Bowen (2005), Flanagan and Norman (1993), Godfrey (1996), Smith (1998, 2003), Thompson and Perry (1992), and Weatherhead et al. (2005), present theories and guidelines for *applying* project risk management, rather than for *implementing* project risk management. Less common is research about risk management at *organizational* level, as provided by Augustijn (2006) and Olsson (2006). However, also their research largely neglects specific implementation issues. All these researchers focussed on the *development* and *application* of *new* risk management methodologies, rather than the routinized application or *implementation* of *existing* risk management methodologies in organizations. Except for Halman (2008) and Van der Heijden (2006), scientific research focussing on implementing existing risk management methodologies in the construction industry have not been identified from the literature.

Second, the topic of routinely applying or *implementing* new methodologies in *organizations* also has only limited attention within academic research, as raised by scholars such as Klein and Knight (2005), Klein and Sorra (1996), and Vrakking and Cozijnsen (1992). In contrast, Marcus (1988) mentions a large body of research dealing with problems of implementation. However, none of the available research about *implementation* issues, as for instance provided by Danserau et al. (1999), Detert et al. (2000), Drazin et al. (1999), Holahan et al. (2004), Jasperson et al. (2005), Klein et al. (2001), Lapointe and Rivard (2005), Lewis and Seibold (1993), Swanson and Ramiller (2004), and Rogers (2003), addresses the implementation of *risk management* within organizations. According to Rogers (2003), innovation process research generally ends at the start of implementing the innovation. Consequently, suitable methods and approaches for implementation remain hidden. This limited scientific implementation attention is remarkable because of the high failure rates of implementation attempts. For instance, Cozijnsen et al. (2000) refer to a US study by Carr (1996), who investigated the success rate of implementing several types of organizational innovations. Examples were total quality management (TQM), business process systems (BPS), and information technology (IT). While twenty to thirty percent of the innovation projects ended in failure, fifty percent of the innovation projects did not show improvement.[4] Several other researchers, such as Aiman-Smith and Green (2002), Baer and Frese (2003), and Repenning and Sterman (2002), estimated that at least fifty percent of the attempts to implement major technological and administrative changes end in failure.[5]

Third, worldwide a number of scholars seriously question the *scientific relevance* of *academic management research*, as for instance raised by Denyer et al. (2008). In words by Van Aken (2004: 219): "Academic management research has a serious utilization problem". A major cause is usually descriptive-driven management research, which lacks generating clear, pragmatic, and prescriptive results, which can be used by managers in their daily practices. This also applies to academic construction management research, according to Flyvbjerg (2006). Furthermore, the science base of academic management research is highly fragmented, because of the gap between the organizational sciences and the humanities (Romme, 2003). Rigorous and in-depth research, by combining scientific demands of validity and reliability with practical quests for being teachable, learnable and particularly actionable, is relatively scarce. Therefore, currently designing organizations and organizing them is largely left to practitioners, such as management consultants (Romme, 2003).

In conclusion, because of the discussed three main reasons, the research topic of this dissertation has been considered a *niche* from a scientific point of view. It may significantly contribute to the very limited scientific knowledge base about implementing existing risk management methodologies in organizations in general, and in the construction industry in particular.

---

4 The results of this US survey challenged Cozijnsen et al. (2000) to investigate success and failure of fifty innovation projects in Dutch companies. The quantitative study of a random sample of fifty organizations that tried to realize product, technological, and organizational innovations learned that 23 percent of the innovation projects were successful. Within these projects at least fifty percent of the defined objectives have been realized. Furthermore, 61 percent of the projects were partially successful, indicating that less than fifty percent of the objectives were realized. In total 16 percent of the projects failed completely (Cozijnsen et al., 2000).

5 The costs of failing implementation of innovations seem to be high. Klein and Knight (2005) refer to a report by the financial firm Morgan Stanley. They estimated that per year some 500 billion US dollar is wasted by failing implementations, out of the 2700 billion US dollars that companies spent on new technology. In The Netherlands, the failure costs of implementing ICT are assessed between several hundreds of million and two billion euro per year (Van Oosterhout, 2007).

Practical relevance

In addition to scientific relevance, is there also *practical* relevance of this research? Answering this question required investigating four main major challenges of the global construction industry.

First, there is an ever-increasing *complexity* of many construction projects. Technical causes are construction sites within build environments with poor geotechnical conditions (Van Staveren, 2006). Probably even more important are non-technical causes. Examples are an industry structure with severe competition on lowest price, clients putting pressure on control of costs, time, quality and safety, and increasing public expectations for minimizing construction nuisance and environmental impact, for example raised by Barends and Mischgofsky (2005), European Construction Technology Platform (2005), Sleight (2005a, 2005b), and Van Staveren and Chapman (2007).

Second, there seems to be an *integrity* issue (Van Staveren, 2006). Transparency International (2005) classified the construction industry as the most fraudulent in the world.[6] Within many countries, there is a growing attention to improving construction integrity, for instance reported by Blockley and Godfrey (2000), Brandl (2004), Ericson and Doyle (2003), and Schinzinger and Martin (2000).

Third, *safety* remains a major concern for the construction industry. Human shortcomings, rather than a lack of technology, are the main causes of failure, as revealed by researchers such as Bea (2006), Cummings and Kenton (2004), Derdink et al. (2005), Kreling (2007), Reason (2006), Sowers (1993), and Van Tol (2008).[7] As revealed by Beal (2007), only implementing new regulations seems not to be way for increasing safety.[8]

Fourth, *failure costs* in the construction industry are typically ten to thirty percent of the total construction costs, as for instance presented by Al–Jibouri (2006) and Avendano Castillo et al. (2008). These figures align with other research results, such as provided by Barber et al. (2000), Egan (1988), Latham (1994), Marr (2001),

---

6 Some ten percent of the worldwide expenditure on construction seems not spend in the way it was intended to be. Initiators of multi-billion mega-projects appear to systematically misinform parliaments, the public, and the media, for getting their projects approved and build (Flyvberg et al., 2003).

7 International studies of Bea (2006) and Sowers (1993) of respectively 600 and 500 well-documented but failed construction projects indicate that over eighty percent of these cases failed by *human shortcomings*. The remaining less than twenty percent of the cases failed by a *lack of technology*. In The Netherlands, similar cases are available. Examples, in which failures also are primarily caused by human shortcomings, are presented by Derdink et al. (2005), Kreling (2007), and Van Tol (2008).

8 For instance, in the UK the new construction, design and management (CDM) regulations have produced very little improvement in construction *safety*. Nevertheless, its implementation costs, since 1994, are several billion pounds. The main targeted benefit of the regulations, which is the reduction of accidents on construction sites, has not been realized. There are many different opinions about why the regulations failed, including poor implementation (Beal, 2007).

and Wichers Hoeth and Fleuren (2006).[9] These failure costs, which are usually unforeseen, are seriously threatening profit margins in the construction industry. Between two and five percent, these profit margins are rather low, as for instance raised by Brokelman and Vermande (2005) and Van Staveren (2001).[10]

Currently, applying *risk analysis* seems more embedded within the construction industry than routinely applying *risk management* (Van Staveren, 2007a). Analyzing risk is an exercise that provides insight in risk causes, probabilities of occurrence, and effects. It is however (only) an element of risk management, which includes also taking risk remediation measures, and monitoring and adapting those measures when needed. The ultimate purpose of risk management is improving overall construction project performance, as for instance stated by Chapman and Ward (1997). Therefore, is implementing risk management within organizations a promising solution for dealing with the four challenges in the construction industry?

It seems so, for four reasons. First, the well-structured way of approaching potential problems by risk management may reveal and reduce project complexity, as presented by Smallman (1996) and Shrivastava et al. (1988). Particularly when using web-based integrated systems, Han et al. (2008) expect that construction firms are able to make better decisions by considering key risk factors at each stage of a project. Second, bringing risks into the open and executing the most appropriate remediation strategies, preferably by involving all stakeholders, will increase project transparency. This is a prerequisite for integrity, according to Blockley and Godfrey (2000), and Schinzinger and Martin (2000). Third, risk management is applied already for years in the nuclear and the chemical industry for guaranteeing acceptable levels of safety, as for instance raised by Perrow (1984), Reason (1997), and Roberts and Bea (2001). Fourth, applying risk management aims to reduce failures and the associated negative effects of cost and time, as presented by Elliot et al. (2000), Smith (1996), Sperry (1998), and Waring and Glendon (1998). Figure 1.2 presents *potential* relationships between the four main construction industry challenges and corresponding solutions, by implementing risk management.

9 A lot of studies indicate the dominant role of *ground conditions* in failure of constructions and the associated unfavourable effects on budget, time, and reputation. Examples are presented by Brandl (2004), Brokelman and Vermande (2005), Essex (1997), Fookes et al. (2000), Gould (1995), Hoek and Palmieri (1998), Molendijk and Aantjes (2003), and Morgenstern (2000). This explains the growing attention for risk management, and its implementation, in the geotechnical industry.

10 Flyvberg et al. (2003) present numerous examples of infrastructure projects, all over the world, with cost overruns up to 1900 percent (the Suez Canal project).

1

The potential relationship between construction industry challenges and potential solutions by implementing risk management are recognized by construction industry initiatives in several countries. For instance, in the US, the main areas of attention in the construction industry are innovative contracting, safety, cost analyses, research and development, and training. Attention to these trends should contribute to providing better, faster, and cheaper solutions to geotechnical problems in construction projects. Applying risk management was considered as the best chance for meeting these demands in *each* of the trend areas (Smith, 2008).[11]

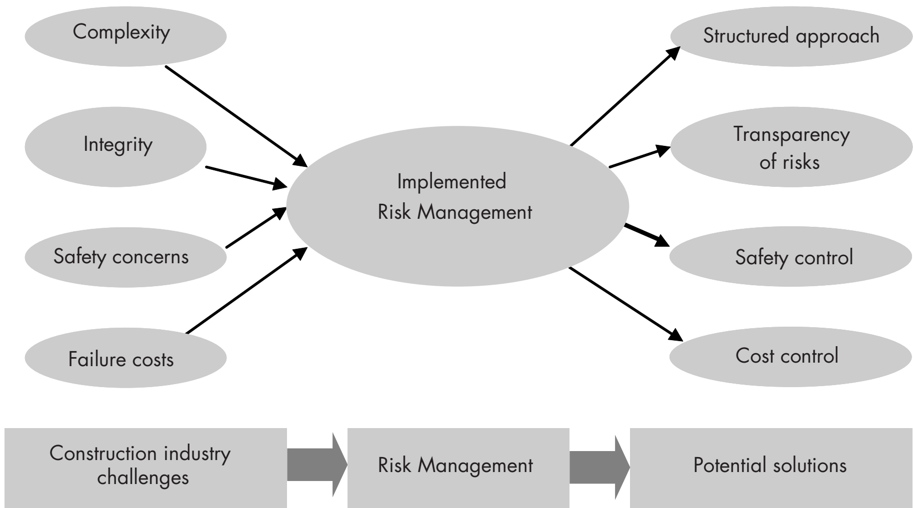

Figure 1.2 Potential relationships between challenges and solutions, by implementing risk management.

In The Netherlands, major construction industry players agreed to apply risk management explicitly in eighty percent of all Dutch construction projects by the year 2012. By signing their agreement, the parties are committed to support risk management implementation within their organizations. For instance, risk communication between clients, engineers, and contractors should become common practice during the planning and construction phases of projects. Anticipated benefits are an increase in trust, transparency, and communication, which should reduce failure costs, time delays, and disputes within projects.

11 Smith (2008) reports about a workshop of the US GeoCouncil of December 2006. A group of fifty geo-professionals, including academics, designers, and builders, examined a number of trends in the construction industry.

Particularly risk transparency within the construction is considered necessary for applying innovations (Jonker et al., 2008).[12]
However, realizing these risk management benefits requires routinized application within organizations in the construction sector. While increasing, the degree of risk management diffusion in the construction industry is still relatively low, when compared with other industries (Van Staveren, 2006).[13] These other sectors demonstrate that risk management implementation is not easy. It seems that risk management is routinely applied in operational business processes in several sectors, for many years. Examples are the financial industry, the nuclear industry, and the oil and gas industry, according to Elliot et al. (2001), Macpherson (2001), NASA (2004), Smith (1996), Sperry (1981), and Waring and Glendon (1998). Nevertheless, others demonstrate also serious risk management implementation concerns in these industries. For instance, according to O'Rourke (2004), many insurance companies struggle with implementing enterprise-wide risk management (ERM), while recognizing the need for it.[14] Within the financial industry, it seems that chief executives are placing a greater emphasis on risk management, although many companies struggle with implementing the necessary changes (Oversight Systems, 2005). While embracing risk management, the implementation struggle seems to remain (Oversight Systems, 2006).[15] A longitudinal project management analysis over the years 1998-2003, which was initiated by the Project Management Institute (PMI), showed that organizations consistently fail to apply risk management across projects (Mullaly, 2006). Researchers and practitioners, such as Hillson (2002), Hillson and Murray-Webster (2007), and Olsson (2006) confirm these

12 On November 1, 2007, leading organizations in the Dutch construction industry signed an agreement on the rigorous application of risk management within Dutch construction projects. The signing parties included three Dutch ministries, the four largest Dutch cities, the Dutch organization of contractors, Bouwend Nederland, the Dutch organization of consulting engineers, ONRI, and the Dutch rail infra-structure provider ProRail. All of these organizations are member of the steering committee of the Dutch knowledge network on risk management, RISNET, which aims to support the construction industry with the implementation of risk management in the daily construction practice (Jonker et al., 2008).

13 For example, while relatively new, geotechnical risk management gets globally more attention, which is demonstrated by an increase in conferences, courses and papers about the topic (Van Staveren, 2007b).

14 A survey, including 44 leading insurance companies in Asia, Australia, Europe and North America, revealed a wide gap between the planning and doing phases of the enterprise risk management (ERM) programmes. Of the respondents, 58 percent could not agree with the statement that ERM was fully integrated within their firm's strategic business decisions, which seems a prerequisite for well-implemented ERM (O'Rourke, 2004).

15 Oversight Systems is an Atlanta-based firm providing data by continuously monitoring transactions within financial systems. Yearly, the firm presents a report about the status of risk management within the financial industry, based on research amongst over 200 financial executives. Obviously, commercial firms providing risk management services have commercial interests in implementing risk management. Consequently, their research on risk management issues may be somewhat biased in favour of their commercial activities. Nevertheless, while acknowledging this situation, such reports may reveal relevant trends in the professional practice about risk management within organizations. Therefore, this information has been considered.

findings. They state that most organizations and managers would agree that risk management is not producing the expected and promised results. Sometimes, it is even because of the negative meaning of the words *risk* and *risk management*.[16] Otherwise, organizations are not ready for implementing organizational innovations, such as risk management.[17]
Figure 1.3 summarizes the foregoing discussion and shows the logic of the resulting main research question: How to implement risk management within organizations in the construction industry? The next section presents the research approach and thesis structure for answering this research question.

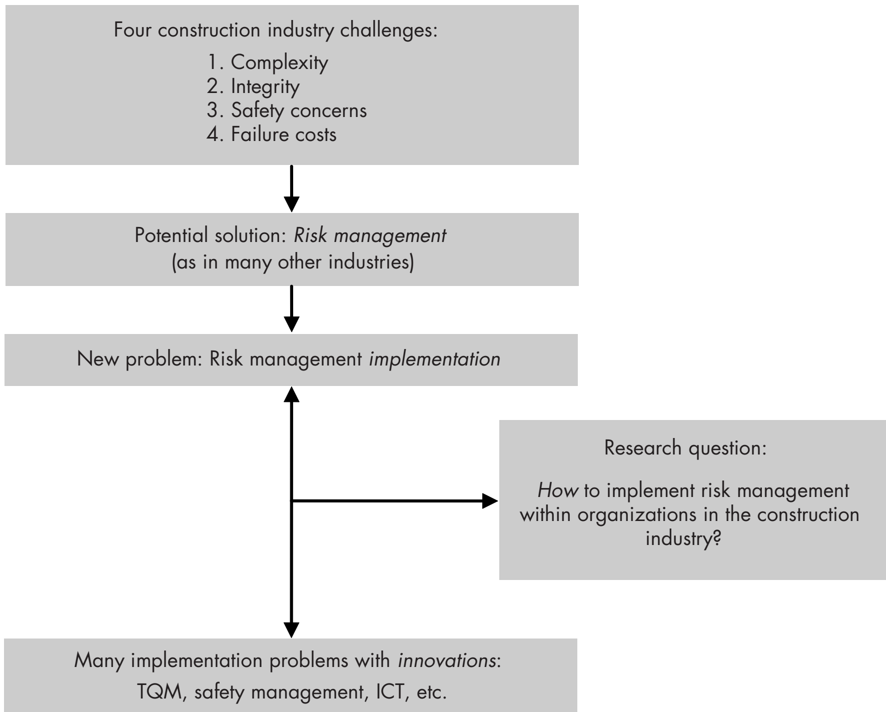

Figure 1.3 Deriving the practical relevance of the research topic.

16 For instance, in public organizations, just relating the word *risk* to a planned construction project may already raise difficulties. The Dutch municipality of Vlissingen is an example of not wanting to hear about risk and its management. This municipality demonstrated being not ready for applying risk management in a 150 million euro redevelopment project, involving 1800 houses. Key risk issues were not (sufficiently) acknowledged, such as the remediation of polluted ground. It resulted in a budget deficit of at least several million euro (Karstens et al., 2006).

17 As stated by Clayton (1997) in Choi and Price (2005), many innovations do not fail because of technical deficiencies. These innovations fail due to a lack of acceptance and use by its organizational members.

1.3 Research approach and thesis structure

Research approach

The research approach for answering the research question about how to implement risk management methodologies within organizations included four parts:

- Part 1: Introduction and design of the research approach, which resulted in the research methodology;
- Part 2: Exploration-oriented research, consisting of an exploratory part and a synthesizing part. The exploratory part generated the relevant concepts and variables of subsequently risk management, innovation management, and change management from a literature survey and field research. In the synthesizing part, the identified concepts and variables have been analyzed and classified;
- Part 3: Development-oriented research, which generated initial, modified, and final design propositions for risk management implementation in organisations, including scientific and empirical validation by a multiple-case study, as well as practical evaluation by an expert panel;
- Part 4: Evaluation of the research process and the research products, resulting in conclusions and recommendations for future research.

In summary, the selected research methodology of Part 1 determined the exploration-oriented research of Part 2 and the development-oriented research of Part 3. The research methodology of Part 1, as well as results of Part 2 and Part 3, have been evaluated in Part 4. Figure 1.4 presents the logical sequence of this research approach, together with the corresponding chapters.

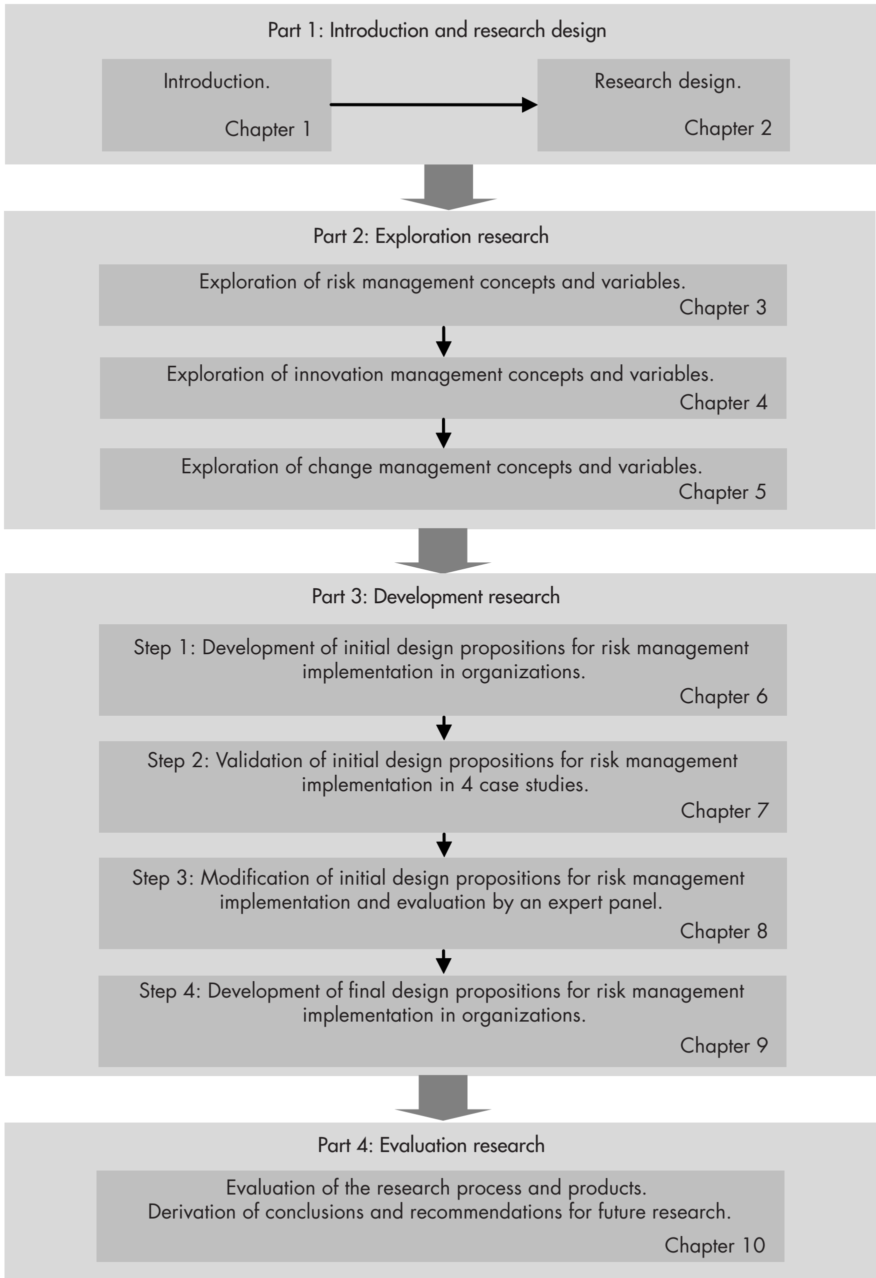

Figure 1.4 The research approach.

Dissertation structure

This dissertation provides a research report. The structure of this report has been based on the *intervention cycle* of Verschuren and Doorewaard (2005). Applying this cycle aims to generate effective interventions in problematic situations, such as the field problem of implementing risk management in organizations within this dissertation. The intervention cycle includes five subsequent steps: (1) raising awareness about the problem, (2) diagnosing the problem, (3) developing a solution, (4) intervening the problem with the proposed solution, and (5) evaluating the result of the intervention by the developed solution. Figure 1.5 presents the resulting logical structure of this dissertation, by presenting the chapters and summarizing the content and results of each chapter.

Throughout this dissertation, research results and contributions to the next chapter(s) are highlighted at the end of each chapter.

Structure	Chapters	Content and Results
Part 1 Introduction & Research design	Introduction (Chapter 1)	Problem awareness: description of the research topic and motivation, the scientific and practical relevance, the research approach, and the dissertation structure.
	Research design (Chapter 2)	Research methodology: selection of a scientific framework, design of the exploration research and the development research.
Part 2 Exploration research	Exploring risk management (Chapter 3)	Problem diagnosis: literature and field research for identification, analysis, and classification of state-of-the-art concepts and variables for applying risk management.
	Exploring innovation management (Chapter 4)	Problem diagnosis: literature and field research for identification, analysis, and classification of state-of-the-art concepts and variables for implementing innovations.
	Exploring change management (Chapter 5)	Problem diagnosis: literature and field research for identification, analysis, and classification of state-of-the-art concepts and variables for executing interventions.

Part 3 Development research	Initial design propositions for risk management mplementation (Chapter 6)	Problem solution: initial design of a risk management implementation approach, consisting of a conceptual model and an audit instrument.
	Validation of initial design propositions for risk management implementation (Chapter 7)	Applying the solution: validating the initial conceptual model and audit instrument for implement ting risk management by single- and cross-case analyses
	Modified design propositions for risk management implementation (Chapter 8)	Improving the solution: refining the conceptual model and audit instrument, adding a design process model for implementing risk management, and evaluation of the results by an expert panel.
	Final design propositions for risk management implementation (Chapter 9)	Finalizing the solution: refining the modified conceptual model, the design process model, and the audit instrument. Adding an intervention proposition. Providing a knowledge base with design propositions for implementing risk management in organizations.
Part 4 Evaluation	Conclusions and recommendations (Chapter 10)	Problem evaluation: deriving conclusions, evaluating the scientific and practical contribution of the research results, presenting research limitations and resulting recommendations for future research.

Figure 1.5. Dissertation structure with chapters, content, and results.

2

RESEARCH DESIGN

2.1 Introduction

This chapter aims to present the purposeful selected research design for the entire Ph.D. research. The research design consisted of selecting an appropriate scientific framework, followed by defining the exploration research approach and the development research approach, according to that framework.
Appropriate research strategies and methods were selected from the literature. Together, these provide the methodology for the exploration research part and the development research part. The next section of this chapter motivates the scientific framework, which has been selected in view of the research objective of the previous chapter. The following two sections concern subsequently the exploration research and development research. Finally, the main results of this chapter are summarized in the last section of this chapter.

2.2 Scientific framework

This section presents the selected scientific framework for this research. It motivates the *ontological* and *epistemological* choices made, as well as the resulting positions in the scientific framework. Ontology concerns assumptions about the nature of *reality*. Epistemology provides a set of assumptions about understanding reality and exchanging knowledge about reality (Boonstra and De Caluwé, 2006). The latter implies assumptions about the nature of *knowledge* about reality, particularly its limits and validity.

Ontological positioning

As stated by Gummesson (1988), academic researchers should be aware of their personal values and beliefs, because these play an important role in their approach to science. For choosing a suitable ontological position, or the assumptions about the nature of reality, two opposite positions have been considered: (1) a positivistic position and (2) a hermeneutic position. According to Olsson (2006)[18], referring to Arbnor and Bjerke (1997), a *positivistic* view explains the world *objectively* and *independent* of any observer, by looking for causal relationships.[19] Other researchers criticize this position, which is particularly common in the natural sciences. Not because it is wrong, but merely because it seems not universally applicable for research in other disciplines, outside the natural sciences, such as organizational sciences.

Contrary to the positivistic view, the *hermeneutic* view on the nature of reality considers the world as a *social construct*. It is content-directed and rejects the single and objective reality of the positivists (Gumesson, 1988). Post-modernism can be considered as the extreme hermeneutic position, because it assumes the existence of innumerable realities (Vattimo, 1992). The hermeneutic worldview is usually applied in the humanities, when the subjectivity of people plays a role and the positivistic approach fails (Olsson, 2006).

By building forward on the hermeneutic worldview, Dake (1991, 1992) and Slovic (2000) introduce the *personal* worldview as individual attitudes towards the world

18 The reason for particularly referring to the Ph.D. work of Olsson (2006) is its risk management topic. However, Olsson focussed his research merely on *developing* risk management methodologies and tools in on specific organization, rather than on risk management *implementation*. Nevertheless, the epistemological and ontological concerns of Olsson's research align well with the topic of this Ph.D. research. Both research journeys aim developing knowledge about managing risk within organizations.

19 As revealed by Knorr-Cetina (1981) and Latour and Woolgar (1979) in Romme (2003), even positivistic scientists may become subject to some degree of subjectivism, due to their unavoidable involvement in social processes. These processes introduce, in an aware or unaware way, social constructive elements in (apparently) objective scientific research.

2

and its social organization. For instance, these attitudes guide responses in complex situations. Regarding risk and risk management, it is assumed that the personal worldview of an individual will effect one's risk perception and risk attitude. For this reason risk management research demands explicit awareness of individual attitudes and social constructs. Therefore, the hermeneutic ontological position has been chosen for this research.

Epistemological positioning

Epistemological positioning of this research involved selecting a set of appropriate assumptions about the nature of *knowledge* about reality. The resulting epistemological position should contribute to the research objective of providing a scientifically designed and validated approach for implementing risk management within organizations. According to Schafersman (1997), reliable knowledge is *justified true belief*. He distinguishes this knowledge from belief that is true but not (yet) justified, or even false belief. According to Schafersman (1997), generating reliable knowledge by *scientific* thinking is based on three pillars: (1) using empirical evidence, (2) practicing logical reasoning, and (3) possessing a sceptical attitude.

For selecting a suitable epistemological position, three main scientific research paradigms are considered and discussed in view of the research objectives of this thesis. As stated in Van Aken (2004), Kuhn (1962) introduced the term "paradigm" by using it for different meanings. In line with Masterman (1970), here the term *paradigm* is used in a sociological sense. A paradigm is viewed as a system of scientific habits that is used by a group of scientists for trying to solve scientific questions.

As raised by Lobkowitz (1967) and Squires (1999) in Denyer et al. (2008), Aristotle already distinguished three different types of knowledge: (1) *theoria*, (2) *techne*, and (3) *praxis*.[20] Theoria is *explanatory* knowledge for its own sake. Techne is knowledge that is required for *making* artefacts. Praxis is knowledge for *acting* upon a situation for improving one's condition. Different terminology, with rather similar explanations, will be found in the literature.[21] Acknowledging these scientific research paradigms, and particularly considering their interfaces, is crucial within *organizational* research (Romme, 2003). This is confirmed by Arbnor and Bjerke

20 Why is it relevant considering knowledge terminology, which originated some 2500 years ago? It is because these three ancient types of knowledge generation evaluated, at different paces, towards today's three main scientific research paradigms. By using some simplification, theoria developed into the *natural sciences*, such as physics. Techne developed into *design sciences*, including engineering and architecture. Praxis is represented by the *humanities*, such as sociology.

21 For instance, Flyvberg (2006) distinguishes *episteme*, theoretical know why, from *phronesis* for practical common sense.

(1997), who propose three scientific approaches for business research: (1) the *analytical* approach, (2) the *systems* approach and (3) the *actors* approach. These approaches seem to correspond with the scientific paradigms of respectively the natural sciences, the design sciences and the humanities.
The type of research within this thesis can be classified as *organizational* research. Several scholars, including Romme (2003) and Van Aken (2005a, 2004), indicate that organizational research is currently mainly based on a combination of two scientific research paradigms, (1) the natural sciences and (2) the humanities. The natural sciences have a merely descriptive and analytical nature, while the humanities assume knowledge to be constructivist and narrative. Particularly for organizational studies Romme (2003) and Van Aken (2008a, 2005a, 2004) propose using a third scientific research paradigm: the *design* science. This third way is inspired by the work of Argyris (1993), Schön (1983), and Simon (1996). Applied disciplines like engineering, architecture, and medicine widely apply the design science paradigm. While the natural sciences and humanities focus on *explaining* and *predicting* the behaviour of *existing* systems, the design science approach concentrates on *changing* existing systems, either by *improving* or by *creating* entirely *new* systems. The concept of applying organizational research as a design science is elaborated in detail by Van Aken (2008a, 2005a, 2004) and Denyer et al. (2008). Figure 2.1 presents the three main scientific research paradigms from an epistemological point of view.

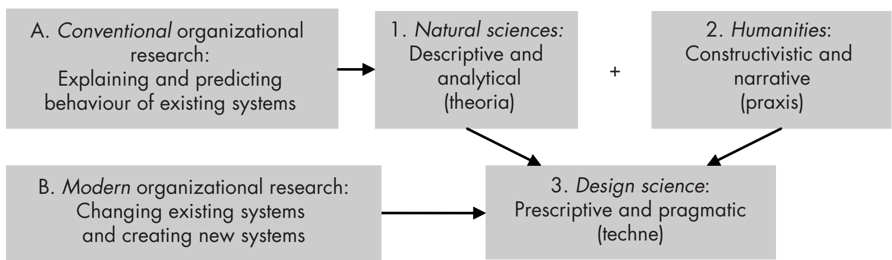

Figure 2.1 Scientific research paradigms from an epistemological point of view.

Of other epistemological concern is the distinction between *mono-disciplinary* and *multi-disciplinary* knowledge generation. Scholars such as Gibbons et al. (1994), Rotmans (2006), and Van Aken (2005a) distinguish Mode 1 knowledge generation from Mode 2 knowledge generation. Mode 1 knowledge production

is *purely academic* and *mono-disciplinary*. It tends having characteristics of the natural sciences with the associated positivistic elements.[22] Mode 2 knowledge production is *multi-disciplinary* and aims at *solving* complex and relevant *field problems* (Van Aken, 2005a). Hatchuel (2001) considers the design of research-oriented partnerships of academics and practitioners as an essential condition for Mode 2 research. According to Rotmans (2006), Mode 2 science may even become *trans-disciplinary*, be creating a new science mode out of the existing modes. For solving complex organizational problems, considering more than one single discipline seems usually a prerequisite. For instance, for implementing risk management within organizations, inclusion of other disciplines in addition to risk management, such as organizational disciplines, seems to be unavoidable.[23]
Conventional research questions in the natural sciences and the humanities are: Is it *valid*? Is it *true*? The main question in a design approach is: Will it *work?* The main question in this research was:

Do the design propositions for implementing risk management in an organization work?

Answering this question demands the application of pragmatic validity for generating solution-oriented knowledge (Van Aken, 2008a). Therefore, the intervention cycle of Verschuren and Doorewaard (2005) has been selected. Applying this cycle aims providing effective interventions in a problematic situations. The intervention cycle includes five subsequent steps: (1) raising awareness about the problem, (2) diagnosing of the problem, (3) designing a solution, (4) intervening the problem with the designed solution, and (5) evaluating the result of the intervention by the designed solution.[24]
In conclusion, for meeting the objectives of this research, applying the *design science paradigm* with *Mode 2 knowledge generation* and the *intervention cycle*, seems the appropriate choice from an epistemological perspective. However, for confirming this positioning, the design science needed to be explored in some more detail.

22 The sociologist Becker (1998) warns for the danger of monopoly on ideas by mono-disciplinary experts with their own social and scientific conventions.

23 The next section about the exploration research explains the need for a multi-disciplinary approach in more detail.

24 The structure of this thesis, which has been presented in Chapter 1, is based upon the intervention cycle by Verschuren and Doorewaard (2005).

Exploring the design science paradigm

Romme (2003) presents five characteristics of the design science paradigm: (1) purpose, (2) view of knowledge, (3) nature of research objects, (4) focus of theory development and type of research results, and (5) concept of causality. By reviewing these characteristics, the design science paradigm seems appropriate for this research about implementing risk management in organizations.

First, because of its *purpose*. One of the purposes of a design approach is changing existing organizational systems and situations in desired ones. This aligns with the purpose of implementing risk management in organizations, which will change an existing organizational situation in one with well-embedded risk management.

Second, the design science paradigm seems appropriate because of its *view of knowledge*. As explained by Romme (2003), design science is pragmatic by providing knowledge that supports to take action. This *actionable* knowledge is open to validation, as for instance raised by Romme (2003) and Van Aken (2008a). Furthermore, the nature of thinking is normative and synthetic, rather than analytic. The latter is common within the natural sciences. Synthetic thinking uses observations of an organization, rather than analysing the nature of the organization.[25]

Third, the design science paradigm seems suitable because of *the nature of objects*. As set out by Romme (2003), these entities are typically *organizational* issues and systems, with descriptive and *ill-defined* properties and problems. Improving these entities requires non-routine actions by people with insider positions. This actual research concerns implementing risk management in *organizations*. Properties of risk management methodologies and users, as well as their organizations, are ill defined.[26]

Fourth, the design science paradigm seems useful because of the *focus* on *theory development* and its *type of result*. According to Romme (2003), the focus of theory

25 Romme (2003) presents seven attributes of the view of knowledge according to the design science. To start with, design science acknowledges that (1) each organization is unique. It focuses on (2) creating ideal situations, (3) uses systems thinking and (4) acknowledges the usual situation of limited information within the design process. Furthermore, it (5) stresses the importance of participation and involvement in decision making and implementation of organizational changes, by those involved and affected. In addition, it (6) considers dialogue and discourse as a medium for the required interventions. Finally, (7) pragmatic experimentation is essential for creating improved or new artefacts. These seven attributes of the design science align well with the targeted knowledge generation for implementing risk management in organizations. (1) Every organization for implementing risk management is unique. (2) Ideal situations are defined by the material and immaterial objectives of well-implemented risk management within organizations. (3) Using a system thinking is useful for risk management (Van Staveren, 2006). (4) Acknowledgement of limited information is the very core of risk management. (5) Participation and involvement, as well as (6) dialogue and discourse, do adress the key role of people and their communication for adequate risk management (Van Staveren, 2006). Finally, (7) pragmatic experimentation is essential for making existing risk management methodologies fit-for-purpose within an organization, as proposed by Klein and Sorra (1996) and Rogers (2003).

26 As described by Archer (1984), in case of an ill-defined problem, only transforming, reducing, optimizing or superimposing the available information is insufficient for generating a designed solution.

2

development within the design science paradigm is on generating an integrated set of *design propositions* that will work in ill-defined situations.[27] Van Aken (2005a, 2004) presents these propositions as a set theoretically grounded and practically tested technological rules. Denyer et al. (2008) prefer the term design propositions, because the word “rule” may be incorrectly understood being rather mechanistic and precise instructions. Such misunderstanding neglects the generic character of the rules, together with the fact that these are (only) input for designing context-specific solutions.

Fifth, and related to the fourth characteristic, the design science approach is preferred because of its *causality concept*. This corresponds with the CIMO-logic of context, intervention, mechanism and outcome, by building on Pawson (2002) in Denyer et al. (2008). As presented by Numagami (1998) in Van Aken (2008a), design science applies design causality, by studying how relatively invariant patterns arise and how these patterns can be changed. This implies the need for *heuristic technological rules*, rather than *algorithmic technological rules*, as distinguished by Roozenburg and Eekels (1995) in Van Aken (2005b).[28] While the latter algorithmic rules guarantee the finding of a solution by providing an instruction, heuristic technological rules do *not* guaranteeing a solution. The heuristic rule just facilitates the *finding* of a solution, which seems to align well with the selected *hermeneutic* ontological position that considers the world as a *social construct* with inherent subjectivities.[29]

Recommendations of other scholars seem to align well with the design science approach. For instance, Gummesson (1988) describes three criteria for conducting quality business research.[30] These criteria are (1) having access to empirical data, (2) pre-understanding or insights in the specific research problem and its social environment and (3) using appropriate and proven methods. These criteria correspond with the design science approach. Nevertheless, in addition to these five favourable characteristics, there are also a number of *difficulties* with applying the design science paradigm in organizational research.

27 Implementing risk management, whith its inherent uncertainties, in organizations seems typically representing such an ill-defined situation.

28 The so-called *technological rule* originates from Bunge’s philosophy of technology (Bunge, 1967 in Van Aken, 2004).

29 For instance, organizational hurdles for implementing risk management can be considered as invariant patterns. Setting organizational conditions for implementing risk management, by applying interventions, aim to change these patterns. Heuristic technological rules may suggest the appropriate series of conditions and interventions for implementing risk management in organizations.

30 Implementing risk management in organizations may be considered as some sort of business research.

Difficulties of the design science paradigm

This section aims to identify and discuss any difficulties of applying the design science paradigm for research about implementing risk management in organizations. From a variety of researchers, five generic difficulties are subsequently presented and discussed: (1) the interfaces of design science with the natural sciences and humanities, (2) the rather controversary role of action research, (3) the lack of invariant laws, (4) the ruling concept of equifinality, and (5) the newness and lack of experience with organizational research by using the design science paradigm.

First, as indicated by Romme (2003), the design science approach needs to become more synthesized with the research approaches of the natural sciences and humanities. Given the pluralistic character of organizational studies, considerable communication and collaboration, as well as creating synergies between each of the three research paradigms is needed. This demands research at the *interfaces* of the three paradigms, which increases research complexity and confirms the need for Mode 2 knowledge development. Romme (2003) presents a few suggestions for interface-related research methods, such as combining insider-outsider approaches. Van Aken (2001) suggests applying alpha-testing and beta-testing of design propositions by means of action experiments and comparative case studies. According to Romme (2003), developing the interface between the design science mode and the humanities remains a promising area for future research.

Second, the action focus of designing research has similarities with the concept of *action research* (Romme, 2003). There are several different schools of action research and its acceptance is still subject of debate. For instance, Oates and Fitzgerald (2001) highlight that research findings about the action research *process* are still limited. Therefore, they provide some sort of meta-framework for executing action research that is based on its paradigm, purpose, participants, process, and product, with due attention to research validity and relevance. According to Baskerville and Meijers (2004), action research becomes a more widely accepted research method in management of information systems. Contrary, by referring to research in the 1990s such as performed by Tranfield and Starkey (1998), Romme (2003) states that action research is still not well accepted. He highlights a fundamental difference between action research and design research: the focus in time. Action research has merely a *retrospective* problem diagnosis focus, thus looking back in time for learning purposes. In addition, scholars such as Revans (1982) put emphasis on *action learning*. Contrary, design science looks forward into the *future*, for finding solutions. However, also this view is not without debate. It conflicts for instance with the cyclic process of action research by Susman and Evered (1978). Nevertheless, Järvinen (2005) advocates considering action research

2

and design science as similar research approaches. The role and contribution of action research in relation to the design science paradigm seems still fuzzy and subject of conflicting views between scholars. However, action research does not seem to add fundamentally new and purposeful elements to the design science approach. Therefore, the concept of action research has not been further explored within this research.

Third, the *lack of invariant laws* due to the role of human agency in organizational research (Van Aken, 2008a) raises difficulties.[31] By referring to Numagami (1998), Van Aken (2008a) states that at best *patterns* and *regularities* in behaviour may be found in organizations, unlike universal and invariant laws, which rule in the physical world. This fundamental difference is caused by the free will of individuals, as well as the influence of social systems on the free will. The lack of invariant laws generates the need for at least two levels of research: (1) individuals and (2) their social systems. This free will phenomenon creates an additional problem for managers. Unlike medical doctors, who perform their designed interventions usually by themselves, managers have to realize their designed interventions by their subordinates (Van Aken, 2008a). Therefore, the outcome of their interventions depends on the quality of their own intervention design, but also on the subsequent actions of their subordinates with their free will.[32] According to Van Aken (2008a), the fundamental differences between the social and physical world in organizational studies have two consequences for the design of the research: (1) transfer of knowledge from one social setting to another, rather than generalization (Lincoln and Guba, 1985), and (2) looking for generative mechanisms, instead of general laws (Pawson and Tilly, 1997).

Fourth, another difficulty of the design science paradigm, closely related to the lack of universal laws, originates from the *concept of equifinality*. As for instance presented by Holahan (2004), Klein and Sorra (1996), and Nord and Tucker (1987), using different implementing processes may give the same end result. In other words, different implementation practices and processes may create the same level

31 Cozijnsen et al. (2000) distinguish *organizational objectives* and *human objectives* of implementating an innovation. Organizational objectives are for instance increased profits and turnover. Examples of human objectives are reduction of staff turnover and enhanced motivation of employees. According to Cozijnsen and colleagues, it is impossible to check innovation results against external success criteria. There is simply no external and generic success measure that is suitable for equally measuring and comparing the variety of innovations, such as product innovations, technological innovations and organizational innovations. This aligns with the idea of lacking invariant laws within organizational research. By acknowledging these facts, any design proposition for implementing risk management within an organization could not but considered with care and modesty.

32 For instance Wilson (2002) raises additional complexity about human agency, by posing that human behaviour is largely generated by *unconscious* mental processes. Therefore, the degree of actual freedom of the free will seems rather restricted.

of implementation effectiveness. Moreover, as concluded by Cozijnsen et al. (2000) and based on a study of fifty Dutch innovation projects, the *success* and *failure* factors differ per innovation type. There seems to be no success or failure factor(s) that unambiguously influence the success of all types of innovation.[33]

Fifth and finally, applying the design science paradigm within organizational research is rather *new*, with a limited number of available research methodologies, results, and case studies (Van Aken, 2005b). Consequently, confusion about the meaning and characteristics of a design science approach seems easily developed. Cross (1993) distinguishes design science, being a *prescriptive* and systematic approach to design, from the science of design. The latter concerns to a rather *descriptive* approach for improving understanding of design. Boonstra (1996) presents fundamental differences between a *design* approach and a *development* approach for realizing organizational change. The first approach aims realizing a designed end situation, while the second approach develops the final situation in a step-by-step way. Table 2.1 presents these differences. It shows that the design science paradigm, as previously presented and discussed, blends a lot of the characteristics of both approaches presented by Boonstra (1996).

Table 2.1. Differences between a design and development approach for organizational change (Boonstra, 1996).

***Design* approach for organizational change**	***Development* approach for organizational change**
Organization as source of *problems*	Organization as source of *experiences*
New organizational design with a blue-print	Improving the *existing* organization
Top-down approach	Using knowledge and insight of *employees*
Attention to *solutions*	Attention to *problems*
Stable *end result*	Increasing the ability to *change*
Once in a time and *linear* process	*Continuous* and *iterative* process
Dominance of *technical* and *economic* perspectives	Dominance of *social* and *political* perspectives
Fixed norms and planning	Attention to the *ability* to *change*
From *abstract* models towards *concrete* practices	From *concrete* practices to *abstract* models
Focus on *expert* knowledge	Using *practical* knowledge
Separating design and implementation	Smooth *transitions* between different phases

33 While the quantitative study by Cozijnsen et al. (2000) did provide some correlations between different innovation implementation factors, such as resistance to leadership and resistance against too many or previous innovations, these correlations varied strongly between different types of innovations. Some of the correlations even disappeared, when relative effects of different types of innovations were included.

Summary of the selected scientific framework

In view of the research objectives, the main ontological and epistemological *concerns* of this research have been explored. This resulted in the following selected ontological and epistemological *positions*:

- From an *ontological* point of view about assumptions of the nature of reality: A *hermeneutic* worldview that considers the world as a *social construct* with inherent subjectivities;
- From an *epistemological* point of view concerning assumptions of the nature of knowledge about reality: A *design science* paradigm with *Mode 2* knowledge generation and a *practical* research approach for generating *solution oriented* knowledge.

Together, these selected *ontological* and *epistemological* positions provided the scientific framework of this research. The resulting practical design science approach aims providing solution-oriented and prescriptive knowledge that supports solving field problems by professionals. The logic of prescription is according to the CIMO-logic of context, intervention, mechanism and outcome (Denyer et al., 2008). This approach can be summarized by using a residue-definition (Van Aken, 2008a): The practical design science approach is *not* an explanatory science approach. The carefully selected design science approach for organizational research has been critically analyzed, by revealing and discussing its inherent difficulties. Figure 2.2 presents the resulting research design.

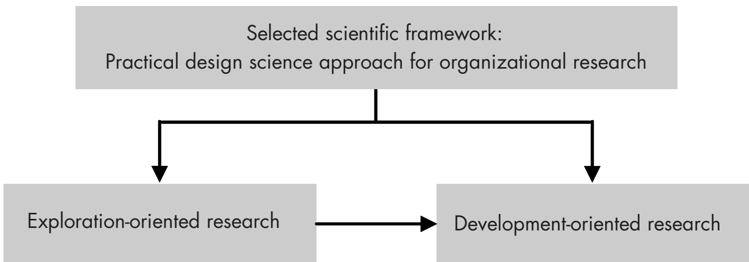

Figure 2.2 Research design.

The next two sections define of the exploration-oriented research and the development-oriented research approaches, in view of the selected scientific framework. The exploration research consisted of an exploratory part and a synthesizing part. It intended revealing and synthesizing the relevant concepts and variables for implementing risk management in organizations. Subsequently risk management, innovation management, and change management concepts and variables have been explored by literature and field research. The results of the exploration research served as input for the development research part. The latter aimed generating and validating design propositions for implementing risk management in organizations, with scientific accountability as well as practical relevance. Synthesis-evaluation iterations (Van Aken, 2008a) have been applied in the development part of this research, for generating the optimum final design propositions.

2.3 Exploration research approach

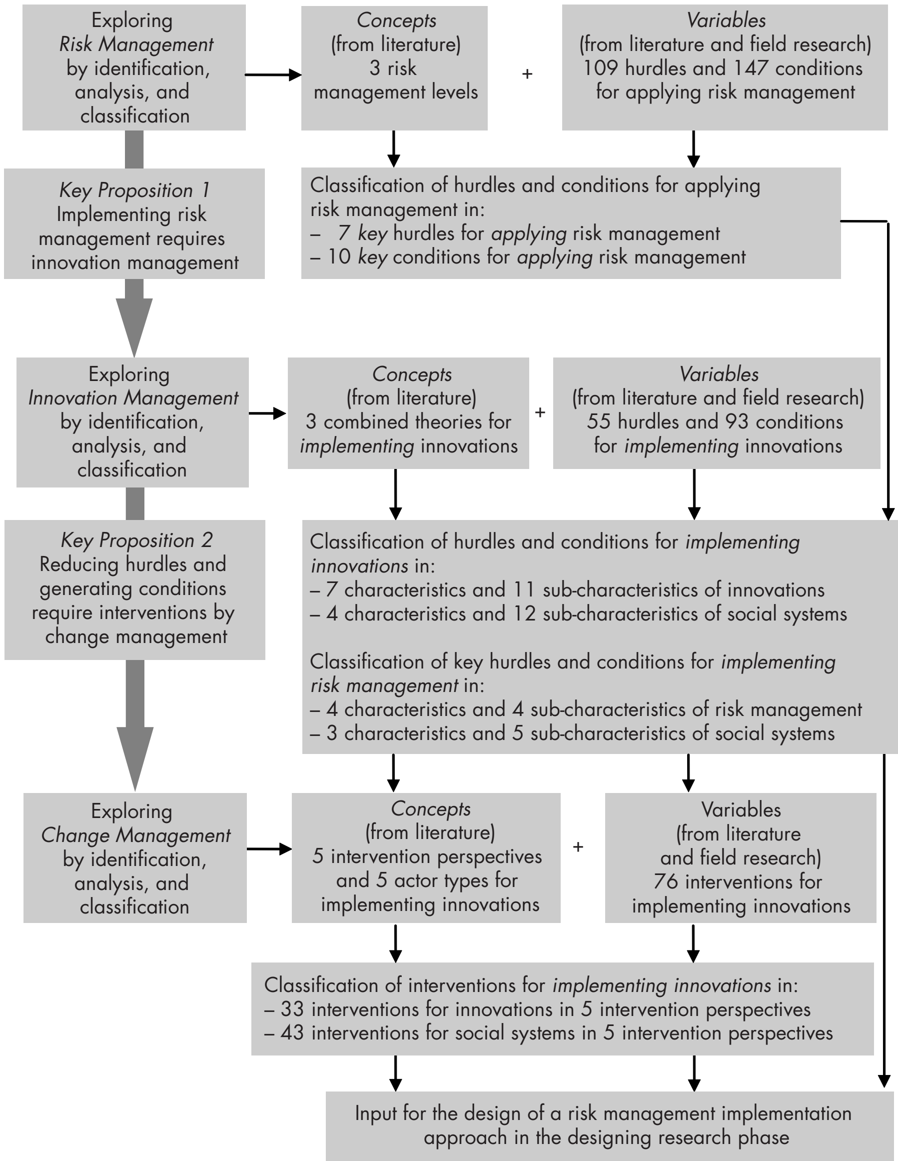

Figure 2.3 The structure and results of the exploration research.

The logical sequence of exploring three disciplines

The exploration research included subsequently investigating the disciplines of risk management, innovation management, and change management. Figure 2.3 (on the previous page) presents the logical sequence of exploring these disciplines, together with the main results. One key proposition links risk management to innovation management and another key proposition links innovation management to change management. Next, this logic is motivated.

Exploratory research and synthesizing research

The exploration of the disciplines of risk management, innovation management, and change management consisted of an exploratory research part and a synthesizing research part. In the exploratory part, concepts and variables have been identified. In the synthesizing part, these concepts were selected and combined by analyses. Moreover, the identified variables were classified according to the selected and combined concepts. Consequently, the exploration research included the steps of (1) identification, (2) analysis, and (3) classification of concepts and the variables. Figure 2.4 shows these three steps.

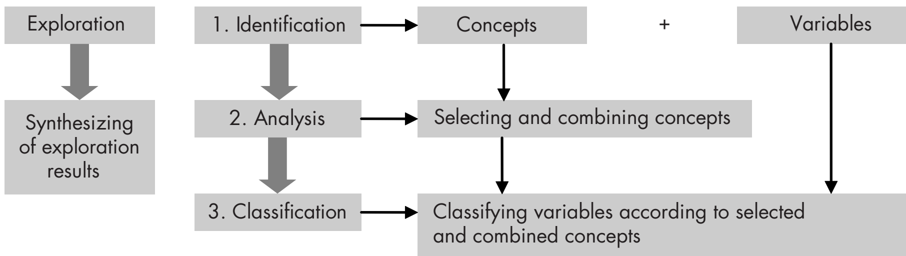

Figure 2.4 The subsequent steps of identification, analysis, and classification during the exploration research.

First, state-of-the-art concepts and sets of variables were *identified* in each of the disciplines. *Concepts* are mental models for simplifying the world (De Bono, 1998). While being inherently fuzzy, concepts prevent us from getting stuck in details.
For *risk management* and *innovation management* two sets of *variables* were considered: *hurdles* and *conditions* for respectively applying risk management and implementing innovations in organizations. Hurdles are barriers, obstacles, or unfavourable situations for implementing risk management. Contrary, *conditions* are prerequisites, requirements, or favourable situations for implementing risk management in organizations.

Within the discipline of *change management* another two sets of variables were explored: *interventions* and *actors*. By synthesizing definitions by Daft (1998), Rogers (2003), and Verschuren and Doorewaard (2000), interventions are well-planned and user group specific actions for *changing* unfavourable hurdles into favourable conditions for implementing innovations within organizations. By the earlier introduced CIMO-logic of context, intervention, mechanism, and outcome (Denyer et al., 2008), the *mechanisms* of *interventions* should generate appropriate conditions or *outcomes* for implementing innovations within a given organizational *context*. Actors, the other set of change management variables, are the main players during the innovation implementation process, including users, their managers, change agents, opinion leaders, and champions (Rogers, 2003).
Next, by *analyzing* the identified concepts, the most promising ones for implementing risk management in organizations have been selected and combined. Finally, all identified variables were *classified* by using the selected and combined concepts. This exercise structured the considerable number of identified variables to manageable proportions.

Summary of the exploration research results

The exploration research generated a number of promising concepts and a considerable number of variables. Table 2.2 summarizes these results, which served as input for the designing research.

Table 2.2. Summary of the exploration research results.

Disciplines of exploration research	Resulting concepts	Resulting variables
Risk management	3 levels of applying risk management within organizations.	109 hurdles and 147 conditions for *applying risk management*, classified in 7 key hurdles and 10 key conditions.
Innovation management	3 combined theories for implementing innovations that are considered promising for implementing risk management.	55 hurdles and 93 conditions for *implementing innovations*, classified in 7 characteristics and 11 sub-characteristics of innovations and 4 characteristics and 12 sub-characteristics of social systems.
Change management	5 intervention perspectives and 5 types of actor, who are relevant during the process of implementing innovations.	76 interventions for reducing hurdles and generating conditions for *implementing innovations*, classified in: – 33 interventions and 5 intervention perspectives for innovations – 43 interventions and 5 intervention perspectives for social systems.

Summing up all of the resulting variables in the three cells of Table 2.2 gives a total of 480 variables. Of these variables the total number of hurdles is 164. The total number of conditions is 240. These were identified by exploring the disciplines of risk management, innovation management, and change management. All of the variables appeared in some way effecting the implementation of risk management in organizations. They stem from several different data sources, and obviously a considerable number of variables may have overlapping characteristics. The identification of this huge number of variables, from exploring risk management, innovation management and change management reveals the enormous complexity of implementing risk management within organizations. These variables were analyzed, structured, and classified by using the resulting synthesized concepts. Furthermore, two key propositions were generated during the exploration research:

Key Proposition 1: *Implementing risk management requires innovation management;*

Key Proposition 2: *Reducing hurdles and generating conditions require interventions by change management*.

These key propositions connect the disciplines of risk management, innovation management, and change management. Obviously, both theoretically derived propositions required empirical confirmation. Therefore, a risk management implementation approach has been developed and empirically tested in the development research phase, which addressed both key propositions. This approach considers the application of risk management within an organization, provided it is new to that organization, as an innovation. Furthermore, it suggests interventions, according to five perspectives, for reducing hurdles and generating conditions for implementing risk management. These conditions are essential for generating the relevant (sub-)characteristics of risk management methodologies. They are also required for generating the relevant (sub-)characteristics of the social system(s), in which the methodologies are implemented. Moreover, the relevant actors during the implementation process are acknowledged. The topic of the next section is inferring an appropriate and well-structured approach for this development research part.

2.4 Development research approach

2

Development research for generating design propositions

This section presents and motivates the development oriented research part of this dissertation. It defines the required development research process for providing design propositions for implementing risk management within organizations.[34] The development research part aimed *generating* and *validating* these design propositions, with scientific accountability as well as practical relevance. The results of the exploration research provided the input for the development research part.

According to Van Aken (2008a), there are many good definitions for the term *design*. One of these defines design as “a model of an entity to be realized, as an instruction for the next step in the creation process” (Van Aken 2005b: 391). Van Aken (2005b) distinguishes three types of design in the immaterial world of designing: (1) process design, (2) object design, and (3) realization design. The latter realization design serves as input for the realization process that creates the demanded entity in the material world. *Process design* concerns formally planning and organizing the design process itself. This is in fact a sort of meta-design. *Object design* is obviously designing the object or artefact itself, such as a foundation or an entire bridge. Similarly, at a more abstract level, *entity design* involves designing an entity, such as an organization structure. *Realization design* is the formal design of the realization process of the object or entity of concern. By having a realization design, the material world of realizing the object can be entered, for instance by actually constructing the foundation or entire bridge.

Within this research, the *entity* to be realized is implemented risk management within an organization. This entity seems remaining largely in the immaterial world, because risk management implementation as such is abstract and intangible. Obviously, there may be some artefacts that demonstrate the implementation of risk management in an organization, such as the availability of written risk management procedures, the presence of risk registers for each of an organization’s construction projects, and formally issued statements with the risk responsibilities for employees[35]. Nevertheless, *implemented* or routinely applied risk management within an organization is particularly embedded in attitude, behaviour, and acting of its employees.

34 The design of risk management implementation itself starts in Chapter 6, which reports the initial design propositions for risk management implementation.

35 Development of artefacts, such as new risk management methodologies, is beyond the scope of this research that (only) considers existing methodologies.

The *process* of *designing* can be defined as making a design (Van Aken 2005b: 392). Within this thesis, *development* research means providing scientific research in order to *design* an *approach* for implementing risk management within organizations in the construction industry. Because the entity to be realized is implemented risk management within an organization, the research focuses on *realization design*. In other words, of major concern is *how* to design the realization process for implementing risk management within an organization.

Design knowledge

By referring to Schön (1983), Van Aken (2005b) distinguishes three types of *design knowledge*, similar to the previously introduced three types of design. Table 2.3 presents the relationships between generic design types, design activities, and the required design knowledge.

Table 2.3 Generic design types, design activities, and related design knowledge (after Van Aken, 2005b).

Design types	Design activities	Design knowledge
1. Process design	Formally planning and organizing the design process itself.	Knowledge about characteristics and properties of design processes.
2. Object or entity design	Formally designing an object or entity at the end of each sentence in this table.	Knowledge about characteristics and properties of the object or entity.
3. Realization design	Formal design of the realization process of the object or entity.	Knowledge about the various processes required for actually realizing the object or entity.

Table 2.4 presents the relationships between design types, design activities, and the required design knowledge for specifically this research: Developing design propositions for implementing risk management in organizations in the construction industry. Table 2.4 shows that the results of the exploration research are relevant for the design of the entity of implemented risk management in organizations, as well as for the realization design that aims to reveal how to implement risk management in organizations in the construction industry.

Table 2.4 Specific design types, design activities, and related design knowledge for this research.

Design types	Design activities	Design knowledge
1. Process design	Formally planning and organizing the design process of the designing research.	Knowledge about the *design science approach*, as presented in Section 2.2 of this thesis.
2. Entity design	Formally designing the implementation of risk management within an organization at the end of each sentence in this table.	Knowledge about *risk management* and *innovation management*, gathered by exploration research, as introduced in Section 2.3 and elaborated in Chapter 3 and Chapter 4 of this thesis.
3. Realization design	Formal design of the realization process of the object or entity.	Knowledge about *change management*, gathered by exploration research, as introduced in Section 2.3 and elaborated in Chapter 5 of this thesis.

Design specifications

Usually, designing is performed on the basis of a set of requirements or *design specifications* (Van Aken, 2008b). Within this research, two sorts of design specification are distinguished: (1) *meta-specifications* of the entire designing research, and (2) *specific specifications* for the design of the risk management implementation approach. The latter specific specifications are presented later in this section.

By applying the *principle of minimal design specification* (Van Aken, 2008b), the two meta-design requirements for this research are (1) guaranteeing reliability and validity, from a scientific point of view (Becker, 1998; Kardon et al., 2006; Yin, 2003), and (2) providing *solution-oriented* and *prescriptive knowledge* that supports solving field problems by professionals (Van Aken, 2008a), from a practical point if view.

Reliability implies the ability to replicate the same research results, when the research is repeated by other researchers under the same circumstances (Yin, 2003). Carefully structuring and explaining the designing research approach aimed guaranteeing the scientific reliability of this research.

Validity expresses to which degree a research method investigates what it aims to. By referring to Kidder and Judge (1986), Yin (2003) distinguishes (1) construct validity, (2) internal validity, and (3) external validity. Establishing correct operational measures for the concepts studied should provide *construct validity*. *Internal validity* concerns establishing causal relationships between variables. Within this research, the CIMO-logic of context-intervention-mechanism-outcome (Denyer et al., 2008)

guided this causality. It should be considered heuristically and context dependant, rather than linear and universal. The degree of *external validity* corresponds with the degree to which the research results can be generalized (Yin, 2003). Van Aken (2008a) stresses the importance of external validity of organizational research results, because of the desire and need to transfer findings within one organizational context to another one. However, as has been raised before, conventional generalization is highly complicated for organizational research results, due to the lack of invariant laws.
The selected practical design science with applying the logic of the prescription according to the CIMO-logic of context, intervention, mechanism and outcome (Denyer et al., 2008) aims providing *solution-oriented* and *prescriptive* knowledge that effectively and efficiently supports solving field problems by professionals.

Meta-design specifications

By performing so-called synthesis-evaluation iterations (Van Aken, 2008b) both before introduced meta-design requirements should be satisfied, by strengthening each other. Synthesis-evaluation iterations involve synthesizing and evaluating a possible solution to the design problem on paper. If design requirements are not realized to an acceptable degree, a modified or even new design has to be made. Obviously, also adaption of the specifications may be needed.

For the development oriented research of risk management implementation in organizations, this approach resulted in four subsequent steps:

1. Initial design for risk management implementation;
2. Validation of initial design for risk management implementation;
3. Modified design and evaluation for risk management implementation;
4. Final design for risk management implementation.

Figure 2.5 presents the logical sequence of these four steps. Next, the steps are briefly described. Each step is described in much more detail in Chapter 6 through to Chapter 10.

Step 1: Initial design for risk management implementation

The principle of minimal specification is fundamental in design theory. It teaches that a designer should only specify in a design what those people, who have to realize it, need to know for being able to realize it (Van Aken, 2008b). By acknowledging this principle, only three *specific design criteria* have been defined:

1. The *conditions* and *interventions* for risk management implementation should be perceived *relevant* by the actors during and after the risk management implementation process;
2. There should be a *causal* and *positive relationship* between *interventions* and *conditions*, which means that executing interventions should generate the required conditions;
3. There should be a *causal* and *positive relationship* between the degree of presence of *conditions* for implementing risk management and the degree of *risk management implementation* within the organization. This implies that an increase in presence or strength of conditions, due to executed interventions, does increase the degree of risk management implementation within an organization.

Together, the three design criteria form the set of *design specifications* for the *initial* risk management implementation proposition. Based on these initial design criteria, first a conceptual risk management implementation *model* has been derived. Within this model, hurdles have been transformed into conditions.
The initial model includes 41 *key* conditions (situations) for implementing risk management within an organization and 19 *key* interventions (actions) for generating these key conditions. *Key* conditions and *key* interventions should be considered as the most relevant conditions and interventions for realizing risk management implementation within an organization. These key conditions and key interventions are developed in three steps:

1. Deriving *key conditions* for implementing risk management in organizations;
2. Allocating *key conditions* to five intervention perspectives;
3. Deriving *key interventions* for generating key conditions for each intervention perspective.

Next, an *initial instrument* for *auditing* risk management implementation has been developed. This instrument allows measuring and monitoring to which degree that the 41 key conditions are present within an organization. It also reveals to which degree the 19 key interventions are executed, according to the CIMO-logic of context-intervention-mechanism-outcome (Denyer et al., 2008).

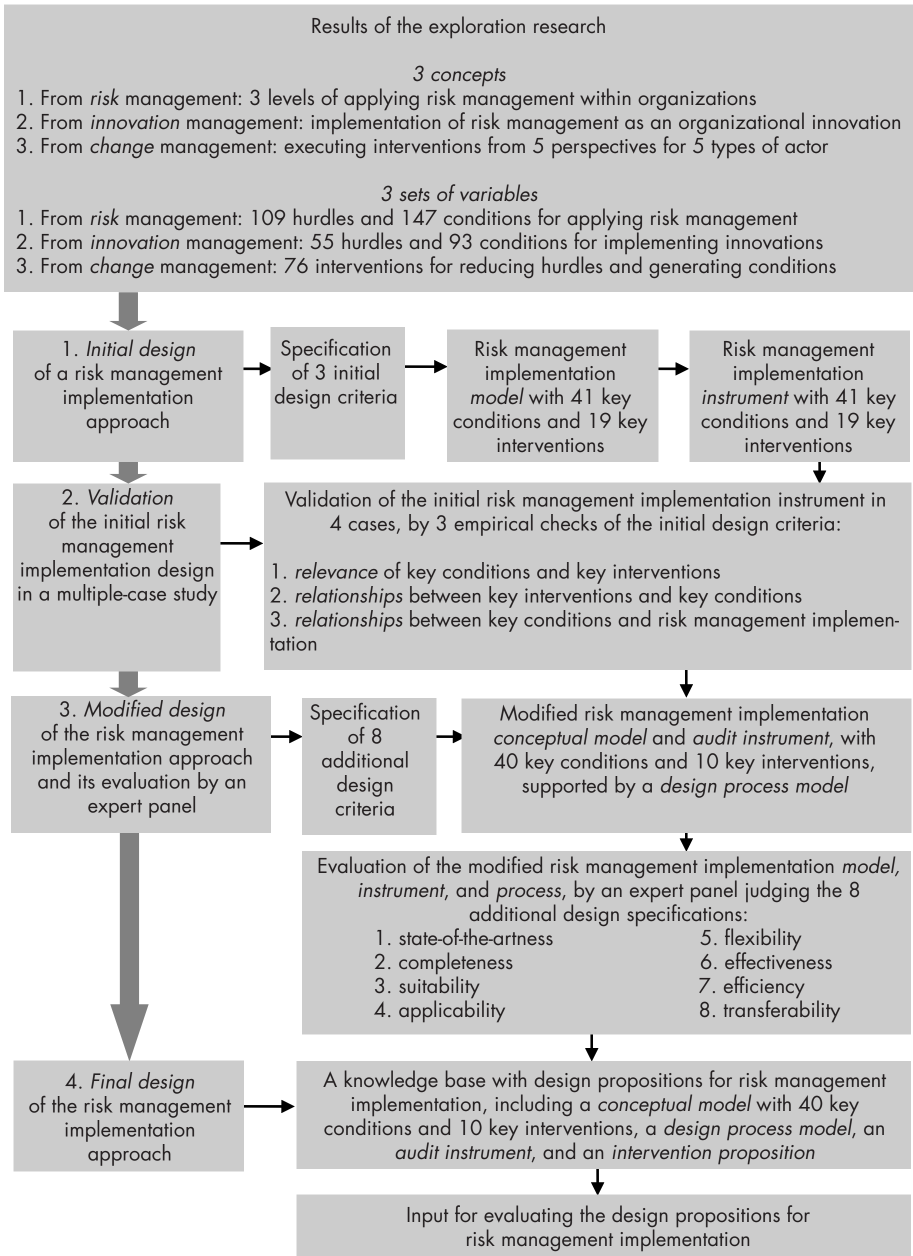

Figure 2.5. The structure and results of the development oriented research part.

2

Step 2:
Validation of initial design for risk management implementation

The *initial* risk management implementation design has been *validated* in a multiple-case study with four single cases and a cross-case analysis. Alternative validation approaches, such as experiments, surveys, and historical and archival analyses (Yin, 2003), were considered not suitable for checking the design proposition.[36]
Olsson (2006) completed Ph.D. research on managing project uncertainty by using an enhanced risk management methodology. According to him, the case study approach is particularly relevant, because the effectiveness of risk management cannot be easily measured. In the view of Eisenhardt (1989), accumulating supporting evidence from multiple-case studies generates theoretical saturation of a design proposition. Van Aken (2008a) refers to Rousseau (2001) for highlighting the value of cross-cases analysis within applied organizational research.
Commonly encountered scientific concerns of case studies, such as lack of rigor with resulting biased views and equivocal evidence, and a small basis for generalization (Flyvbjerg, 2004; Yin, 2003), have been addressed within this research by a number of measures. Cases have been carefully selected and a case study protocol (Yin, 2003) has been designed. Furthermore, the hierarchical approach of starting with single cases and using their results for a cross-case analysis has been applied, as suggested by for example Verschuren and Doorewaard (2000) and Brown and Eisenhardt (1997). In view of the initial design criteria, three empirical checks of have been performed in the multiple case study. These checks purposed to validate (1) the perceived practical *relevance* of the key conditions and key interventions by professionals, (2) the *relationships* between key interventions and key conditions, and (3) the *relationships* between key conditions and risk management implementation.

Step 3:
Modified design and evaluation for risk management implementation

Based on the results, the initial conceptual model for risk management implementation and its supporting instrument have been *modified*, according to eight additional design criteria. This approach of theory building from case studies is suggested by Eisenhardt and Graebner (2006). It also corresponds with the so-called synthesis-evaluation iterations by Van Aken (2008b). Specific attention to innovation user groups have been added to design.

36 This statement is motivated as follows. An experiment type of validation requires control over behavioural events, which is not possible in case of implementing risk management in organizations. The context of each organization is too specific for applying the required standardisations for a survey type of validation. Archival analysis and studying historical analysis neglect the modern character of this research, which investigates how to implement risk management in today's and tomorrow's organizations, rather than yesterday's ones (Yin, 2003).

Furthermore, a *design process model* for the risk management implementation process has been developed, by building forward on the model for innovation diffusion by Rogers (2003). By building forward on Van Aken (2005b), the function of this model is structuring the design process of risk management implementation. The design process model aimed providing guidance about which steps should be undertaking by which actors during the process of risk management implementation within an organization.[37] For *validation* purposes, an expert panel evaluated the *modified* risk management implementation approach by critically considering the conceptual model, the audit instrument, and the design process model for implementing risk management within organizations.

Step 4: Final design for risk management implementation

Incorporating the recommendations of the experts resulted in the *final* design for risk management implementation in organizations. The resulting knowledge base consists of final versions of the conceptual model and the design process model for implementing risk management within organizations, together with an modified audit instrument and an intervention proposition. As proposed by Van Aken (2005b), the design process model includes a *process-structure* part and a *role-structure* part. The process-structure part includes the organization part by presenting a number of logical steps for the risk management implementation process within an organization. The role-structure part defines the roles, tasks, and responsibilities of the actors during the risk management implementation process. The latter was still missing in the modified design. In the final design, the audit instrument has been made more user-friendly.

In addition, an detailed *intervention proposition* has been added. It provides additional guidance for selecting and executing user group-specific key interventions with supporting activities. These should increase motivation and commitment of the individual risk management users within the user groups for routinely applying risk management in their day-to-day activities. Moreover, the suggested interventions facilitate setting key conditions for risk management methodologies and social systems, in which the methodologies are being implemented.

37 Other terms for design process model may be encountered, such as design strategy (Cross, 1994 in Van Aken, 2005b).

2

Summary of the development research results

The defined development-oriented research approach consisted of four subsequent research steps. Table 2.5 summarizes the results of the development research.

Table 2.5. Summary of the development-oriented research part: Research steps and research results.

Development-oriented research steps	Development-oriented research results
1. Initial design	An initial *conceptual model* and an *audit instrument* for risk management implementation, with 41 key conditions and 19 key interventions.
2. Validation of initial design	Insight in (1) *relevance* of key conditions and key interventions, (2) *relationships* between key interventions and key conditions, and (3) *relationships* between key conditions and risk management implementation of the initial *conceptual model* and *audit instrument* for risk management implementation.
3. Modified design and evaluation	A modified *conceptual model* and *audit instrument* for risk management implementation, with 40 key conditions and 19 key interventions. A *design process model* for guidance of the risk management implementation process. Insight in (1) state-of-the-artness, (2) completeness, (3), suitability, (4) applicability, (5) flexibility, (6) effectiveness, (7) efficiency and (8) transferability of the modified *conceptual model*, the *audit instrument*, and the *design process model* for risk management implementation.
4. Final design	Final knowledge base for implementing risk management within an organization consisting of a *conceptual model* with 40 key conditions and 10 key interventions, a *design process model*, an *audit* instrument and an *intervention proposition*.

2.5 Results and next research step

Research results

The results of the research design, as presented in this chapter are (1) a purposefully selected scientific framework, (2) an exploration research approach, and (3) an approach for the development research part. Scientific validity and reliability, as well as overall usefulness within the professional practice of the research results, served as meta-design criteria for the development research part that aimed to generate design propositions for implementing risk management in organizations.

Regarding the *scientific framework* for this research, the *hermeneutic* worldview with a *design science* paradigm, *Mode 2* knowledge generation, and a *practical* organizational research approach has been selected. The resulting *practical design science* approach aims providing solution-oriented and prescriptive knowledge that supports field problem solving by professionals. This approach has a rather explorative and innovative character. Nevertheless, despite a few inherent and acknowledged difficulties, the practical design science approach for organizational research was considered the most appropriate approach for meeting the research objectives.

The design of the *exploration research* part provided a well-structured approach for exploring and synthesizing concepts and variables from subsequently the disciplines of risk management, innovation management, and change management. The exploration research included identification, selection, and synthesis of *concepts* for implementing risk management in organizations. Moreover, in total 480 *variables* were identified by exploring the disciplines of risk management, innovation management, and change management. All of these variables appeared in some way to affect the implementation of risk management in organizations. These variables were analyzed, structured, and classified by using the synthesized concepts. The exploration research results served as input for the development research part. Chapter 3 through to Chapter 5 present the exploration research process and results.

The definition of the *development research* approach for generating design propositions included elaborating the concepts of design, design knowledge, and design criteria. It resulted in four subsequent research steps for developing and validating design propositions for implementing existing risk management methodologies within organizations. Chapter 6 through to Chapter 10 present the development research process and the research results. These generated a knowledge base with a conceptual model, a design process model, an audit instrument, and an intervention proposition for implementing risk management within organizations in the construction industry.

Research limitations

Any inherent research limitations were comprehensively discussed in the section about selecting the scientific framework in this chapter. During the exploration and development research, these limitations have been addressed in the best possible way, by selecting an using the most appropriate research strategies and tactics. Nevertheless, being an inherent consequence of doing research, limitations arose. These have been addressed at the end in each of the forthcoming chapters. These research limitations were incorporated in the design of each new research step during the entire research process. Finally, the conclusions section of Chapter 10 presents the resulting research limitations of this research, which served as basis for the recommendations for future research.

Next research step

According to the selected scientific framework, the next research step involved exploring the discipline of risk management, as part of the exploration part of this research.

3

EXPLORING RISK MANAGEMENT

3.1 Introduction

This is the fist chapter about the exploration research. It reports the three subsequent steps of *identifying*, *analyzing*, and *classifying* risk management concepts and variables in three distinct sections. In the last section, the main research results, research limitations, and the resulting next research step are presented. This resulted in a key proposition that generated the need for exploring innovation management, which is the topic of Chapter 4.

3.2 Data identification

State-of-the-art *concepts*, as well as *variables* for applying risk management have been identified by *literature* and *field* research. First, the main and relevant concepts about *uncertainty*, *risk*, and *risk management* have been identified from a literature survey. Second, variables for applying risk management, *hurdles* as well as *conditions*, have been derived from the literature survey and from field research. The researcher's book *Uncertainty and Ground Conditions: A Risk Management Approach* (Van Staveren, 2006), with its abundant references, served as main source of literature. Moreover, additional risk management literature has been explored. During field research, practical knowledge from international experts and Dutch experiences served as data sources for the identification of hurdles and conditions for applying risk management.

3.2.1 Concepts about uncertainty, risk and its management from literature research

Within this section, the main and relevant concepts about *uncertainty*, *risk*, and *risk management* for this research have been identified from the literature. The concept of risk management has been in-depth explored by identifying scientific, heuristic, fatalistic, and holistic risk management approaches.

Uncertainty

Within the literature, several types of *uncertainty* are present. For instance, Frank (1999) distinguishes aleatory uncertainty from epistemic uncertainty. *Aleatory* uncertainty refers to variation and change, while *epistemic* uncertainty addresses (a lack of) knowledge. Based on extensive literature analysis, integration of proposed classes of uncertainty, and discussions with experts, Van Asselt and Rotmans (2002) distinguish two sources of uncertainty at the highest level of aggregation: (1) variability and (2) limited knowledge.

Variability is considered as an ontological attribute of reality and corresponds with aleatory uncertainty.[38] Rowe (1994) presents five *sources* of variability: (1) the inherent *randomness of nature*, (2) *technological surprises*, (3) *value diversity* or differences in the mental maps of people, (4) *behavioural variability* of people, such as non-rational behaviour and discrepancies between what people say and do by

38 Other scholars refer to this type of uncertainty as *stochastic uncertainty* (Helton, 1994), random uncertainty (Henrion and Fischhoff, 1986), *external uncertainty* (Kahneman and Tversky, 1982), *primary uncertainty* (Koopmans, 1957), and objective uncertainty (Natke and Ben-Haim, 1996).

cognitive dissonance, and (5) *social randomness* that results from social, economic and cultural dynamics at the level of groups, organisations, and societies.[39]

Limited knowledge, by incomplete or uncertain information, results from the inherently limited resources to measure and obtain empirical information about variability. This corresponds with epistemic uncertainty. Van Asselt and Rotmans (2002) present a continuum with seven types of knowledge limitations. These range from inexactness, at the end of a maximum of knowledge, towards irreducible ignorance at the opposite end with a minimum of knowledge. This latter fundamental knowledge uncertainty can be classified as structural uncertainty (Rowe, 1994) or systematic uncertainty (Morgan and Henrion, 1990). Blockley and Godfrey (2000), use the term *incompleteness* for addressing limited knowledge. Bea (2006) and Taleb (2007) divide incompleteness in that what we know that we do not know (*known unknowns*) and that what we not know that we not know (*unknown unknowns* or *unk unks*). Therefore, as raised by Smallman (2000), even when information is perceived as complete, uncertainty is present. In addition and perhaps somehow disappointing, more knowledge does not automatically generate less uncertainty.[40]

Risk

Given the concepts of uncertainty, what is their relationship with risk? According to Van Asselt and Vos (2006), the terms *uncertainty* and *risk* are intermingled. Is there any difference between these terms? Yes, there is. For instance, by interpreting Rowe (1977), Halman (1994) presents risk as a process chain. A cause triggers an event, which results in some sort of exposure and a sequences of effects. Uncertainty is present in each of the elements of this chain. In the view of Carlsson et al. (2005), an uncertainty becomes a risk by assigning a *probability* to it.

In addition to its relation with uncertainty, the term risk is also often associated with the term *hazard*. Waring and Glendon (1998) notice that the words risk and hazard are commonly intermingled. They define a *hazard* as some sort of threat to people and the things that they value.[41] Such unwanted events may be caused by

39 Particularly for the construction industry, Blockley and Godfrey (2000) distinguish *randomness*, a lack of specific pattern, from *fuziness* due to imprecise definitions or imprecision of concepts.

40 This aligns with the *theory of unknowledge* by Shakle (1995) in Taleb (2007) and Van Asselt and Rotmans (2002). This theory implies that there would be no uncertainty, if a question could be aswered by additional information.

41 According to Bernstein (1996), the word risk comes from the early Italian risicare, which means to dare. By this meaning, exposure to risk is rather a choice than a fate. Also according to Bernstein (1996), the word hazard seems to be derived from the Arabic al zahr, which is the Arabic word for dice. Therefore, contrary to risk, fate seems to play a dominant role in the meiining of the word hazard. Vlek and Hedrickx (1988), in Halman (1994), present a gambling-type of risk definition.

physical entities, conditions, substances, activities, or behaviours that are capable of causing harm.

Among the many available and overlapping definitions of risk within the literature, a common definition of *risk* is the *product* of the probability of occurrence and the impact of a hazard, for instance proposed by Smallman (2000). However, the term *probability* is often narrowly interpreted as a mathematical term (ISO, 2007a). The closely related term *likelihood* has a wider meaning. It refers to the chance of something changing and is therefore preferred in this thesis.[42] Moreover, Williams (1996) rejects the idea of *multiplying* likelihood and impact of risks. By an example of Halman et al.(2008), a risk with a very low likelihood and very high impact (a tsunami) would get the same numerical value as a risk with a very high likelihood but very low impact (a rain shower). Obviously, both risks need quite different risk remediation measures. For this reason, likelihood *and* impact of each risk should always be considered separately, with indicates a two-dimensionality of risk.

Probably for reasons of simplicity, risks are widely considered *static* or constant over time (Van Staveren, 2006). However, reality does not follow this simplicity: Risks change over time.[43] Therefore, Edwards and Bowen (2005) add a third dimension to risk, the dimension of *time*. In their view, the likelihood and impact of the occurrence of a hazard may *change* over time. The time dimension causes the inherently *dynamic* character of risk. Van Staveren (2006) suggests a simple two dimensional contingency model for acknowledging this dynamic risk character. Over time, any risk depends on (1) the ever changing external *circumstances*, which are *factual* and *objective* factors, and (2) the ever changing internal human *perceptions*. The latter are dominated by *interpretative* and *subjective* factors.[44] All of these factors may change views on risk events and effects over time. Consequently, once selected risk remediation measures have to be regularly evaluated, and possibly redefined. These concerns reveal the importance of risk *monitoring*. This approach transforms rather static risk *analysis* to dynamic and cyclic *risk management*.

Finally, many different risk *types* can be distinguished. For instance, Waring and Glendon (1998) address pure and speculative risks. *Pure* risks are by definition related to hazards or unwanted events and have therefore always an undesirable

42 This chance can be defined, objectively measured, or subjectively estimated. Likelihood can also be indicated by classifiers,such as unlikely and likely, or be expressed in frequencies and mathematically derived probabilities.

43 About 2500 years ago, the Greek philosopher Heraclitus from Ephesus already spoke the words pantha rhei – everything flows (Aufenhanger, 1985).

44 These interpretative and subjective factors, caused by human agency, are worked out in the forthcoming Section 3.2.3.

outcome. *Speculative* risks can have both desirable and undesirable outcomes.[45] While supporting positive risk or *opportunity* management, Edwards and Bowen (2005) warn that catching opportunities should not replace remediating negative risks that threat the project objectives. Other risk classifications are *foreseen* or predictable risk and *unforeseen* or unpredictable risk, as for example recognised by Altabba et al. (2004). [46] From a legal point of view, Jansen (2001) distinguishes information risk and interpretation risk. *Information* risk results from wrong and incomplete factual data. *Interpretation* risk is caused by *subjective* and therefore different ways of interpreting factual data by different persons.

Risk management

While the concept of risk management is widely known, its meaning differs highly between the different professions. For instance, Halman (1994) and Olsson (2006) reveal that the meaning of risk management differs when used by the economist, the sociologist, the geologist, the statistician, the physician, or the engineer. According to Olsson, even within the engineering discipline the meaning of risk management differs widely. This situation raises difficulties that could cause confusion and mistakes.[47]

Among the many definitions, Clayton (2001) defines risk management straight forward as the overall application of policies, processes, and practices dealing with risk. Risk management should therefore be a well-defined and understood responsibility within the entire (project) organisation. According to the definition in the ISO Guide 73 (ISO, 2007a), risk management involves the coordinated activities to direct and control an organization with regard to risk. The notion of *coordinated* activities indicates the explicit character of risk management.[48] These simple risk management definitions proved their practical value in engineering and construction. Given the inherent uncertainty of risk, as well as the impossibility of direct verification of risk management effectiveness and efficiency, Van Staveren (2006) considers risk management as some sort of *management of expectations.*[49]

45 Pure and speculative risks interact. Therefore both sets of risk should be considered, preferably in a holistic way (Waring and Glendon, 1998).

46 The distinction between foreseen and unforeseen risks corresponds with the before presented known and unknown uncertainty, for instance raised by Bea (2006) and Taleb (2007).

47 Therefore, Roedler's (2006) call for converging the variety of risk terminology towards uniform standards also applies to risk management terminology.

48 The term coordination differentiates *real* risk management from the often heard statements about *apparent* risk management within the construction industry. A statement such as "we are already doing risk management for years" implies only an *implicit* process of reducing uncertainty, for instance within engineering design, rather than an explicitly coordinated and communicated set of activities for reducing risk. Therefore, professionals who are reducing uncertainties in their implicit and traditional way are *not* doing risk management.

49 The word *expectation* originates from the word spectare, which means seeing. The word ex refers to something outside ourselves. Therefore, an expectation is something that one sees happening out there, in the future.

For gaining insight in managing these expectations, four risk management paradigms or schools have been identified in the literature: (1) *scientific* risk management, (2) *heuristic* risk management, (3) *fatalistic* risk management, and (4) *holistic* risk management. These approaches are discussed and compared in two sets in the next sub-sections.

Scientific and heuristic risk management

Scientific and heuristic risk management form the first set of risk management schools to be considered. The traditional school of risk management is that of *scientific* risk management (Van Staveren, 2006). This approach aligns with the technical and hard systems approach in engineering and construction (Blockley and Godfrey, 2000). While the scientific approach is based on *quantitative* modelling, it is not as objective as it at first appears. Any human individual performing scientific risk management is inherently value-driven and influenced by his or her organizational culture. Furthermore, current methods for quantified risk assessments are not capable of including typical soft system elements, such as power relations, motivations, organisational culture, as well as individual attitudes and perceptions. According to De Meyer et al. (2006), conventional project risk management is related to scientific risk management. It has a rather *instructionalist* approach and its well-established risk management methods concentrate largely on strict contingency planning. Even with pre-planned flexibility, these methods seem not able to respond effectively to unforeseeable uncertainties and risks, the unknown unknowns.

Another main school of risk management is the so-called *heuristic* or *rule of thumb* risk management approach. It involves a rather *qualitative* approach that relies in particular on experiences and the collective judgement of individuals (Waring and Glendon, 1998). It fits well with the soft systems approach of engineering and construction, according to Blockley and Godfrey (2000). Heuristic risk management may nevertheless include risk quantification that stems from the scientific risk management approach. Particularly at the start of a risk management process, the heuristic risk management approach is appropriate for most applications (Waring and Glendon, 1998). Detailed risk analysis, including statistical quantification according to the scientific approach, may be an appropriate next step with regard to the risk appraisal of technical (sub-)systems.

Additional arguments for applying heuristic risk management originate from the notion that risk management requires more than just focussing on the major risks. As some kind of paradox, as stated by Ansoff (1984) and Reason (1990), it is also very important paying attention to the so-called weak signals. These might be important indicators of latent failures and risks (Smallman, 1996). Weak signals are often derived from sources of information that provide *qualitative* and rather *soft* or subjective information. Therefore, effective risk management requires dividing attention and resources between identified large risks and latent signals. The latter may accumulate to major risks in the future, for instance during construction of a building project. It is this balancing of both the details and the bigger picture, within the inevitable limits of time, budget, knowledge, and expertise, which makes heuristic risk management more of an art than just a rational mean.[50]

De Meyer et al. (2006) extend the heuristic risk management approach by adding *learning* and *selectionist* approaches. Particularly in projects with a lot of unforeseeable influences or many interactions, they advise to add combinations of *learning* and *selectionist* approaches to conventional risk management. The essence of a *learning* risk management approach is to acknowledge that each activity will provide new insights and information, which can be used to review and revise the (original) project plan. This approach aligns with the action learning concept (Argyris and Schön, 1974; Schön, 1983). Within a *selectionalist* risk management approach, after applying multiple and parallel test cases the most favourable approach will be selected.[51] Clearly, also this approach needs a high degree of learning ability. According to De Meyer et al. (2006), applying learning and selectionist approaches require a different mindset for managing projects. It is not anymore about asking where we are in the plan, but about what we really know at this very moment. This requires adopting the concept of *mindfulness* (Weick and Sutcliffe, 2001), which is an internalized habit to constantly look for even small deviations from the norms or expectations. Creating organizational mindfulness needs an appropriate *organizational culture* of never taking things for granted. Additionally, successfully applying learning and selectionist risk management approaches calls for an appropriate project management infrastructure. In other words, an appropriate set of planning systems, monitoring systems, coordination systems, information systems and evaluation procedures and incentives.

50 For instance, the heuristic risk management approach proved to be particularly viable for the discipline-based type of geotechnical risk management (Van Staveren, 2006).

51 This approach is common in geotechnical engineering and construction, for instance by buidling trial embankments for gaining insight in ground stability, before starting with the actual embankment for a railroad project.

Fatalistic and holistic risk management

Reactive or fatalistic risk management and proactive or holistic risk management (Smallman, 1996) form the second set of risk management schools. *Reactive risk* management focuses primarily on risk retention and risk transfer. *Retention* of risk is in fact just accepting the risk with its consequences and losses, when the risk occurs. *Transfer* of risk requires another party willing to bear the risk. This reactive risk management approach is difficult and dangerous, because risk forecasting is limited by its inherent uncertainty, as well as by biased individual and team perceptions (Van Staveren, 2006). This reactive risk management approach is more of a *laissez faire* of the recognised risk, where one of the parties involved bears the consequences, if the risk occurs.

It is therefore often favourable to consider risks and their interrelationships on a more *proactive* basis, by considering potential risks and taking measures to *do* something to reduce the cause or effect of those risks. This approach serves as basis for avoidance, prevention, and reduction of risk (Van Staveren, 2006). Risk *avoidance* implies taking such measures that the risk is no longer present.[52] The *prevention* of risk is defined as taking measures for reducing the main risk causes.[53] *Reduction* of risk means taking measures for reducing the effects or consequences of the risk occurrence.[54] The need for proactive and holistic risk management is supported by Holt (2001), who states that many risk aspects normally remain unacknowledged. Holt distinguishes two complexity dimensions: (1) the degree of *dynamic complexity* and (2) the degree of *behavioural complexity*. According to Holt (2001), conventional risk management deals with providing solutions for so-called tame problems. These are problems with a dynamic and structural complexity, which can be solved by analytical and algorithmic approaches. For solving problems with a high dynamic complexity, arising from systems interdependency and (high) behavioural complexity, wider views of risk management are needed. This implies enriching typical technical risk management frameworks, in which experts perform probabilistic reasoning, with awareness about how typical human and thus rather fuzzy aspects such as perception, whim, and vision may effect the future. More arguments for holistic risk management approaches are for instance provided by Rahman and Kumaraswamy (2005). They propose the concept of *joint risk management* (JRC), as a condition for effectively dealing with unforeseen risk at the

---

52 Such as the application of a piled foundation for a building to avoid settlement risk of a shallow foundation on soft soil.

53 For instance, ground improvement will minimize the settlement risk of a shallow foundation for a building.

54 Regarding a shallow foundation for a building on soft soil, certain technical solutions may allow some settlements of the foundations, without causing damage.

post-contract stage of construction projects. In their view, exhaustive and definitive allocation of risk cannot be achieved by drawing clear contract conditions alone. Each and every risk item is difficult to foresee at the outset, because of the inherent complexity and uncertainty that exists in construction projects. By building forward on these assumptions, effective risk management *within* construction projects seem to be dependant upon the ability to manage risk *in-between* all external parties involved in the construction project. This requires a sufficient degree of relational contracting, by carefully balancing contractual rigidity, a transactional approach, with contractual flexibility, which is a relational approach[55]. Again, hard and soft system approaches are required (Blockley and Godfrey, 2000). Capabilities to balance between hard and technical factors, such as costs, time and quality, and soft and relational factors, such as attitude towards teamwork, negotiation skills and managing workplace relations is a condition for professionals and their organizations involved in relational contracting (Rahman and Kumaraswamy, 2005).[56]

3

3.2.2 Concepts about risk management methodologies from literature research

Within this section, the main and relevant concepts about risk management methodologies for this research are presented. First, examples of what are considered the *principles of risk management*, according to well-established institutions, are presented. After that *risk management processes* and *risk management tools* have been identified from the literature.

Risk management principles

Principles for applying risk management have been provided by several institutions and experts in the professional risk management practice.[57] For instance, ISO 31000 (2007b) presents eleven rather generic principles for effective risk management within an organization. According to this guideline, risk management should:

---

55 Examples of relational contracting approaches are partnering contracts and alliance contracts.

56 This requires for instance building and operating high quality inter-organizational project teams.

57 For disicipline-based types of risk management, such as geotechnical risk management, specific principles might be relevant. For instance, according to Stacey (2006), geotechnical risk should be considered as a design criterion. In his view, defining acceptable geotechnical risk levels is the responsibility of the project manager or the client, rather than the geotechnical engineer.

1. Create value by contributing to the demonstrable achievement to objectives;
2. Be an integral part of normal organizational processes without being a stand-alone activity;
3. Be part of decision making by prioritizing actions and distinguishing between alternative courses of action;
4. Explicitly address uncertainty by dealing with those aspects of decision making that are uncertain;
5. Be systematic and structured by using practicable approaches that produce consistent, comparable and reliable results;
6. Be based on the best available information, including sources such as experience, expert judgements, feedback, observation, and forecasts, while acknowledging the limitations of data and modelling, as well as divergences among expert opinions;
7. Be aligned with the external and internal context of the organization, as well as it's risk profile;
8. Take into account human factors, by recognizing the capabilities, perceptions and intentions of external and internal people that may either support or obstruct meeting the organizational objectives;
9. Be transparent and inclusive, by timely involving all stakeholders with their perceptions and risk tolerance, as well as all levels of the organization;
10. Be dynamic, iterative and be continuously sensing and responding to change, by monitoring and reviewing;
11. Be capable of continual improvement and enhancement, by developing strategies for improving the organizational risk maturity alongside all other aspects of the organization.

For another example from particularly the construction industry, The American Society of Civil Engineers (1980) defined three general principles with a costs of risk and its management focus:

1. Consider the unavoidable associated cost of every identified risk, somewhere in the construction process;
2. Allocate the risk responsibility to the party or parties who are best able to control the risk, including bearing the costs and the potential benefits;
3. Acknowledge that many risks are best shared for their most cost-effective control.

In addition, a well-established risk management principle is that of guaranteeing the *manageability* of risk in particularly construction projects. Smith (1996) recommends that each and every identified and classified risk needs to be *assigned* to one of the parties of a project. Such risk assignment should be done according to the widely accepted principles for risk allocation, which minimizes the risk of litigation (Wildman, 2004) and its associated costs (Hatem, 1998).
In conclusion, there seems a considerable agreement, worldwide, on a number of principles for applying risk management. Explicit principles for implementing risk management in organizations are however not encountered, which supports the relevance of this research.

Risk management processes

Largely based on the presented risk management principles, over the years, a large number of risk management *processes* have been worldwide developed. A search in the literature or on the Internet provides numerous guidelines for applying risk management. For example, a *generic* risk management process has been provided by the ISO 31000 guidelines (ISO, 2007b). This process is based on six risk management steps:

1. Communication and consultation;
2. Establishing the internal and external context for establishing risk criteria;
3. Risk assessment by risk identification, risk analysis and risk evaluation;
4. Risk treatment by selection of treatment options and preparing and implementing risk treatment plans;
5. Recording the risk management process;
6. Monitoring and review of the risk management process.

Step 2 through to Step 5 are performed subsequently, while Step 1 and Step 6 should take place during all of the other steps. The ISO 31000 guidelines include a number of organizational attributes (ISO, 2007b) that are considered relevant for applying risk management. Presence of these attributes, such as an emphasis on continuous improvement of risk management and organizational decision making that explicitly acknowledges risk, should represent a high level of organizational risk management performance.[58] Rather generic risk management processes, such as

58 However, despite the presence of the word *implementation* in the title of the ISO 31000 guidelines (*Risk Management: Guidelines on Principles and Implementation of Risk Management*), recommendations about *how* to apply the principles and realize the attributes within an organization are not presented in ISO 31000. This situation confirms the relevance of the research that is reported in this thesis.

provided by the ISO 31000 guidelines, may assist the application of risk management in entire organizations. As raised by O'Rourke (2004), risk management frameworks are required for applying enterprise risk management.

Regarding risk management within the *construction industry*, project risk management processes are for instance presented by Boothroyd and Emmet (1996), Edwards (1995), Edwards and Bowen (2005), Flanagan and Norman (1993), Godfrey (1996), Smith (2003, 1998), Thompson and Perry (1992), Van Well-Stam et al. (2003), and Weatherhead et al. (2005). There seems to be a considerable degree of world-wide agreement about the structure and content of these risk management processes. While the risk management terminology varies, all of these risk management processes present a number of discrete and subsequent steps, which should be repeated in time.

In The Netherlands, the RISMAN (RISk MANagement) approach has been developed since 1995. This project risk management approach has been applied in a lot of infrastructure projects (Van Staveren, 2006). As for instance presented by Van Well-Stam et al. (2003), the RISMAN approach includes five generic steps:

1. Setting the objectives of the risk analysis in the context of the project;
2. Identifying risk from a number of different perspectives;
3. Classifying these risks;
4. Identifying and executing risk remediation measures;
5. Updating of the risk analysis for the next project phase.

An example of a risk management process that is similar to RISMAN has been developed by the risk management task force of the Canadian Information Processing Society (CIPS, 2007).[59] This process has been particularly provided for the *ICT industry*.

For another sector, the *geotechnical industry*, the GeoQ risk management process has been developed.[60] GeoQ, where the Q stands for Quality, is a risk-driven approach for managing and communicating all ground-related aspects in a well-structured way. It combines the relevant aspects of construction projects,

59 Apart from providing a similar risk management process as that of RISMAN, the Canadian Information Processing Society taskforce also provides a wealth of related practices and references to other guidelines and websites. The CIPS risk management practice guideline can be downloaded for free from the Internet.

60 GeoQ has been developed since 2001 within the former Dutch Institute for GeoEngineering, GeoDelft. In 2008 GeoDelft merged with partners into Deltares. Many external parties have been involved in the step-by-step development of GeoQ. By trial and error, the process has been evaluated towards to state-of-the-art, as presented by Van Staveren (2006). The GeoQ concept and its experiences has been further dissipated by for instance Halman (2008), Van Staveren (2008a, 2008b, 2007a), Chapman et al. (2007), Smith (2008), Van Staveren and Chapman (2007), Van Staveren and Van der Meer (2007), Van Staveren and Van Seeters (2004), and Weisscher (2006).

ground conditions, risk management, and the human factor (Van Staveren, 2006).[61] The GeoQ process is an in-depth approach of the more generic RISMAN risk management process. Applying GeoQ should contribute to successful projects from a geotechnical perspective. The GeoQ risk management process includes six subsequent risk management steps, which should be repeated in each phase of a construction project:

1. Gathering information and targeting the project's objectives from a geotechnical perspective;
2. Identifying risks with ground-related causes;
3. Classifying these risks;
4. Identifying and executing risk remediation measures;
5. Evaluation the effectiveness of the risk remediation measures;
6. Updating all relevant risk information in the risk register for the next project phase.

According to Weisscher (2006) in Halman (2008), three elements differentiate GeoQ from other risk management processes that are available in the construction industry: (1) the focus on ground-related risk, (2) the inclusion of the role of the human factor within the process of managing ground risk, and (3) the availability of tools for supporting ground-related risk management.[62] Augustijn (2006), Halman (2008), Hillson and Murray Webster (2007), and Olsson (2006) suggest to develop project risk management processes towards *portfolio* risk management, in order to manage the risks of entire portfolios of projects. This seems a rather unexplored area of research.[63]

Risk management tools

Finally, in view of risk management methodologies something needs to be mentioned about existing risk management *tools*. Adequate tools may highly support individuals with effectively and efficiently managing risk. When compared with the previously presented generic risk management processes, a search in the literature or on the Internet provides even more generic risk management tools, including a

61 Although others like Clayton (2001), Hatem (1998), and Skip (1993) do focus on ground risk management, they pay little attention to its soft side, the human factor.

62 Smith (2008) considers GeoQ as the most relevant amongst several risk management approaches, because of its comprehensive coverage of the fundamentals of ground risk and its step by step management of risk through the life of a project.

63 In 1990, Markowitz received the Nobel price for his modern portfolio theory, which concerns merely spreading risk, rather than reducing risk (Augustijn, 2006).

lot of risk management supporting software. Regarding the tools, there seems to be a substantial lower degree of worldwide agreement than for risk management processes. Tools vary from simple to complex and from qualitative to quantitative. Their effectiveness and efficiency is context-specific and may demand a variety of skills and competencies. Apart from being a mission impossible, generating a complete overview of risk management tools is beyond the scope of this research. Just for illustrative purposes, a few tools are briefly presented and discussed.
An example of a software tool for risk identification and classification is the electronic board room (EBR). It is ICT-facilitated method for team-based risk brainstorming (Van Staveren, 2006). Examples of other methods for facilitating the risk management process, and particularly the risk analysis within that process, are the risk diagnosing method (RDM), potential problem analysis (PPA), fault tree analysis (FTA), and failure mode and effect analysis (FMEA), as presented by Halman (1994). In addition, the risk analysis and management for a project (RAMP) method by Lewin et al. (2005) in Halman (2008) is widely encountered. The risk and opportunity portfolio (ROP) database facilitates tracking the risk management progress and reporting to project management and senior management (Olsson, 2006). Other rather analytical methods are for instance hazard and operability (HAZOP) studies and scenario analyses (Edwards and Bowen, 2005). Finally, examples of specific tools for specific risk management processes, such as geotechnical risk management, are specific risk checklists and databases (Van Staveren, 2006).

3.2.3 Concepts about human agency and risk management from literature research

Within this section, the main and relevant concepts about human agency and risk management for this research are presented. Subsequently *individuals* and risk management, *teams* and risk management, and external *stakeholders* and risk management have been explored by literature surveys.

Individuals and risk management

For being effective, any developed or acquired risk management methodology need to be operated by people within an organization. This subsection considers individuals and risk management. When searching for conceptual approaches to individuals and risk management, the literature reveals abundant terminology. A few examples that seem particularly relevant for this research are *individual risk behaviour* with regard to decision-making in organizational settings (Sitkin and

Pablo, 1992), *individual risk cognition* for risk appraisal (Waring and Glendon, 1998), *human risks* arising out of human agency (Edwards and Bowen, 2005), the *human factor* within engineering reliability (Bea, 2006), and the *people factor* in geotechnical risk management (Van Staveren, 2006). Two concepts appear to play a dominant role when considering individuals and risk management: (1) the *concept of the individual* and the (2) *concept of risk perception*.

Regarding the *concept of the individual*, the term "individual" literally means "not to separate". A valuable characteristic of an individual is *authenticity* or a person's sincerity about himself or herself. According to Kets de Vries (2002, 2000), authenticity gives individuals the courage to be different, which is vital for implementing new concepts in organizations, such as risk management. This seems to align with Handy (2002), who considers *independence* of individuals the key towards change. Goffee and Jones (2005) highlight *trust* as a prerequisite for change, which also demands authentic people, particularly when they are leading other people. Van Staveren (2006) considers change at individual, team, and organizational level as a prerequisite for routinely applying or implementing risk management in an organization. Therefore, truly authentic individuals are essential within an organization, because only they will be able to create an *authentozoic organization* (Kets de Vries, 2000). This ancient Greek phrase describes an organization that is both *authentic* as well as *zotikos*. The latter word means being of true significance to the people within organizations. In conclusion, addressing the concept of the individual seems required for implementing change in organizations in general, in for implementing risk management in particular.

The *concept of risk perception* concerns the way individuals perceive risk, which is receiving information about a risk and giving a subjective meaning to it. While focussing on the effect of risk on decision making, Sitkin and Pablo (1992) define risk perception as a decision maker's assessment of the risk inherent in a situation. Others, for example Waring and Glendon (1998) prefer the term *risk cognition* to risk perception. According to them, risk cognition represents a more inclusive indication of processes involved when individuals appraise risk. Changes of individual risk perception or cognition over time, as well as changes of virtual or real distances towards risk exposure, further increases the inherent complexity of individual risk perception (see for instance Rohrman, 1998, Smallman, 1998, Wildavsky and Dake, 1990).

Risk perceptions may *differ* considerably between people, even if individuals base their assumptions on exactly the same factual information. The utmost importance of individual risk perception is summarized by Sitkin and Pablo (1992), by referring to a number of scholars. Individual risk perception plays a dominant role because of the impact on decision makers behaviour (Bazerman, 1986, Slovic, 1972), the effect on individual knowledge appraisal (Monroe, 1976, Rao and Monroe, 1988), and the impact on performance in risky circumstances (March and Shapira, 1987, Slovic et al., 1980).[64]

Wildawsky and Dake (1990) present three *theories of risk perception*: (1) the knowledge theory, (2) the economic theory and (3) the personality theory. Rorhman (1998) attributes the social context, the individual context and the character of risk to individual risk perceptions. Sitkin and Pablo (1992) present a mediating role of risk perceptions. In their view, three clusters of factors influence risk behaviour of a decision maker. These are (1) characteristics of the individual, (2) characteristics of the organization, and (3) characteristics of the problem of concern.[65] According to Pablo and Sitkin (1992), five common organizational and problem characteristics directly effect individual risk perception, which does indirectly influence individual risk behaviour.[66]

Finally, from the literature and supported by experience, Van Staveren (2006) selected six *principles*, which may *support* individuals during the tedious implementation process of risk management: (1) be risk aware, (2) be risk responsible, (3) act beyond blame and claim behaviour, (4) act beyond fear, (5) acknowledge the relevance of rational, as well as emotional and even some sort of spiritual intelligence, and (6) take sufficient time. Principles of this set of six are supported by findings by for instance Blockley and Godfrey (2000) and Paine et al. (2005) regarding risk responsibility, Block (2002), Covey (1992), and Imai (1986) concerning the role of blame and claim in risk management, Van Oirschot (2003) about the role of fear, Goleman (1996) and Zohar and Marshall (2004) for the role of different types of intelligence, and Witten and Tulku (1998) about the necessity and benefits of time taking.

Teams and risk management

As raised in the previous subsection, for being effective, any developed or acquired risk management process needs to be operated by people within an

---

64 From a technical point of view, Barends (2005) warns that the effects of subjective individual interpretation of facts and data are underestimated within the discipline of geotechnical engineering.

65 These three sets of characteristics from Pablo and Sitkin (1992) seem to correspond with the earlier presented three aspects of Rohrman (1998): (1) individual context, (2) social context, and (3) risk character.

66 The five organizational and problem characteristics in the reconceptualized model of the determinants of risk behaviour by Sitkin and Pablo (1992) are (1) problem framing (Kahneman and Tversky, 1979), (2) top management team heterogeneity (Janis, 1972), (3) social influence by cultural risk values (Douglas and Wildavsky, 1982, Hofstede, 1980) and a leader's risk orientation (Schein, 1985), (4) problem domain familiarity (Slovic et al., 1980), and (5) organizational control systems (Ouchi, 1977).

organization. After focussing on the individual, this subsection considers groups of people, particularly teams, and risk management. Among the abundant scientific and professional literature about *teams*, significant contributions towards the understanding of teams is provided for example by Belbin (1993) about *team roles* at work, Janis (1972) about *group think*, Stoner (1968) about the *risky shift phenomenon* in group decision making, Tuckman (1965) about inherent *team dynamics*, and Schein (1984) about organizational culture. The latter seems to be useful for understanding *team culture* as well.

When recalling the complexity of individual risk perception, bringing people together in groups or teams may further increase this complexity. However, groups of people may reduce the difficulty of different individual risk perceptions, due to compensating effects when bringing different perceptions together. Regarding the latter effect, comparing and discussing different perceptions of the same risk may considerably contribute to the effectiveness of risk management. For instance, individual bias due to the inherently subjective risk perception may be compensated by different risk perceptions of team members (Van Staveren, 2006). Nevertheless, despite these promising team effects with regard to risk appraisal and management, social-dynamic effects seems to bring additional complexity to risk management by teams. These effects may even add new risks to the already complicated risk behaviour of individuals, such as group think (Janis, 1972 in Sitkin and Pablo, 1992) and the risky shift phenomenon (Stoner, 1968 in Sitkin and Pablo, 1992). By synthesizing all of these team factors, three concepts seem to play a dominant role when considering teams and risk management: (1) the *concept of the team,* (2) the *concept of team culture* and (3) the *concept of risk communication* in teams. Next, these concepts are presented and discussed.

The *concept of the team* separates teams from groups of people. Amongst many definitions, Katzenbach and Smith (1994) define teams as a small number of people with complementary skills, who are committed to a common goal and approach, for which they hold themselves mutually responsible. For becoming a team, their members have to go through the subsequent and dynamic phases of forming, storming, norming, and performing, according to the team model by Tuckman (1965). Therefore, effective teams in general, and those for effectively managing risk in particular, usually do not develop just naturally. For establishing effective teams, distinct aspects, such as team roles (Belbin, 1993) and team leadership (Oakland, 1993), should be considered. In addition, the risk of unfavourable team effects need to be acknowledged. Two widely known but nevertheless potentially dangerous effects on managing risk are *groupthink* and the *risky shift phenomenon* (Sitkin and Pablo, 1992). The concept of groupthink has been introduced by Janis

(1972). It rules when team members are unwilling or unable to disagree with one another. In such teams, decisions are solely based on keeping group consensus and harmony (Daft, 1984). The risky or cautious shift phenomenon of Stoner (1968) suggest that a group will perceive either less risk or more risk than its individual members will. As raised by Sitkin and Pablo (1992), groupthink, as well as the risky shift, may influence individual risk behaviour.

Moreover, acknowledgement of the *concept of team culture* or shared team values is required for understanding how teams may contribute, or not, to effective risk management. Team culture is closely related to organizational culture, which Cameron and Quinn (1998:14) briefly define as "how things are around here". Schein (1984) distinguishes three levels of organizational culture, which are increasingly difficult to change: (1) artefacts of visible characteristics, (2) espoused values, and (3) basic underlying assumptions. In view of teams, the first level of artefacts is what team members show. Examples of artefacts of for instance management teams are all members wearing ties (or not), and reserved parking places for their cars. The second level of espoused values is about what team members are saying, which may differ from what they are actually doing. The third level of basic underlying assumptions are the unwritten team rules about what the team members really think.

The foregoing two team-related concepts should be acknowledged when applying effective risk management by teams, because of the third *concept of risk communication*. According to Edwards and Bowen (2005), concerning risk management in project organizations, the *effectiveness* of a project team is directly related to the *communication* between the team members. Amongst the many available definitions of communication, Dibb et al. (1997) describe *communication* rather simple as a sharing of meaning through the transmission of information. Communication is not easy, for instance due to the importance of communication *content* and *context*, according to the social-cognitive configuration theory (Watzlawick et al., 1967). Communication about risk between team members increases communication difficulties, because the core values of people are normally directly connected to risk (Arvai et al., 2001). Leiss (1996), in Gurabardhi and Gutteling (2002), defines *risk communication* as the flow of information and risk evaluation back and forth between academic experts and regulatory practitioners, interest groups, and the general public. This definition reflects the modern *democratic* view on risk communication, which acknowledges the social construction of risk. Open dialogue is the basic assumption for the democratic risk communication approach. According to Gurabardhi and Gutteling (2002), this democratic approach is increasingly replacing the traditional and *technical* approach of risk communication. In the technical view, only scientists and other experts with the relevant knowledge are able to decide and inform others about risk.[67] According to Otway (1992), the main product of risk communication is however *not* information, but the quality of the *social relationship* it supports. This may be one of the key issues for effective risk communication and seems very uncommon for particularly by technicians, who tend to focus on information.[68] The risk communication approach of Otway (1992) aligns with the above mentioned social-cognitive configuration theory, raised by Watzlawick et al. (1967), as well as with the democratic approach in Gurabardhi and Gutteling (2002).[69] For effective risk communication, Covello et al. (1989) emphasize the need for *targeting* any risk communication specifically to the receiving individuals or teams. Moreover, for instance Thompson and Bloom (2000) suggest risk communication *guidelines*, including appreciating and presenting the broader contexts of risk management decisions.

Finally, the literature presents abundant suggestions for *establishing* effective teams. This topic is beyond the scope of research. However, just to illustrate that establishing effective teams with regard to applying and implementing risk management is far from an easy task, a few factors are presented. These are derived from applying and implementing quality management and are not meant to be complete. According to Oakland (1993), for effective teams distinct aspects, such as individual roles within teams, its dynamics and development stages, and team leadership should be addressed. Uhlfelder (2000) adds that teams need to understand the nature of their problems (which are obviously risks, in case of risk management). Furthermore, team members need easy access to tools that support their teamwork, such as groupware-type of software, and team members should understand how to use team information and knowledge effectively.

In conclusion, there is a lot (more) to say about teams and risk management, where concepts about teams, organizational culture, and communication seem meeting

67 This view is for instance elaborated by Gutteling and Kuttschreuter (2002). They discuss the role of expertise in risk communication, based on empirical data on the risks posed by the Millennium bug in 1999 in The Netherlands.

68 An example of such an technically focussed, and thus ineffective, type of risk communication has been demonstrated after a sudden occuring and serious damage of a few monumental houses in the city centre of Amsterdam, autumn 2008. The occupants had to leave their houses immediately and for many months. The damage was caused by the excavation of a 30 meters deep building pit, at a few meters distance of these houses. An independant authority, who was appointed by the Amterdam local government to investigate this construction project incident, concluded that the risk communication was below an acceptable level.

69 The concept of risk communication is rather new. The term *risk communication* seems to be first used in 1984 (Leiss, 1996 in Gurabardhi and Gutteling (2002). A comprehensive study by Gurabardhi et al. (2004) describes the development of risk communication in the environmental and technological domain, by systematically analyzing scientific journals. In total, 349 articles published between 1988 and 2000 were analyzed.

each other closely. The concepts presented here are just briefly mentioned and far from complete.[70] The main objective of presenting and discussing these concepts is raising awareness. In most cases, applying risk management in teams will add significant complexity to teams, which are already inherent complex because of the usual social-dynamic teams effects. Due to team effects as groupthink and risky shift, teams may even form a risk in itself. For instance, raised by Sasou and Reason (1999), in the working environment of large complex systems insufficient emphasis has been given to team errors. On the other hand, several types of team, including expert teams, multidisciplinary teams, and teams as change agents, may be able to contribute significantly to applying effective risk management, (far) beyond the contribution of individual persons (Van Staveren, 2006).

Stakeholders and risk management

As raised in the two previous subsections, for being effective, any developed or acquired risk management process needs to be operated by people within an organization. These may be individuals or teams. While the focus of this research is on implementing risk management *within* organizations, actually applying risk management requires a permanent look to the environment *outside* the organization. As mentioned by Waring and Glendon (1998), there is common agreement that any organization is in a largely dependent and reactive position. Attempts by an organization to influence and control the external environment, including economies and markets, government policies, regulation, and so on, can only have limited success. Nevertheless, there seems to be an increasing interest to influence at least some aspects the external organizational environment, which is represented by the *stakeholder concept*.
Freeman (1984: 46) defines a stakeholder as "any individual or group who can affect or is affected by action, decisions, policies, practices, or goals of the organization". According to Scott and Lane (2000), by fostering a stakeholder approach organizations consider the explicit and implicit behaviour of stakeholders as a reflection of the strategies and practices of the organization. An example is project stakeholder management proposed by Cleland (1998) in Edwards and Bowen (2005), which intends to lower *stakeholder uncertainties* that might adversely affect for example a construction project. On the other hand, project stakeholder

70 For the role of human and organizational factors within risk management in the construction and offshore industry, particularly in the subdiscipline of safety management, reference is made to Bea (2000a, 2000b, 2001, 2002a, 2002b).

management also aims to encourage *stakeholder support* of project objectives.[71] Edwards and Bowen (2005) make a common distinction between primary and secondary stakeholders. Primary stakeholders have contractual or legal obligations to a project, as well as responsibility and authority to allocate resources to the project. When considering a construction project, primary stakeholders are for example the client, the engineer, and the contractor. Secondary stakeholders are typically interest groups, including the federal government, local authorities, the mass media, and society as a whole.

In view of stakeholders of construction projects, Van Staveren (2006) introduced so-called *ostrich behaviour*. Particularly clients, but also other stakeholders in construction projects, such as contractors, engineers, government representatives, and politicians, hesitate to look at the potential dark side of their projects. These persons, teams, departments, or entire organizations opt for ostrich behaviour, which is not wanting to see and deal with the reality of risk. Clients are particularly important, as they pay for the products and services within the construction industry. If clients are not willing and prepared to consider risk in their projects, this causes additional complexity for managing risk by those parties working for clients, such as architects, engineers, and contractors. In such conditions, when not all primary stakeholders are willing to be involved in the risk management process, applying risk management is (much) more difficult, and probably also less effective.

Finally, all primary and secondary stakeholders of for instance a construction project are member of the same society. However, modern societies are increasingly unwilling to accept risk (Taleb, 2007). In particular, moderns societies are becoming less tolerant of failures of engineering structures (Ho et al., 2000). Mulhearne and Vane (1999) explain so-called externality effects. Applied to risk management, externality effects are consequences of occurring risks, such as costs or personal damage, which are felt by secondary stakeholders (for instance families in monumental houses near construction sites), while caused by primary stakeholders (such as contractors digging construction pits). This raises difficulties about risk responsibilities and contractual risk allocation, which is since many years indicated a serious threat to the stability and financial security of the construction industry (Douglas, 1974).[72]

---

71 An example of successful project stakeholder management is presented by Munfah et al. (2004). This paper presents the East Side Access Project in New York, a 6300 million US dollars project that is considered one of the largest underground transporation projects undertaken ever.

72 Codes of conduct should guide construction players with responsibly dealing with externality effects. Such codes are for instance provided by Blockley and Godfrey (2000) and Paine et al. (2005). Moreover, fair contractual risk allocation should minimize the risk of litigation within construction projects (Wildman, 2004), as well as reduce the professional liability exposure of the design and construction professionals involved in a construction project (Hatem, 1998).

In conclusion, once again there is a lot (more) to say about external stakeholders and organizations, and about their mutual effects on risk management. The primary objective of presenting the stakeholder concept is demonstrating the huge complexity of actually applying risk management, once it is implemented within an organization. For any person or team applying risk management, there is a huge challenge for balancing and blending the large variety of risk perceptions at individual, team, organizational, and societal level (Van Staveren, 2006).[73] Obviously, awareness about this complexity by managers and potential risk management users may cause organizational resistance towards implementing risk management. A next step for overcoming this resistance is identifying the relevant variables for applying risk management, which is the topic of the next section.

3.2.4 Variables from literature research

After thoroughly considering the relevant concepts about uncertainty, risk, risk management, risk management methodologies and the role of the people factor in risk management, the relevant variables have been considered. Two sets of variables for applying risk management have been identified by a literature survey: *hurdles* and *conditions*. Hurdles are barriers, obstacles, or unfavourable situations for applying risk management. The presence of hurdles impedes the application of risk management in organizations. Contrary, conditions are prerequisites, requirements, or favourable situations for applying risk management in organizations.

The researcher's book *Uncertainty and Ground Conditions: A Risk Management Approach* (Van Staveren, 2006) served as the primary source for revealing hurdles and conditions. Table 3.1 and Table 3.2. list 5 hurdles and 10 conditions for applying risk management. The *order* of the hurdles and conditions in Table 3.1 and Table 3.2 resulted from the literature survey and is arbitrary. The *numbers* in the first column of Table 3.1 and Table 3.2 are only for identification purposes. They do not reflect the relative relevance of the hurdles and conditions to each other, which was of no concern yet. This stage of the research focussed on identifying variables, rather than on classifying their relevance, which has been performed at later research stages.

73 Schumpeter (1950) introduced the term *creative destruction*, by considering innovation as the as the central component of competition. If innovations occur at high pace, entire industries can be destructed (Grant, 1998). This seems indeed being occured during the worldwide financial crisis that started in October 2008. One of the causes seems to be selling innovative, very complicated, and apparently high-risk types of financial products. This serious worldwide financial crisis dramatically reduced, amongst others, the number of prestigious investment banks. It forced federal governments to invest billions of euros for rescueing their financial sectors. This crisis is an extreme example of the inherent difficulty of people, at all societal levels, to balance all those different risk perceptions.

Next, additional risk management literature, as well as related literature mainly focussing on the construction industry, has been explored. Previously presented references in Van Staveren (2006) have been used as entrance, as well as databases and search engines on the Internet. This survey identified additional hurdles and conditions for applying risk management. Table 3.3 and Table 3.4. present 17 additional hurdles and 26 additional conditions for applying risk management. Once again, the *order* of the hurdles and conditions in Table 3.3 and Table 3.4 resulted from the literature survey and is arbitrary. The *numbers* in the first column of Table 3.3 and Table 3.4 are only for identification purposes. They do not reflect the relative relevance of the hurdles and conditions to each other, which was of no concern yet. This stage of the research focussed on identifying variables, rather than on classifying their relevance, which has been performed at later research stages.

Table 3.1. Hurdles for applying risk management.

No.	Hurdles for applying risk management	Source
1	Differences in risk (un)awareness and risk perception by different people.	Blockley and Godfrey (2000), Goleman (1996), Rohrman (1998), Smallman (1998), Watzlawick et al. (1967), Wildawsky and Dake (1990), Wildman (2004)
2	The inherently random, fuzzy and incomplete character of ground information.	Blockley and Godfrey (2000)
3	Appointing a separate risk manager, who is responsible for managing all risks.	Edwards and Bowen (2005), Van Staveren (2006)
4	The perceived additional costs of risk management.	Clayton (2001), Mapherson (2001), Smith (1996)
5	Unwillingness (or not being able) to allocate each risk to one of the project parties.	Altabba et al. (2004), Essex (1996), Smith (1996), Wildman (2004)

Table 3.2. Conditions for applying risk management.

No.	Conditions for applying risk management	Source
1	Generating willingness of all project stakeholders for making foreseeable risk transparent.	Munfah et al. (2004)
2	Checking and balancing risk responses with the risk tolerances of the affected parties during the risk evaluation.	Blockley and Godfrey (2000)
3	Appointing a risk coordinator, who coordinates the risk management process.	Edwards and Bowen (2005, Van Staveren (2006)
4	Start early within the project with risk management and reserve ample time and resources to train the players within the project with risk management.	British Tunnelling Society (2003), Van Staveren (2006), Van Well-Stam (2003)

Table 3.2 Continued

No.	Conditions for applying risk management	Source
5	Not accepting any concession to agreements made about the operation of risk management.	Van Staveren (2006)
6	Dedication and patience during implementing risk management.	Edwards and Bowen (2005)
7	Individual dedication and willingness by risk-driven change agents for convincing project stakeholders about the risk management need and benefits.	Barends (2005), Brandl (2004), Nußbaumer and Nübel (2005)
8	Blending individualism of individuals and collectivism in teams.	Flanagan and Norman (2003)
9	Only selective use of appropriate risk management tools.	Hicks & Samy (2002), Ho et al. (2000), Toft (1993, 1996), Waring (1996), Waring and Glendon (1998)
10	A transformation or transition within the construction industry.	Blockley and Godfrey (2000)

Table 3.3. Additional hurdles for applying risk management.

No.	Additional hurdles for applying risk management	Source
1	Risk fear by people.	Blockley and Godfrey (2000), Goleman, (1996), Slovic et al. (1980)
2	A lack of well-structured systems thinking in the construction industry.	Blockley and Godfrey (2000), Naisbitt (1984), Senge (1990)
3	The complexity and dynamics of the many risk types that can be distinguished.	Altabba et al. (2004), Edwards and Bowen (2005)
4	The limitations of conventional or traditional scientific risk management.	Ansoff (1984), De Meyer et al (2006), Smallman (1996), Waring and Glendon (1998)
5	The inherent fuzziness of alternative heuristic or rule of thumb risk management.	Waring and Glendon (1998)
6	The highly subjective character of risk and its management.	Edwards and Bowen (2005), Blockley and Godfrey (2000), Sitkin and Pablo (1992), Watzlawick (1967)
7	The complexity of individual risk perception, including its changes over time and distance.	Rohrman (1998), Sitkin and Pablo (1992), Smallman (1998), Wildavsky and Dake (1990)
8	The difficulty of risk communication in teams.	Edwards and Bowen (2005), Gurabardhi and Gutteling (2002), Gutteling and Kuttschreuter (2002), Heath et al. (1998)
9	The difficulties of risk dominance and groupthink in and in-between teams.	Daft (1998), Hedges (1985), Janis (1972)
10	The fear of clients for risk transparency resulting from risk management.	Altabba et al. (2004)

Table 3.3 Continued

No.	Additional hurdles for applying risk management	Source
11	The difficulty to understand the client's interests from a client's perception on risk.	Bijsterveld (2005)
12	Difficulties of public clients to deal explicitly with risk in their usual and prescribed way of project approval, procurement, and contracting.	Flyvberg et al. (2003), Laverman (2005), Rahman and Kumaraswamy (2005), Schmidt et al. (1999)
13	Difficulties of contractors to deal explicitly with risk in the ruling industry climate of solely the lowest bid price criterion.	Bijsterveld (2005), Rahman and Kumaras-wamy (2005), Schmidt et al (1999)
14	The ruling industry model of conflict, rather than cooperation and partnerships.	Brandl (2004)
15	Lack of understanding about the scope and activities of risk management.	O'Rourke (2004)
16	Difficulty of envisioning the risk management integration process.	O'Rourke (2004)
17	No clear demonstration of benefits of risk analysis.	Beal (2007)

Table 3.4. Additional conditions for applying risk management.

No.	Additional conditions for applying risk management	Source
1	Using both expert teams and multidisciplinary teams.	Flanagan and Norman (1993), Grant (1998), Hamel and Prahalad (1994), Mintzberg (1998), Oakland (1993)
2	Using teams as change agents.	GeoDelft (2000)
3	Providing an appropriate organizational culture.	De Meyer et al. (2006)
4	Blending risk management with innovation management for delivering value.	Barends (2005), Keizer et al. (2002), Nußbaumer and Nübel (2005)
5	Explaining the uncertainty in (geotechnical) engineering, which needs to be explicitly managed, to decision makers.	Barends (2005), Schmidt et al. (1999)
6	Raising awareness about the economic and social benefits from risk reduction.	Barends (2005), Elliot et al. (2000), Smith (1996), Sperry (1981)
7	Generating stakeholder participation, already in the early project phases.	Munfah et al. (2004), Schön (1983)
8	Considering and combining both hard (factual) and soft (interpretative) information.	Blockley and Godfrey (2000)
9	Identifying a maximum number of foreseeable risks by combining several risk identification methods.	Baya et al.(1997)
10	Considering qualitative, semi-qualitative, as well as quantitative methods for risk classification.	Altabba et al. (2004), Smallman (1999), Viehöfer (2002)
11	Combining risk structuring and risk analysis methods.	Keizer et al. (2002), Shrivastava (1998), Smallman (1996), Smith (1996)

3

Table 3.4 Continued

No.	Additional conditions for applying risk management	Source
12	Considering all risk remediation strategies for project-specific risk management.	Flanagan and Norman (1993)
13	Applying cyclic and step-by-step project risk management.	British Tunnelling Society (2003), International Tunnelling Insurance Group (2006), Van Well-Stam et al. (1993)
14	Use the relevant change management principles to embed risk management within the project organization.	Cameron and Quinn (1998), Jick (1993), Senge (1990)
15	Providing awareness about the costs and other (reputation) effects of major risk events.	Brandl (2004)
16	Adding combined learning, selectionist, and reflective practice approaches to conventional risk management.	Argyris and Schön (1974), Blockley and Godfrey (2000), Schön (1983), De Meyer et al. (2006)
17	Adopting the concept of organizational mindfulness.	Weick and Sutcliffe (2001)
18	Creating an appropriate project management infrastructure, particularly for effective risk management communication.	De Meyer et al. (2006), O'Rourke (2004), Schmidt et al. (1999)
19	Setting clear risk management goals and objectives.	O'Rourke (2004)
20	Widening the risk management scope beyond solely financial risks.	O'Rourke (2004)
21	Enforcing regulations for implementing risk management.	Beal (2007)
22	Extending towards joint risk management between the project parties.	Rahman and Kumaraswamy (2005)
23	Applying relational contracting by balancing between hard and technical factors and soft and relational factors, including setting appropriate contract conditions.	Rahman and Kumaraswamy (2005)
24	Introducing integrated training programmes to improve knowledge, skills, and attitudes towards risk management.	Rahman and Kumaraswamy (2005)
25	Combing performance scores and bid prices in awarding contracts for supporting joint risk management.	Rahman and Kumaraswamy (2005)
26	Up-front funding to facilitate initial risk management sessions with all parties involved.	Schmidt et al. (1999)

3.2.5 Variables from field research

Based on the results of the literature study, *field research* has been performed. During the field research international experts, as well as Dutch experiences, served as additional data sources for the identification of hurdles and conditions for applying risk management.

3

Hurdles and conditions for applying risk management from interviews

The objective of the interviews was adding and confirming hurdles and conditions for applying geotechnical risk management that were retrieved from the literature research.[74] In total seven geotechnical risk management experts from the US, the UK, and South Africa have been interviewed. Five experts are working in the construction industry. They are involved in tunnel projects, foundations, offshore structures, water retaining structures, and so on. Two experts work in the mining industry. They use their geotechnical expertise for instance for slope design of open pit mines.[75] For decades, all of the interviews experts are involved in applying risk management principles in their research, design, and consulting activities. They can be classified as pioneers in this emerging discipline. Three of them are member of the International Task Group 3 on geotechnical risk management. This is part of the Joint Technical Committee 4 on improving the professional practice in ground-related engineering and construction.[76] Two of the interviewed experts are from the United States, three are from the United Kingdom and two are from South Africa. Four experts are professor at respectively the University of California in Berkeley, Massachusetts Institute of Technology (MIT) in Boston, the University of Southampton in the United Kingdom, and the University of the Witwatersrand in Johannesburg, South Africa. They combine research on ground-related risk management with its practical application in construction projects. The remaining three respondents are consultants and work worldwide on variety of construction and mining projects.

---

74 Yin (2003) considers the *interview* as one of the most important data sources, because it will confirm, complement, or provide rival explanations to the literature data. Furthermore, knowledge from interviews is more recent than the knowledge from literature and can be in-depth explored by dialogue during the interview.

75 The mining industry has been included within the research because in mining there is a very delicate balance between maximizing economic returns (by maximising ore excavation), and maximizing safety of personnel by minimizing the number of casualties in mining operations. For maintaining this balance, the value of risk management is more and more acknowledged and its principles are increasingly applied. For instance, effective management of slope instability risk can provide significant economic benefits, as revealed by Cahill and Lee (2006), Little (2006), Little et al. (2007), Naismith and Wessels (2006), and Stacey (2006) in Chapman et al. (2007).

76 In 2006, the three international societies on geotechnical engineering, rock mechanics and engineering geology, respectively the ISSMGE, the ISRM, and the IAEG, started with forming the Joint Technical Committee JTC4.

The interviewed persons provided knowledge as an *expert*, personal opinions and experiences as a *respondent*, and additional information about other people, objects, situations or processes as an *informant* (Verschuren and Doorewaard, 2000). For minimizing defensiveness of the experts, it was decided not to record the interviews.[77] An open and semi-structured interview approach has been selected.[78] Interview protocols were prepared and three main questions were based on the results from the literature research:

1. What is the added value of applying risk management in construction or mining projects?
2. Which hurdles obstruct risk management application?
3. Which conditions should be set to overcome these hurdles?

Sub-questions concerned asking about the role of actors, any differences in hurdles and conditions that are specifically related to risk management motivation, tools and training issues, and any differences between public and private organisations. Moreover, examples and any additional relevant aspects were asked in each interview. So-called how type of questions dominated during the interviews.[79]
For each interview a report has been written. The interview reports have been verified, sometimes provided with additional comments, and approved by the interviewees. The qualitative interviews results have been analyzed according to the method of Baarda et al. (1996), which involved labelling and categorization of key aspects. By applying investigator triangulation, according to Patton (1987) in Yin (2003), all labelled interview results have been carefully analyzed and, when showing large similarities, clustered into similar hurdles and conditions. In total 63 hurdles and 73 conditions for applying geotechnical risk management in construction and mining projects have been identified. These hurdles and conditions are presented in respectively Appendix 1 and Appendix 2.

77 Several scholars, such as Yin (2003), Baarda et al. (1996), and Emans (1986) have different opinions about recording an interview or not.

78 According to Baarda et al. (1996), this approach is preferred when the interview topic is complex and rather new.

79 People tend to give more detailed answers on asking *how* than on asking *why*. Asking why seems to generate defensiveness of the interviewee. Asking how is generally considered as friendlier and less threatening than asking *why* (Becker, 1998).

Hurdles and conditions for applying risk management from Dutch experiences

The field research has been extended by analyzing the application of risk management in Dutch construction projects. A variety of data sources have been used from the Delft Cluster risk management research programme and RISNET. Experiences with developing and applying risk management within the Delft Cluster research programme were retrieved from two research papers by Basta et al. (2007) and Cozzani et al. (2006), two workshops, and a survey that has been executed for evaluating the application of risk management within Dutch municipalities. Within the workshops, which have been reported in Delft Cluster (2006, 2007), risk management practitioners from a number of small, medium and large municipalities in The Netherlands, including the cities of Amsterdam, Rotterdam, The Hague, Delft, and Go, discussed risk management issues, such as:

1. The organizational and cultural aspects of risk management;
2. The practical content and application of risk management;
3. Marketing of risk management, both within and in-between organizations;
4. Learning from each other about risk management experiences.

For the survey in total thirteen interviews were performed within nine municipalities, as reported by Karstens et al. (2006). Three of them were the large cities of Rotterdam, The Hague, and Utrecht. Three were medium sized and the remaining three were small-sized municipalities. Additionally, a risk management consultant and a risk analyst were interviewed. They represented two firms that assist municipalities with applying risk management. The three research questions in the survey were:

1. How do professionals of municipalities and their consultants consider risk management in public owned construction projects?
2. Which risk management methods and tools are used?
3. What are the needs for additional methods and tools?

The survey results provided five main conclusions. First, all interviewed professionals consider risk management as an important part of project management. Second, the majority of respondents needs more structure for applying risk management within municipalities. Third, the main risk types are of a process and organizational type. Technical project risks are considered not very relevant. Fourth, while risk management has been initiated by project managers within the organizations of the municipalities, it is not yet fully embedded within the organizations. Fifth, risk management is more often applied in large and complex projects, than in relatively small and less complicated projects.

RISNET is a Dutch risk management platform and aims to dissipate risk management knowledge and experiences in the Dutch construction industry.[80] According to a joint construction industry agreement, by the year 2012 explicit risk management should be applied within eighty percent of all Dutch construction projects (Jonker et al., 2008).

In the period 2004–2007, RISNET developed the concept of communicative risk management from four pilot projects and two workshops. Contrary to *defensive* risk management, in which parties do not disclose risk management information, *communicative* risk management aims to disclose and share all risk management information with the parties involved. By open discussions between owners, contractors, and other stakeholders, the optimum ways for managing project risk should become clear (RISNET, 2007). This focus on communication aligns with Schmidt et al. (1999) also corresponds with the concept of joint risk management (JRC) from Rahman and Kumaraswamy (2005). RISNET applies an instrumental approach for building communicative risk management competencies by providing tools and training.[81]

Table 3.5 and 3.6 present 24 hurdles and 38 conditions for applying risk management, which were derived from the Delft Cluster risk management research programme and the RISNET experiences. For retrieving these hurdles and conditions, again the previously presented approach from Baarda et al. (1996), with data and investigator triangulation, as proposed by Patton (1987) in Yin (2003), has been applied. The *order* of the hurdles and conditions in Table 3.5 and Table 3.6, which resulted from the field research process, is arbitrary. The *numbers* in the first column of Table 3.5 and Table 3.6 are only for identification purposes. They do not reflect the relative relevance of the hurdles and conditions to each other, which was of no concern

80 RISNET is supported by the Dutch branch organisation of contractors, Bouwend Nederland, the four largest Dutch cities, the Dutch branch organisation of consulting engineers, ONRI, the Dutch rail infra-structure provider ProRail, Rijkswaterstaat of the Dutch Ministry of Transport and Water Management, the Vereniging Stadswerk of the Dutch municipalities, the Ministry of Housing, Development and Environment, VROM, as well as the Rijksgebouwendienst that is responsible for all building owned by the government. The working group RiskForum (2007) assists RISNET with the dissipation of existing knowledge, methods, tools, and experience about risk management in the construction industry.

81 For applying communicative risk management in practice, RISNET developed a *toolbox*, which includes a presentation of the methodology of communicative risk management, a brochure, a set of charts with twelve generic people-related problems in projects (a so-called focus chart with four main questions for focussing on the most relevant issues within a project), and nine fact sheets with suggestions for good project management practices. The tools within the toolbox relate good communication and project management practices with risk management. In addition, risk management ambassadors are trained by RISNET, for assisting professionals in their daily practices with applying communicative risk management.

yet. This stage of the research focussed on identifying variables, rather than on classifying their relevance, which has been performed at later research stages.

Table 3.5. Hurdles for applying risk management from Delft Cluster and RISNET.

No.	Hurdles for applying risk management in construction projects	Sources
1	Lack of (use of) protocols for implementing risk management.	Delft Cluster (2006)
2	Difficulty to have people with risk management competences.	Delft Cluster (2006), RISNET (2007)
3	The (adverse) role of organizational culture for implementing risk management large projects.	Delft Cluster (2006)
4	Lack of organizational awareness about the importance of risk management.	Delft Cluster (2006, 2007a)
5	Unknown what to ask from employees and managers for implementing risk management.	Delft Cluster (2006)
6	Unknown what policies or structure should be used for implementing risk management in daily routines.	Karstens et al (2006), Delft Cluster (2006, 2007a)
7	The unknown and formal consequences of using informal risk management tools.	Delft Cluster (2006)
8	Difficult en ineffective communication within the risk management process.	Delft Cluster (2006, 2007b), RISNET (2007)
9	Lack of benchmarked values for probabilities and consequences of risks.	Delft Cluster (2006)
10	Difficulty to balance formal and practical risk management.	Delft Cluster (2006)
11	Unknown to what level of detail risk analyses should be done.	Delft Cluster (2006), RISNET (2007)
12	Unknown to what extend public-private partnerships reduce financial risks of construction projects.	Delft Cluster (2006)
13	Unknown how a positive content of risk management can be created.	Delft Cluster (2006)
14	Risk management benefits are not clear.	Karstens et al. (2006), Delft Cluster (2006)
15	Unknown how to learn from best practices of risk management implementation.	Karstens et al. (2006), Delft Cluster (2006)
16	Unknown what risk management practices and tools are available.	Karstens et al. (2006), Delft Cluster (2006)
17	Risk management remains project risk management and is not adopted in the parent organizations.	Delft Cluster (2007a)
18	The political level in the municipality does not want to hear about risk.	Karstens et al. (2006), Delft Cluster (2007a)
19	The large number of conflicting interests in a construction project.	Delft Cluster (2007a, RISNET (2007)

Table 3.5 Continued

No.	Hurdles for applying risk management in construction projects	Sources
20	Lack of management commitment and a positive attitude to risk management.	Delft Cluster (2007b)
21	The perceived extra time by actions required for applying risk management.	Delft Cluster (2007b), RISNET (2007)
22	The perceived extra costs by actions required for applying risk management.	Delft Cluster (2007b)
23	The position of the project manager, who has to report to the line organization and political local government, which both have different risk perceptions.	Delft Cluster (2007b)
24	Project managers not being allowed to, able to, or motivated to translate consequences of technical risks to consequences for the entire project.	Karstens et al.(2006), RISNET (2007)

Table 3.6. Conditions for applying risk management from Delft Cluster and RISNET.

No.	Conditions for applying risk management in construction projects	Sources
1	A shared risk management definition within the project team.	Delft Cluster (2006)
2	Acceptance that risks are a fact of live and can never be totally avoided.	Delft Cluster (2006)
3	Availability of sufficient resources: money, time, organization, information, communication.	Delft Cluster (2006), RISNET (2007)
4	An effective project team, which accepts the existence of risks.	Delft Cluster (2006), RISNET (2007)
5	Professionals should be selected according to appropriate risk management competences.	Delft Cluster (2006), RISNET (2007)
6	Everyone involved in the project should be committed to a project-driven way of working.	Delft Cluster (2006)
7	There should be trust between the involved professionals, before risk management implementation starts.	Delft Cluster (2006)
8	Within the municipalities, there should be a clear relationship between project teams and local government members of the municipality.	Delft Cluster (2006)
9	Before starting with risk management implementation, management should become risk aware.	Delft Cluster (2006)
10	Risk management methodologies and tools should naturally fit within the existing work processes, which requires differentiation of methodologies and tools.	Basta et al. (2007), Delft Cluster (2006), RiskForum (2007), RISNET (2007)
11	In the early phase of the project, it should become clear and communicated which risks are the responsibility of which party.	Delft Cluster (2006), RISNET (2007)
12	After a risk analysis, real action should be taken in order to manage, monitor, and report the analyzed risks during the project.	Delft Cluster (2006, 2007a), RISNET (2007)

Table 3.6 Continued

No.	Conditions for applying risk management in construction projects	Sources
13	The risk management approach should be related to the size and the complexity of the project.	Delft Cluster (2006)
14	The project team members, both from the municipality and externally hired experts, should develop some sort of governance sensitivity, for effectively communicating risks with the local government members of the municipality.	Delft Cluster (2006), RISNET (2007)
15	Some sort of risk management protocol should be available and used, which prescribes risk management steps to be taken in each project phase.	Delft Cluster (2006, 2007a), RISNET (2007)
16	The anticipated benefits of applying risk management should be clearly communicated.	Delft Cluster (2006), RISNET (2007)
17	Risk management should be focussed on realizing the project's targets, in order to select the appropriate practices and tools.	Delft Cluster (2006, 2007a), RISNET (2007)
18	Risk management application should be as practical as possible and aligned with the ruling work processes.	Delft Cluster (2006), RISNET (2007)
19	Risk management should not result in rigidity and reducing the creativity of the project participants.	Delft Cluster (2006)
20	Widening risk management to opportunity management, which has a more positive meaning that may increase the willingness to apply risk management.	Delft Cluster (2006), RiskForum (2007)
21	Learning of mistakes by project evaluations for increasing willingness to apply risk management.	Delft Cluster (2006)
22	Leadership competences of the project manager for building commitment to apply risk management within the project organization.	Delft Cluster (2006)
23	Exchanging tools and checklists for learning from each other.	Delft Cluster (2006, 2007a), RISNET (2007)
24	A multilevel approach during risk management implementation.	Delft Cluster (2007a), RISNET (2007)
25	Participation of external stakeholders, such as shop owners, within the risk management process.	Delft Cluster (2007a), RISNET (2007)
26	Applying risk management in the early project phases, for instance for feasibility studies by scenario analysis.	Delft Cluster (2007a 2007b), RiskForum (2007), RISNET (2007)
27	It should be clear when risk analyses are required within the project.	Delft Cluster (2007a), RISNET (2007)
28	It should be clear how and when risk management adds to conventional good project management practices.	Delft Cluster (2007a), RISNET (2007)
29	Regulations should allow a variety of risk management responses, by different methodologies and tools, for fitting the specific risk management context.	Cozzani et al. (2006)

3

Table 3.6 Continued

No.	Conditions for applying risk management in construction projects	Sources
30	Transparency and cooperation for sharing all risk management information between the parties involved in a project.	RISNET (2007)
31	Specific tools for facilitating risk communication.	RISNET (2007)
32	Active participation of project owners for increasing the application of risk management.	RiskForum (2007), RISNET (2007)
33	Intensifying education and training of risk and opportunity management.	RiskForum (2007), RISNET (2007)
34	Approaching risk management from a financial perspective, rather than from a civil engineering perspective, for increasing its acceptance.	Delft Cluster (2007b)
35	Creating transparency about the risk responsibilities within the involved organizations.	Delft Cluster (2007b), RISNET (2007)
36	Cooperation between the departments within the line organization of the municipality.	Delft Cluster (2007b)
37	Aligning risk management with the regulation that municipalities need to include a financial risk section in their yearly budgets.	Delft Cluster (2007b)
38	Creating continuous risk awareness, supported by risk analyses, in all project phases.	RISNET (2007)

3.2.6 Summary of identification results

The main *concepts* about uncertainty, risk, and risk management, were identified in the preceding sections of this chapter. Furthermore, a large number of *variables* for applying risk management were identified. These were distinguished in hurdles and conditions. The presence of hurdles impedes the application of risk management in organizations. Contrary, conditions are prerequisites, requirements, or favourable situations for applying risk management in organizations. Table 3.7 presents the numbers of hurdles and conditions that were retrieved from the different types of research and data sources. In total 109 hurdles and 147 conditions have been identified.

Table 3.7. The numbers of identified hurdles and conditions for applying risk management.

Research type	Data source	Hurdles for applying risk management in construction projects (number)	Conditions for applying risk management in construction projects (number)
Literature research	Van Staveren (2006)	5	10
	Other literature	17	26
Field research	Interviews with 7 experts	63	73
	Delft Cluster and RISNET	24	38
Total		109	147

3

3.3 Data analysis

Three steps of *analysis* have been executed. Step 1 provided two key definitions for the terms risk and risk management. Step 2 resulted in three levels for applying risk management in organizations. In Step 3 of the analysis, a Delphi analysis has been executed for revealing the most relevant hurdles and conditions for applying risk management. The following three sub-sections describe these steps of analysis in some more detail.

3.3.1 Providing key definitions

Step 1 of the data analysis involved theory triangulation, as suggested by Patton (1987) in Yin (2003). By analyzing and combining the identified definitions about risk and risk management in Section 3.2, two *key definitions* for risk and risk management have been derived:

- *Risk* is the likelihood of occurrence of an undesired event *and* consequences that event, assessed *at* a certain moment in time;[82]
- *Risk management* is the coordinated application of policies, processes, and practices for effectively and efficiently dealing with risk.

82 This definition is based on Williams (1996) and corresponds with the adverse impact risk perspective, in which risk is considered as something *negative*. An opportunity risk perspective acknowledges also uncertain events with a *positive* impact (Edwards and Bowen, 2005). However, this latter approach is not yet widely accepted and may raise confusion. For this reason, within this thesis the conventional adverse impact risk perspective has been applied, which explains the selected risk definition.

Risk management *effectiveness* indicates meeting the objectives of risk management, which is reducing risk to an acceptable level, or avoiding risk at all. Risk management *efficiency* means that these objectives are realized with a minimum of required resources, such as time and money. Both of the key definitions are used throughout this thesis.

3.3.2 Selecting and combining risk management concepts

Step 2 of the data analysis involved also theory triangulation (Patton, 1987 in Yin, 2003). Analyzing and combining particularly the identified risk management processes resulted in three distinct levels, at which risk management can be applied within an organization:

1. *Discipline* level, for applying discipline-based risk management;[83]
2. *Project* level, for applying project risk management;
3. *Organizational* level, for applying portfolio risk management.

In an organization, risk management can be applied at each of these three levels, as well as at two or all three levels. Discipline-base risk management, such as geotechnical risk management, and project risk management can be applied, while portfolio risk management is not (yet) applied within an organization. Applying project management without applying discipline-related geotechnical risk management within the project is also possible.[84] Therefore, organizations may start with applying risk management at discipline or project level, as a step stone for implementing risk management at organizational level, at a later stage. Applying discipline-related risk management and project risk management can be considered as "*light*" and "*medium* " versions of applying portfolio risk management at organizational level. Figure 3.1 shows the relationships between *applying* risk management at the three distinguished levels within an organization.

83 An example of discipline-based risk management is geotechnical risk management.

84 An example is a large public organization responsible for the realization and maintenance of infrastructure in The Netherlands. This organization applies *project* risk management in its infrastructure projects, but not fully applies *geotechnical* risk management within its projects.

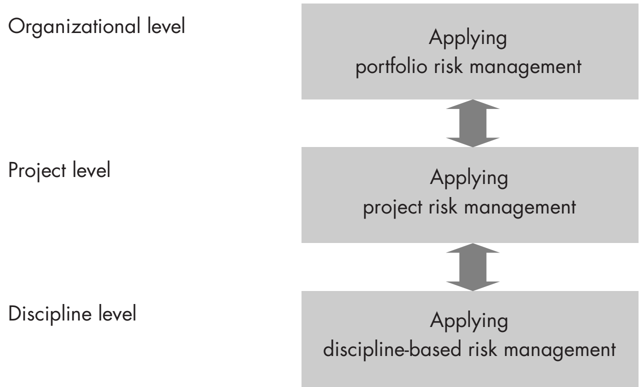

Figure 3.1. Applying risk management at three levels within an organization.

3.3.3 Selecting and combining risk management variables

In Step 3 of the analysis, a Delphi analysis (Verschuren and Doorewaard, 2000) has been applied for revealing the most relevant hurdles and conditions. All 63 hurdles and 73 conditions were presented as statements. The theory about framing effects of risk statements (Kahneman and Tversky, 1979) has been applied. This approach aims providing the most prudent judgement from experts. Hurdles were statically and negatively framed, while the conditions were dynamically and positively framed.[85] Delphi questionnaires with in total 139 statements about the hurdles and conditions have been developed. These questionnaires include a five-point scale, ranging from very low to very high, for indicating the degree of agreement with each statement, as well as the level of importance of each statement. It was also possible to indicate no agreement at all with a statement. Furthermore, the ability to influence each hurdle and condition by the individual professional, the project team, the organization and the client could be scored as low or high.[86]

The Delphi questionnaires were sent to the international experts, who have been interviewed. Completing questionnaires with in total 136 statements proved to be

---

85 As for instance confirmed by Keizer et al. (2002), by building on the findings of Kahneman and Tversky (1979), people tend to judge negatively framed statements rather positively, by considering "it can not be that bad". Otherwise, positively framed statements are generally considered with reserve, such as "is it that positive?". Therefore, negatively framed hurdles will be judged rather positively, while positively framed conditions will be considered with some reserve.

86 External levels, which are out of direct influence of individual organizations, such as the industry level and the national level are beyond the scope of this research and have therefore not been considered.

a tedious task. Four of the seven experts returned the questionnaires, with some comments. Some of the statements were considered more or less similar and could have been combined, according to the comments. Other statements were considered not clear. Two of the four respondents returned only the statements on conditions. One of the four respondents returned only the statements on hurdles and another respondent returned both questionnaires on hurdles and conditions. For generating additional data, also an additional Dutch geotechnical risk management expert completed both questionnaires.

Based on the results of the Delphi analysis, individual professionals, teams, organizations, or clients seem to be able to influence 44 hurdles out of the 63 hurdles, which is 70 percent. Consequently, the remaining 19 hurdles (30 percent) were considered beyond the direct control of individual professionals, teams, organizations, or clients. These hurdles need reduction or elimination by for instance government regulations. Of the total of 73 conditions, 61 conditions (84 percent) were considered controllable to a low or high degree by individual professionals, teams, organizations, or clients. The remaining 12 conditions (16 percent) were perceived beyond direct control. Therefore, it seems that the majority of hurdles and conditions for applying risk management can be directly influenced by individual professionals, teams, organizations, or clients.

Furthermore, the Delphi analysis revealed that only 8 of the 63 hurdles (13 percent) and 12 of the 73 conditions (16 percent) were judged as important to highly important for applying geotechnical risk management by at least 2 out of the 5 interviewed experts who completed the questionnaires. This result demonstrates that expert opinions about the importance of hurdles and conditions for applying geotechnical risk management vary significantly. Apparently, the majority of hurdles and conditions for applying risk management raised in the interviews are highly context-dependant, rather than of a generic type. Each of the 8 generic hurdles and each of the 12 generic conditions for applying risk management could be directly influenced by individual professionals, teams, organizations, or clients.

Table 3.8 and Table 3.9 present the 8 generic hurdles and the 12 generic conditions, which have been judged important to highly important by the participants of the Delphi analysis. The *order* of the generic hurdles and conditions in Table 3.8 and Table 3.9 is arbitrary and resulted from the research process. The *numbers* in the first column of Table 3.8 and Table 3.9 are only for identification purposes. They do not reflect the relative relevance of the generic hurdles and conditions to each other. In this stage of the research, all of the generic hurdles and conditions were considered being of equal significant relevance.

Table 3.8. Generic hurdles for applying risk management from the Delphi analysis.

Generic hurdles for applying risk management	
No.	**Description**
1	The risk management motivation of team members is conflicting.
2	Clients pay no attention to geotechnical risk management.
3	Rigorously applying geotechnical risk management does not guarantee well-performing projects.
4	Non-geotechnical engineers, such as structural engineers, are often not aware of geotechnical uncertainty.
5	There are no economic drivers that motivate applying risk management.
6	Lacking convincing case studies demonstrating geotechnical risk management benefits for training purposes.
7	Conventional health and safety training does not replace geotechnical risk management training.
8	Most geotechnical problems are not publicized and remain unknown, which gives limited risk management urgency.

Table 3.9. Generic conditions for applying risk management from the Delphi analysis.

Generic conditions for applying risk management	
No.	**Description**
1	Enforced geotechnical risk management by professional indemnity insurers.
2	Applying risk management aligns with the client's interests.
3	Public owners enforce risk management in their projects for demonstrating effective spending of public money.
4	Applying risk management is a prerequisite for getting funding from the private financial sector.
5	Use of suitable contractual frameworks that support and reward risk management applications.
6	Presence of a good climate with trust between the parties involved in the project.
7	Fees for geotechnical engineers enable them to apply geotechnical risk management.
8	Formalized peer review on each other's work within the project.
9	Risk management is integrating with strategic management.
10	Long-term monitoring of construction processes, for learning whether identified risks occur or not.
11	Risk management workshops for creating a shared understanding of risk management.
12	Selected teams with a variety of skills and talents.

3.4 Data classification

For classification purposes, data triangulation (Patton, 1987, in Yin, 2003) involved comparing and clustering similar hurdles and conditions. In total 109 hurdles and 147 conditions for applying risk management were *classified* into three categories: (1) motivation, (2) training and (3) tools. *Motivation* concerns the willingness or know *why* to apply risk management. *Training* is required for acquisition of knowledge for knowing *how* to apply risk management. *Tools* aim to support and facilitate the application of risk management.

The classification has been performed on all literature and field research data. Appendix 3 and Appendix 4 present tables with the numbers of hurdles and conditions that were identified from the data sources during the literature and field research. The classification resulted into 7 key hurdles and 10 key conditions for *applying* risk management within organizations in the construction industry, as presented in Table 3.10 and 3.11. The *order* of the key hurdles and conditions in Table 3.10 and Table 3.11 is arbitrary and resulted from the research process. The *numbers* in the first column of Table 3.10 and Table 3.11 are only for identification purposes. They do not reflect the relative relevance of the key hurdles and conditions to each other. In this stage of the research, all of the key hurdles and conditions were considered being of equal significant relevance.

Table 3.10. Key hurdles for applying risk management.

Key hurdles for applying risk management		
No.	**Category**	**Description**
1	Motivation	Lack of risk management awareness.
2		Lack of clear risk management benefits.
3		Fear for risk transparency.
4		Difficulty to apply risk management.
5	Training	Lack of risk management understanding.
6	Tools	Lack of risk management methods, protocols, tools, and data.
7		Lack of risk management benchmarks.

Table 3.11. Key conditions for applying risk management.

Key conditions for applying risk management		
No.	**Category**	**Description**
1	Motivation	Setting of clear goals and objectives.
2		Raising awareness about risk consequences and risk management benefits.
3		Providing clear contractual risk responsibility.
4		Relating risk management to other management approaches.
5		Involving all project stakeholders.
6		Providing resources for applying risk management.
7	Training	Risk management understanding.
8		Understanding of the role of teams.
9		Understanding the role of organizational culture.
10	Tools	Project fit of risk management methods, protocols, tools and data.

3.5 Results and next research step

Research results

The research presented in this chapter generated risk management concepts and variables. The exploration research of risk management *concepts* generated two *key definitions* for risk and risk management:

- *Risk* is the likelihood of occurrence of an undesired event *and* consequences that event, assessed *at* a certain moment in time;
- *Risk management* is the coordinated application of policies, processes and practices for effectively and efficiently dealing with risk.

The risk definition expresses a three-dimensionality of an undesired event: (1) likelihood of occurrence, (2) consequences of occurrence, and (3) the moment in time, in which the likelihood and consequences are assessed.
Furthermore, three risk management levels have been distinguished, at which risk management can be applied: (1) the discipline level, (2) the project level, and (3) the organizational level.
The exploratory research of risk management *variables* generated 109 hurdles and 147 conditions for applying risk management. These have been clustered and synthesized into 7 key hurdles and 10 key conditions for *applying* risk management within organizations in the construction industry. These key variables were classified in three categories: (1) motivation, (2) training, and (3) tools.

Research limitations

The results are based on a literature survey and field research. The latter included a Delphi analysis. As mentioned with Section 3.3, the response to the Delphi analysis was limited. In addition, there was a large variation in expert opinions and little consensus about the relevance of individual hurdles and conditions. Based on the results of the Delphi analysis, a majority of respondents considered a substantial number of hurdles and conditions not relevant for applying risk management, despite the fact that these hurdles and conditions were raised in interviews with individual experts. Therefore, the exploration research results raised a few research questions:

- Did the performed triangulations actually generate an *appropriate* and *complete* set of hurdles and conditions for applying risk management?

- Is the classification into three *categories* of motivation, training, and tools adequate, or are other and more useful classifications preferred?
- Are the derived hurdles and conditions for *applying* risk management in a *project* also appropriate for the routinized application or *implementation* of risk management within a (project) *organization*?

3

Next research step

After critically evaluating all exploration research results about applying risk management, it was assumed that implementing *risk management* could have a lot in common with implementing an *innovation* within an organization. Therefore, a key proposition has been formulated:

Key Proposition 1: *Implementing risk management requires innovation management*.

For verifying this key proposition, a second area of interest needed exploration: innovation management. For this reason the next step of the exploration research targeted *innovation management*.

4

EXPLORING INNOVATION MANAGEMENT

4.1 Introduction

The end of the previous chapter about applying risk management raised a few research questions. For answering these questions, it was suggested that routinely applied or *implemented risk management* within an organization could have a lot of characteristics in common with an *implemented innovation*. This chapter aims to verify this key proposition by exploring the discipline of *innovation management*.

Similar to that of risk management, the exploratory research of innovation management consists of three subsequent steps for identifying, analyzing, and classifying innovation management concepts and variables. This resulted in another key proposition that generated the need for exploring change management, which is the topic of Chapter 5. In this chapter, the execution of the three research steps within the discipline of innovation management is reported in three distinct sections. In the last section, the main research results, research limitations, and the resulting next research step are presented.

4.2 Data identification

State-of-the-art *concepts* and *variables* for implementing innovations have been identified by a *literature* survey and *field* research. First, the main and relevant concepts of *organizations*, *innovations*, and *implementing innovations* in organizations have been identified from the literature. Second, variables for implementing innovations, *hurdles* as well as *conditions*, have been derived from the literature and from field research. During the latter research, Dutch experts served as data source for the identification of hurdles and conditions for implementing innovations.

4.2.1 Concepts about organizations from literature research

Within this section, the main and relevant concepts about *organizations* are identified from the literature survey. Subsequently, concepts about organizations, organizations as systems, organizations as stable systems, and organizations as stable systems with individuals are presented.

Organizations

Organizations exist where people interact for performing functions. These activities should attain common goals. As for instance highlighted by Daft (1998), people and their relationships form an organization, rather than policies and procedures. Van Aken (2008b: 6) defines an organization as "a group of people, cooperating within a system of roles and routines to realize common objectives". Remarkably, conscious design and formalization of roles are not included in his definition. Similarly, among many other definitions in the literature, Rogers (2003: 475) defines an organization as "a stable system of individuals who work together to achieve common goals through a hierarchy of ranks and a division of labour". In this latter definition, the group of people of the former one is substituted by a stable system of individuals. Roles and routines in the definition by Van Aken (2005b) seem replaced by the hierarchy of ranks and division of labour by Rogers (2003), who seems giving more attention to the formalization aspect of an organization. According to Van Aken (2005b), formalization is not an important factor for every organization. By referring to Blau and Scott (1962), an organization is seen as a partly formally designed system, and a rather autonomous and naturally emerged system at the same time. Nevertheless, both presented definitions put emphasis on reaching common objectives or goals and seem to align well with each other, despite their different terminology. Next, subsequently three terms in the definition by Rogers (2003) are explored in some more detail: (1) system, (2) stability, and (3) individuals.[87]

Organizations as systems

Despite its presence in the definition of an organization, Rogers (2003) does not define the word *system*. Fortunately, other scholars do define systems. For instance, Daft (1998: 13) defines a system as "a set of interacting elements that acquires inputs from the environment, transforms them and discharges outputs to the external environment".

Blockley and Godfrey (2000) and Checkland (2000) distinguish *hard* systems from *soft* systems. A *hard* systems approach considers the world as a set of systems that can be engineered. This approach stems from systems engineering, in which the word system is simply used for labelling something that exists in the world outside ourselves (Checkland, 2000). A hard system is physical and objective (Blockley and Godfrey, 2000). Contrary to the hard systems, the *soft* systems approach considers the world as a set of fuzzy and ill-defined situations. The word system is applied for the *process* of dealing with the world, by learning and inquiry (Checkland, 2000). A *soft* system is characterised by its human and subjective elements. Soft systems are related to social sciences, management and marketing. They not only comprise triggers of action and reaction, but also their *intention*. A soft system also incorporates *reasoning* about why we do or why we do not. Hard systems are always embedded in soft systems. It is ultimately humankind, who develops and operates both types of system (Van Staveren, 2006).

According to Lewis and Seibold (1993), the terms *system* and *structure* have the same meaning in many studies. However, within the social system, as defined by Rogers (2003), the social structure is an element within the social system. For avoiding confusion, the definitions of systems and structures from Giddens (1979) in Lewis and Seibold (1993) are helpful. *Systems* are "regularized regulations of interdependence between individuals and groups". *Structures* are " the rules and resources that people use to maintain the systems" (Giddens, 1979: 66). Therefore, analyzing structure seems essential for understanding why and how social systems work.

87 Dr. Everett M. Rogers published the first edition of his book *Diffusion of Innovations* in 1962. In 2003, after receiving various awards, including the Citation Classic in 1990 by the Institute for Scientific Information, the fifth edition of this book has been published. While somewhat modified and expanded, the innovation diffusion model by Rogers of 1962 is still unique in its sort. For these reasons, a lot of terminology proposed by Rogers on organizations, social systems, innovations, and particularly its diffusion processes, are used in this section. Obviously, abundant other literature has been explored for confronting or confirming the terminology from Rogers.

Organizations as stable systems

Rogers (2003: 476) defines a *social* system as "a set of interrelated units involved in joint problem solving to accomplish a common goal". For defining an organization, which has been previously presented, he added *stability* to this definition of a social system. Stability represents an *equilibrium*, when almost no change occurs within the system. Apparently, Rogers (2003) distinguishes situations of *dynamic equilibrium* and *disequilibrium* in social systems. In the first situation, the social system is able to cope with the degree of change, while in the second situation the rate of change is too much or too rapid for the social system to adopt. Moreover, within his social system concept, Rogers (2003) distinguishes *external* social systems, outside the organization, from *internal* social systems, within the organization.[88]

Organizations as stable systems with individuals

Daft (1998) characterizes organizations by four levels of analysis: (1) the individual human being, (2) the group, team or department, (3) the organization itself, and (4) the external environment of the organizations. Rogers (2003) combines the latter three levels in his social system, in which individuals are members of social systems. According to Rogers (2003), individual behaviour in an organization is relatively stable and predictable, because it is driven by predetermined organizational goals and roles, by an authority structure, by rules and regulations, as well as by informal patterns.

This actual Ph.D. research considers the implementation of innovations *within* organizations. This implies focussing on the first three levels of organizational analysis: (1) the individual, (2) the group, team, or department, and (3) the organization. While acknowledging that any organization is dependant upon its external environment, the fourth level of the external environment is beyond the research scope. This marginalization of the external social environment aligns with the findings of Damanpour and Schneider (2006). From their study, amongst 1200 public organizations in the US, they conclude that the organizational context is more influential in predicting all phases of innovation adoption, which including the implementation phase, than the external environment.

4.2.2 Concepts about innovations from literature research

Within this section, the main and relevant concepts about *innovations* are identified from the literature survey. Subsequently, concepts about innovations, innovativeness,

88 For organizations, this open system approach involves buying resources from suppliers (external), adding value to them in one way or another (internal), and selling the resulting goods or services to clients (external).

adoption and diffusion, innovations and attributes, innovations, social systems, and organizational culture, innovations and users, innovations and organizations, several types of organizational innovation, as well as the form, function and meaning of organizational innovations are presented.

Innovations

This section explores the concept of *innovations*. According to Holahan et al. (2004), the traditional way of defining an innovation stems from Nord and Tucker (1987). The latter define an innovation as a technology or practice that is *new* to an organization. West and Farr (1989: 16) give a more extensive, yet essentially similar, definition for an innovation: "The intentional introduction and application within a role, group, or organization of ideas, processes, products, or procedures, new to the relevant unit of adoption, designed to significantly benefit role performance, the group, the organization or the wider society". Rogers (2003: 475) summarizes this definition by considering an innovation as "an idea, practice or object that is perceived as new by an individual or other unit of adoption". Rogers (2003: 473) defines the term adoption as "a decision to make full use of an innovation as the best course of action". The *decision* describes Rogers (2003: 474) as "that which occurs when an individual engages in activities that lead to a choice to adopt or reject the innovation".

The word *perceived* in the innovation definition by Rogers is remarkable. As raised by Van Staveren (2006), the word *perception* has two related and supplementary meanings. The first is that of *receiving* an observation. Perception is however more than just observing an therefore the second meaning is giving some *sense* to the observation.[89] Something can be *perceived* as new and therefore as an innovation by one person, team, organization, or industry, while another person, team, organization, or industry is already using it.[90] Whether something is an innovation or not is therefore context-dependant. It may be even subject to individual perception. The routinized application of risk *management*, in addition to more conventional risk *analysis*, is *perceived* as new by many in the construction industry (Van Staveren, 2006). Therefore, routinized application of risk management can be considered as an innovative development.

89 By this definition, perception appears to be closely related to *interpretation*. Both terms give a subjective meaning to facts.

90 For instance, applying risk management can be an innovation in one firm within the construction industry, while it is already embedded for some years in another firm in the construction industry.

Innovativeness, adoption and diffusion

Three other widely used terms with regard to innovations are *innovativeness*, *adoption* and *diffusion*. Rogers (2003: 475) defines *innovativeness* as "the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than the other members of the system". Furthermore, *adoption* is the decision to make full use of an innovation. Additionally, Rogers (2003: 476) defines the *rate* of *adoption* as "the relative speed with which an innovation is adopted by members of a social system".[91]

Obviously, for becoming innovative an innovation needs to reach its potential users, either individuals, teams, or organizations. In other words, any innovation needs some sort of *diffusion* before it can be implemented within an organization. Rogers (2003: 474) defines diffusion of an innovation as the process in which an *innovation* is *communicated* through certain *channels* among *members* of a *social system* over *time*. Within this definition, the interrelated variables that determine the innovation diffusion are (1) the characteristics or attributes of the innovation, (2) members of a social system, (3) communication channels, and (4) time.

Innovations and attributes

Rogers (2003) presents five main characteristics or *attributes* of innovations: (1) relative advantage, (2) compatibility, (3) complexity, (4) triability, and (5) observability. These attributes are perceived in different ways by individuals. The degree of presence or absence of these attributes determines the rate of *adoption* of an innovation. Relevant sub-attributes for *relative advantage* are economic factors (cost aspects), social status aspects, over-adoption, preventive aspects, incentive effects, and mandates. Incentives are direct or indirect payments in cash or in kind to its diffusers or adopters for encouraging the use of the innovation (Rogers, 2003).[92] Choi and Price (2005) mention the technology acceptance model by Davis (1989), which relates a person's behavioural *intention* to use an innovation and the *actual* use of an innovation to the perceived ease and perceived usefulness of the innovation. The latter are two innovation attributes as identified by Rogers (2003).

---

91 According to Rogers (2003), this rate of adoption over time can be illustrated by the relationship between the percentage of the adoption of an innovation and the time required to reach that percentage. Usually, this relationship is some sort of S-curve, because individuals in a social system, such as an organisation or team, do not all adopt the innovation at the same moment in time.

92 Typical forms of incentives are (1) adopter versus diffuser incentives, (2) individual versus system incentives, (3) positive versus negative incentives, (4) monetary versus non-monetary incentives, and (5) immediate versus delayed incentives. Incentives can be considered as interventions in order to stimulate use of the innovations, which would have been used to a lesser degree or not at all without the incentives, probably because the attributes of the innovation are not sufficiently attractive for its potential users. As raised by Rogers (2003), paying incentives may raise serious ethical issues that need to be explored in future studies.

Relevant sub-attributes for *compatibility* or *fit* of an innovation within an organization are values and beliefs, previously introduced ideas, needs, technology clusters, and naming and positioning of the innovation (Rogers, 2003). The compatibility with existing values and beliefs aligns with the concept of innovation-values fit of Klein and Sorra (1996). Regarding the compatibility with existing ideas, according to Rogers (2003) previous practices of potential users provide the standard for judgement about the innovation. Using previous experience reduces the uncertainty about the innovation.[93] The sub-attributes of indigenous knowledge systems and acceptability research are here not considered explicitly, because these seem highly related to respectively the sub-attributes of previously introduced ideas and needs.

By the direct and indirect network externalities adoption model (DINAM) Song (2006) suggests another four attributes of innovations: (1) direct network externality, (2) indirect network externality, (3) price, and (4) relative usefulness, which are not suggested by Rogers (2003). The network externalities are related to effect of the external environment on the social system and derived from the network externalities theory by Katz and Shapiro (1986, 1985). This theory is for instance used for predicting the adoption of innovations at macro level within markets (Van der Heiden, 2006).

Generally favourable characteristics of Roger's (2003) five attributes for the diffusion of innovations are (1) high relative advantage for providing clear benefits, (2) high compatibility for establishing a good fit between the innovation and its users within their social system, (3) low complexity that reduces the difficulties and learning efforts for using the innovation, (4) high triability, which will invite potential users to experience with the innovation, and (5) high visibility that helps in communication about the innovation and makes it tangible.

Generally favourable characteristics of Song's (2006) additional four attributes for diffusing innovations are (1) many direct network externalities, which indicates that many colleagues and competitors are using the innovation, (2) many indirect network externalities by many clients demanding for the use the innovation, (3) low price, which makes buying and using the innovation accessible for many users, and (4) high usefulness that makes it attractive for users to apply the innovation, because they benefit from it in performing their tasks, in one way or another. For instance, users may be able to do there work faster or with a higher (perceived) quality.

93 Therefore, it is very important for those responsible for implementing innovations, not only to understand the needs of its potential users, which is a form of anticipating the future, but also to acknowledge the professional experiences of these users, which requires a look backwards in time.

Innovations, social systems, and organizational culture

According to Rogers (2003), five main characteristics of the social system should be acknowledged, when trying to explain or predict its effect on the rate of innovation diffusion: (1) social structure, (2) norms of the social system, (3) the role of opinion leaders and change agents within the social system, (4) the type of innovation decision, and (5) the consequences of the innovation. For instance, the type of innovation decision effects the degree of innovation diffusion within a certain time period.[94]

The relevance of *social structure* and *norms* of the social system in view of innovations seems confirmed by other scholars. For instance, Detert et al. (2000) related quality improvement initiatives to *organizational culture*, by presenting a qualitative content analysis of the existing literature about this topic. By referring to Brennan (1994), Detert et al. (2000) highlight that not changing organizational culture is a major reason for failing quality improvement efforts.[95] Detert and colleagues argue that the relation between successful implementation of process innovations and culture has not been adequately explored. They mention that researchers studying the implementation of innovations, such as total quality management (TQM), usually focus on the visible aspects or artefacts of organisational culture. In general, little attention is given to values and beliefs, as well as their underlying assumptions that support or impede required new behaviours. The main reason seems to be the lack of an adequate framework. Therefore, Detert and colleagues developed a framework, which consists of eight generic cultural dimensions for organizations.[96]

Moreover, Orton and Weick (1990) introduced ideas about loosely coupled systems. These are for example networks of firms aiming to jointly apply innovations within an industry. A rather loose coupling of distinct but responsive firms can be compensated by subsequently cognitive coupling and structural coupling. *Cognitive coupling* is the act of building trust and sharing values. *Structural coupling* is for

---

94 An example of an *optional* innovation decision is an engineer, who is able to decide individually about adopting a risk management method for hos or her design activities. Such an innovative approach has been made available by purchasing guidelines and supporting software by the engineering firm where the engineer works. The purchase decision could have been made as a decision based on *authority* of the engineer's manager, or as a *collective* decision in a team meeting of the manager and his or her engineers.

95 Detert et al. (2000) refer to Hammer and Champy's (1994) statement that it is executive's management responsibility to anticipate and overcome adverse cultural characteristics of organizations.

96 Detert et al. (2000) started with revealing the main cultural dimensions. During their analysis, they discovered that only a relatively small number of dimensions underlie the majority of cultural concepts. From their study of over 25 cultural concepts, which have been published in 25 years from 1973 through to 1998, finally eight different and generic cultural dimensions remained: (1) the basis of truth and rationality in the organization, (2) the nature of time and time horizon, (3) motivation, (4) stability versus change, innovation, and personal growth, (5) orientation to work, task, and co-workers, (6) isolation versus collaboration and cooperation, (7) control, coordination, and responsibility, and (8) orientation and internal or external focus.

instance realized by ownership integration and coordination integration (Robertson and Langlois, 1995). These types of coupling seem to confirm the relevance of social structure and norms, even beyond the boundaries of individual firms.

Klein and Sorra (1996) use the term *organizational climate*, rather than organizational culture. They refer to Schneider (1990: 384), who defines a climate as "the employee's perceptions of the events, practices and procedures and the kinds of behaviours that are rewarded, supported, and expected in a setting". This definition gives the concept of climate a highly subjective character, because of explicitly addressing perception. Apparently, in this view there is a focus on the beliefs of the organizational members. It seems that an appropriate climate for innovation can be considered as the positive or innovation-stimulating part of an organizational culture.

According to Rogers (2003), innovation consequences are (1) desirable or undesirable, (2) direct or indirect, (3) anticipated or unanticipated, and (4) increasing or decreasing equality.[97] The first three consequences aim to increase the *level of good* in a social system. The fourth consequence about equality concerns the distribution of this *additional good* amongst the members of a social system. Rogers (2003) states that everyone in a social system, thus adaptors and rejecters, is touched in some way by the consequences of an innovation. Furthermore, also third parties outside the social system may be affected.

Also raised by Rogers (2003), *consequences* of innovations are not always adequately considered. One reason is the over-emphasis of change agents on the adoption of the innovation, while assuming that the consequences are positive. Possibly, also other factors play a role, such as commercial ones of selling consultancy services for implementing the innovation. Another reason for insufficient attention to innovation consequences is the fact that these are difficult to predict and to measure.[98] Given the inherent differences in perception between individuals within a social system, as well as between individuals inside and outside the social system, considering the consequences of using an innovation seems to require a multi-actor and multi-stakeholder approach. Whether the consequences are perceived desirable or not will be highly dependent upon the viewpoints of individual innovation users or stakeholders.

---

97 For instance, a *desirable, direct*, and *anticipated* consequence of implementing risk management within an organization is a measurable reduction of risk. An *unanticipated* consequence may be emerging risk aversion within the organization. This may reduce the propensity toward adopting innovations within an organization and illustrates the complexity of implementing innovations within organizations.

98 While this difficulty of predicting and measuring the consequences is particularly applicable to managing risk, it seems not at all restricted to implementing risk management within an organization. For instance, technically advanced innovations will normally generate significant (un)anticipated consequences because of the increase in interdependencies between systems that are difficult to understand or predict. Even in case of relatively simple innovations, uncertainty about its consequences can never be completely eliminated.

Innovations and users

Regarding the *members* of a *social system*, different groups of actors that effect or are effected by the innovation can be distinguished. Probably the most important group is formed by the intended professionals that should *adopt* and *use* of the innovation. For these individuals, Rogers (2003) introduces five innovation adopter or user categories: (1) innovators, (2) early adopters, (3) early majority, (4) late majority, (5) laggards.[99] These five groups are presented in an order that represent decreasing *innovativeness*. Innovators are the most innovative, while the laggards are the least innovative. The *innovativeness* of an *individual* is determined by (1) the characteristics of that individual and (2) the nature of the social system to which the individual belongs. Table 4.1 presents the five innovation user categories, together with their characterization in one key word and some main aspects. Within the column *main aspects*, the relevant aspects are presented with regard to three distinguishing features of (1) socio-economic status, (2) personality values and (3) communication behaviour. Different features may have a different importance during the implementation of innovations in different organizational settings.[100]

Table 4.1 Descriptions and characteristics of the five innovation user categories (after Rogers, 2003).

Innovation user categories	Characteristic	Main aspects
1. Innovator	Venturesome	1. Rather high socio-economic status, with financial resources for compensating losses from failing innovations; 2. Able to deal with a high degree of uncertainty about the innovation; 3. Communication outside the social system over large distances.
2. Early adopter	Respectful	1. Respected by its peers as opinion leader and role model for using the innovation; 2. Decreases uncertainty about the innovation by adopting it; 3. Communication, more than innovators, within the social system over local distances.

99 Similar classifications are used within the discipline of marketing, where specific marketing actions are defined for each of these five groups (Dibb et al., 1997).

100 For instance, based on research by Damanpour and Schneider (2006), including 1200 public organizations within the US, a manager's *attitude* towards innovation influences all phases of innovation adoption more than his or her *socio-economic environmental factors*, such as urbanization and community wealth. This research confirms the findings of Rogers (2003), that organizations in wealthier and growing communities initiate, adopt and implement more innovations than organizations in less favourable socio-economic settings. These aspects are presented to illustrate the complexity of predicting innovation attitude and behaviour of different adopter categories. Further elaborating these features is beyond the scope of this research.

Table 4.1 Continued

Innovation user categories	Characteristic	Main aspects
3. Early majority	Deliberate	1. Frequent interaction with peers within the social system, without being opinion leader; 2. Waiting for a certain time period before using the innovation, after it is well-tested; 3. Communication in the social systems by providing interpersonal networks.
4. Late majority	Sceptical	1. Adoption because of economic necessities or peer pressure, after others have done so; 2. Because of rather scarce financial resources, most of the uncertainty of the innovation need to be disappeared; 3. The innovation must match with the system norms of the late majority and communication seems to concentrate within the system.
5. Laggards	Traditional	1. Adoption if its in line with earlier decisions made in the past; 2. Resources are limited and therefore innovations must certainly perform; 3. Laggards are nearly isolated and communicate merely with other laggards in the social networks of their systems.

Despite the relevance of *individual* innovation user characteristics, according to Rogers (2003) the characteristics of a *social system*, as previously discussed, do influence the diffusion of an innovations to a higher extend than the characteristics of individuals in the social system. Rogers (2003) presented the adopter categories initially for classifying the innovativeness of *individual* users. A similar categorization can be also used for research with the social systems of individuals, such as teams or departments within organizations, organizations within an industry, the industry as a whole within a nation, or compared with similar industries in other countries.[101] The innovation implementation processes within organizations is even more complex than the innovation adoption processes of individuals. It is because in organizations many individuals, in many different roles, are involved. Implementing an innovation includes adaptation of the organizational members towards the innovation. Furthermore, it requires often also organizational change (Rogers, 2003).

101 For instance, the Dutch construction industry can be classified as a laggard with regard to adopting risk management, when compared with other industries, such as the oil and gas industry, and also when compared with the construction industries in particularly Anglo-Saxon countries, such as the United Kingdom and Australia (Van Staveren, 2006).

Innovations and organizations

Similar to individual innovativeness, *organizational innovativeness* can be defined as the degree to which an organization is relatively earlier in adopting new ideas than other organizations within the same industry. Already in the 1970s, hundreds of studies of organizational innovativeness were completed (Rogers, 2003). For reasons of simplicity, entire organizations were considered as single units of analysis, which was also common practice in studies about individual innovativeness. However, many organizational characteristics do not have individual counterparts. This explains the importance of the social system approach in the diffusions of innovations.

Later studies explicitly acknowledged the role of organizational characteristics in the innovation diffusion process, such as the degree of system openness, the degree of centralization, the degree of formalization, the degree of innovation complexity, the degree of interconnectedness of organizations, and the degree of organizational slack in an organization. Nevertheless, these studies about organizational effectiveness seem to have lost a lot of their relevance over the years. Rogers (2003) provides two main reasons for this development.

First, the causal relation between independent variables of an organization and their innovativeness was quite low. These studies followed a merely quantitative approach by sampling and statistically evaluating large numbers of organizations, sometimes even more than hundred. However, any over-time effects of innovation processes within organizations were overlooked. Favourable variables in one phase of the innovation process may become unfavourable in a subsequent phase. For instance, Cozijnsen et al. (2000) confirmed this statement, based on studying fifty Dutch innovation projects.

Second, the data for studying organizational innovativeness were usually provided by highly ranked organizational members, such as chief executive officers. It became therefore doubtful whether this data reflected the actual innovation behaviour of the *members* of the organization. For these reasons, the studies of *organizational innovativeness* evaluated towards studies about the *organizational innovation processes* within organizations.

Several types of organizational innovation

Daft (1998: 291) defines an *organizational innovation* as "the adoption of an idea or behaviour that is new to the organization's industry, market or general environment". In contrast, Daft (1998: 291) defines *organizational change* as "the adoption of a new idea or behaviour by an organization". According to these definitions, the first organization in an industry that adopts a new idea is considered the innovator.

Organizations that copy and follow the innovator are therefore adopting changes. According to Daft (1998), the change process within an organization is however similar, whether the idea is only new to the organization or new to the entire industry.[102]

Daft's definitions correspond with the definition of a *user-based* sort of innovation, as presented by Klein and Sorra (1996). They refer to Nord and Tucker (1987), who describe user-based innovation models that are founded on the perspectives of innovation users, rather than innovator developers. Within their user-based approach, an innovation is a technology or a practice "being used for the first time by members of an organization, whether or not other organizations have used it previously" (Nord and Tucker, 1987: 6).

Rogers (2003) defines a *preventive innovation* as "an idea that an individual adopts in order to lower the probability that some future unwanted event will occur".[103] Such events are typically risks, with inherent uncertainty about its occurrence and consequences. Therefore, it seems that risk management can be considered as typically a preventive sort of innovation. Risk management should provide desired consequences, by reducing or avoiding adverse events or their effects, somewhere in the future.[104] The relative advantage or reward of risk management is thus delayed. Furthermore, as also set out by Rogers (2003), the unwanted event that is avoided by a preventive innovation is difficult to perceive, because it is a non-event. It is very difficult, if possible at all, to measure the direct or even indirect effects of risk management. Therefore, preventive innovations are (even) more difficult to diffuse than non-preventive innovations. The latter, for instance *incremental innovations,* may demonstrate short term effects (Rogers, 2003). Given the inherent difficulties of preventive innovations such as risk management, well-designed communication strategies are required to achieve the wanted degree of innovation diffusion. In conclusion, it seems that risk management, when new to an organization, can be considered as an organizational, user-based and preventive type of innovation.

Form, function, and meaning of organizational innovations

Rogers (2003) distinguishes the *form*, the *function* and the *meaning* of innovations. This features seem significant for organizational innovations. The *form* is the

102 This assumption should be considered with some reserve. For instance, due to *direct network externalities* (Song, 2006) it may be easier for an organization to adopt innovations that are already used by others in the industry, than adopting innovations that are entirely new to the industry.

103 Examples of preventive innovations are family planning programmes, preventive HIV/AIDS campaigns, and seatbelts in cars.

104 Therefore, *risk management* is quite different from *crisis management,* which requires immediate action.

direct observable appearance of an innovation. The *function* of an innovation is its contribution to the social system. The *meaning* of an innovation is the subjective perception of an innovation by the members of a social system. Because of this social construction, its meaning is usually difficult to predict. For preventive types of innovation, function and meaning approaches each other closely, because *perceived* functionality and *perceived* meaning are both subjective and socially constructed.

4.2.3 Concepts about implementing innovations in organizations from literature research

Within this section, the main and relevant concepts about *implementing innovations* in organizations are identified from the literature survey. Subsequently, concepts about organizational innovation processes and implementing organizational innovations are presented.

Organizational innovation processes

Over the years, many models for executing innovation processes within organizations have been developed. These models describe the entire process, from starting to adopt an innovation towards its common use within an organization. Kamal (2006) presents eleven different models, which have been developed over the last fifty years. All models are staged and the number of phases vary between a minimum of two phases (Zaltman et al., 1973) and a maximum of six phases (Frambach and Schillewaert, 2002). Six of the eleven models explicitly distinguish the *implementation* or continuous using phase, including a model as proposed by Rogers (2003). The latter divides the organizational innovation process in an *initiation* and *implementation* phase, which are separated by an explicit *innovation decision*. The initiation phase has two sub-phases: (1) agenda setting and (2) matching. The sub-phases of the implementation phase are subsequently (1) redefining the innovation and restructuring the organization, (2) clarifying the innovation, and (3) routinizing the innovation. Figure 4.1 presents an example of an organizational innovation process, as suggested by Rogers (2003). While using somewhat different terminology, this model is almost similar to that suggested by Vrakking (1995), which distinguishes four phases, including initiation and implementation, and seven sub-phases, starting with a research phase and ending with an adjustment phase.

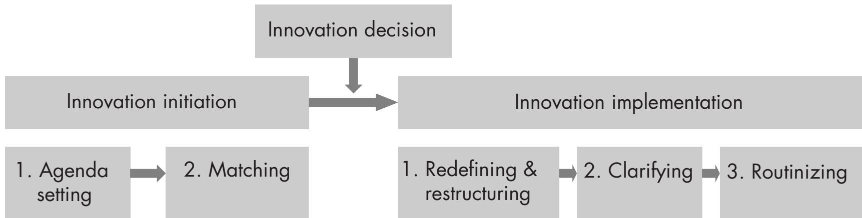

Figure 4.1 An example of an organizational innovation process, after Rogers (2003).[105]

The initiation phase starts with *agenda-setting*, when an organizational problem or performance gap arises that may create a need for an innovation.[106] The desire or need to get rid of the problem may be an important trigger for initiating an innovation. The second sub-phase of the initiation phase is conceptually *matching* or fitting of the identified performance gap with one or more promising innovations. The feasibility of the innovation will be judged with regard to its potential for reducing or solving the problem.[107] Before starting the implementation phase, an explicit managerial decision to adopt one or more of the proposed innovations needs to be taken. Only after a positive decision, the implementation phase starts with *redefining* the innovation and *restructuring* the organization. The innovation redefinition is in fact an innovation re-invention. If needed, organizational structures are altered for fitting the re-invented innovation.[108] According to Van de Ven (1986) in Rogers (2003), innovations not only adapt to the existing organizational and industry systems, but they also transform the structure and practices within these systems. It is because an innovation almost never entirely fits within an organization, even after a process of re-invention.[109] Nevertheless, internally developed innovations within an organization are generally more successfully implemented than innovations that are brought in from outside the organization. It is because the organizational members

105 Figure 4.2 is a slightly revised version of Figure 10-3 in Rogers (2003: 421).

106 An example of a performance gap is the occurrence of considerable failure costs in the construction industries, in The Netherlands and abroad that has been raised in Section 1.2 of Chapter 1.

107 It should be recognized that without an actual performance gap setting an innovation agenda also could be fruitful. By such a pro-active approach, scientific and business environments are scanned for discovering potential innovations that may improve the organizational performance. This type of innovation is beyond the scope of this research.

108 A simple example is establishing a risk management team with an organization. This team may assist organizational members with learning how to apply risk management within their design processes (Van Staveren, 2006).

109 This may explain why organizations having difficulties with realizing organizational change may also experience difficulties with successfully implementing innovations. Examples of such organizations are for instance units of municipalities trying to implement risk management for controlling construction projects (Van Staveren, 2007b).

tend to consider the first type of innovation as their own.[110] Next, in the *clarifying* phase, the relationship between the innovation and the organization is established. During this phase, the *meaning* of the innovation should become gradually clear to the organizational members. *Framing* of the innovation is important, for obtaining acceptance by the organizational members. Any innovation can be framed in different ways.[111] This clarifying stage consists typically of social construction. The inherent differences in perceptions and attitudes of individual organizational members complicates this process.

Finally, in the *routinizing* phase, the innovation becomes a usual part of the work processes. Normally, a *critical mass* of individuals, who adopted the innovation, would have been reached within the social system during this phase. Then, further dissipation of the innovation becomes self-sustaining. In the ideal situation, the innovation will loose its innovative identity, because its users are fully used to its routine application.

According to Rogers (2003), *interventions* are ideally selected, prepared, and planned in the early part of the risk management implementation phase, when a re-definition or re-invention of the risk management methodology takes place, together with restructuring of the organization. According to Lapointe and Rivard (2005), in the early phases of implementation, the object of resistance tend to be the innovation and its features.[112] They refer to Tyre and Orlokowski (1994), who consider this period as a window of opportunity for adapting or re-inventing the innovation. During later phases of implementation, the entity of resistance tends to shift significantly towards the social system or those persons who advocates the social system. In other words, the resistance becomes politicized. Managing this type of resistance is more difficult than re-inventing the innovation. However, re-inventing tends to become rather obsolete during the later phases of implementation.

Sustainability of use of the innovation can be defined as the degree to which an innovation continues to be used after being routinized (Rogers, 2003: 183). A high degree of innovation re-invention, user participation during the innovation process, and the presence of innovation champions, who are able to overcome

110 At least with regard to risk management, this seems not always the case. For example, as described by Van Staveren (2006), despite its development within the organization, the implementation of a geotechnical risk management process in a geotechnical knowledge institute proved to be a difficult process. This example has been elaborated in Case 1 in Chapter 7.

111 For instance, the implementation of risk management within the organization of a contractor in the construction industry can be framed as a *safety* issue (reducing the number of accidents with workers involved), an *economic* issue (increasing the firm's profitability), an *environmental* issue (reducing the adverse effects of construction on the environment), or even a *societal* issue (reducing the nuisance of construction projects within city centres for the public).

112 A review by Lapointe and Rivard (2005) of twenty IT-related journals over the past 25 years identified 43 articles that considered *resistance* as the key implementation issue.

indifferences or resistances within the organization, seem to act favourable to the sustainability of an innovation over time. Contrary to sustainable innovations, in some cases discontinuation or entirely terminating an innovation process may be required. For instance, when unanticipated and unwanted consequences occur, or when major changes within the external or internal social environment creates a mismatch between then innovation and the organizational objectives. Sustainability of innovations is therefore not always favourable.

Implementing innovations in organizations

This sub-section concerns particularly the implementation phase of organizational innovation processes, which has been presented by Figure 4.1 in the previous sub-section. While the implementation phase has been explicitly addressed in Rogers' (2003) model for organizational innovation processes, particular guidelines for *how* to execute this implementation phase has not been addressed. Furthermore, the definition of an implementation of an innovation by Rogers (2003: 474) is rather thinly "that which occurs when an individual puts an innovation into use". Klein and Sorra (1996: 1057) provide a more extensive definition: "Implementation is the transition period during which targeted organizational members ideally become increasingly skilful, consistent, and committed in their use of an innovation". Others, such as Daft (1997: 579) approach implementation rather implicitly, by defining implementation *competencies* as the ability to translate ideas into actions and generate positive outcomes.

As stated by Marcus (1988), a large body of research deals with problems of implementing innovations in organizations. For confirming this statement, by identifying concepts and models about how to execute the implementation phase, a specific literature research within the ABI-Inform electronic database has been performed.[113] This search identified a set of frameworks that specifically focus on the actual implementation of innovations within organizations, as well as a number of modifications of these frameworks. The first sort of framework has a rather high degree of complexity and is represented by the model of Lewis and Seibold (1993). They developed a model for innovation modification during the intra-organizational implementation of innovations. It relates a considerable number of variables to each other, such as the external environment, organization structure, user characteristics and perception, and implementation activities. Central in the model of Lewis and Seibold (1993) are the notions of fidelity and similarity. *Fidelity* represents the match

113 The top five scientific journals, according to ISI-2007 impact factor, have been searched. These journals are, ranked from number 1 to number 5, *MIS Quarterly, Academy of Management Review, Academy of Management Journal, Organisation Science, and Strategic Management Journal.*

between the intended and actual use of an innovation. *Similarity* is a measure for the uniformity of use, across users.

The second type of framework for implementing innovations have a considerable higher degree of simplicity, when compared with Lewis and Seibold (1993). A rather simple framework has been developed by Klein and Sorra (1996). Their matrix shows only a few determinants. Central are the notions of climate for implementation and innovation-values fit. *Climate for implementation* refers to the shared perceptions of the proposed users of the innovation (Klein and Sorra, 1996). It concerns the degree to which their use of the innovation is rewarded, supported, and expected within the organization. The climate for innovation shows therefore a lot of similarity with the social system from Rogers (2003). *Innovation-values fit* is the degree of matching of the characteristics of the innovation with the values of the proposed users of the innovation (Klein and Sorra, 1996). Innovation-values fit corresponds with the innovation attributes at the level of the individual user, as proposed by Rogers (2003). In the view of Klein and Sorra (1996), the strength of the climate of innovation within an organization, together with the degree of innovation-values fit at individual level, determine the implementation effectiveness of an innovation in an organization.[114]

Modifications of the presented frameworks have been suggested by a number of scholars. For example, Klein et al. (2001) extended the model of Klein and Sorra (1996) towards a path-type of model for implementing computerized technology. Holahan et al. (2004) extended and empirically tested the latter model for implementing computer technology in a multi-organizational test. They added so-called *organizational receptivity towards change* to the model. Their empirical research demonstrates strong support for the relationship between the variables of climate for innovation, organizational receptivity towards change, and implementation effectiveness.

4.2.4 Variables from literature research

Two sets of variables for implementing innovations have been identified by a literature survey: *Hurdles* and *conditions*. In Chapter 2, hurdles are described as barriers, obstacles, or unfavourable situations for implementing innovations. Contrary, conditions are prerequisites, requirements, or favourable situations for

114 The innovation implementation matrix by Klein and Sorra (1996) relates strong and week innovation climates to poor, neutral, and good fit of innovation with values. Each of the six cells presents different combinations of *emotional responses* by employees and the degree of *innovation use*. According to Klein and Sorra (1996), only for the combination of a strong implementation climate and good innovation–values fit, employee enthusiasm and committed, consistent, and creative innovation use should be expected.

implementing innovations in organizations. These variables have been identified from Ph.D. theses, scientific top journals, and other literature.

Given the context and objectives of this research, first four relevant Ph.D. theses have been selected and explored. Table 4.1 and Table 4.2 present respectively 4 hurdles and 14 conditions that have been identified from these Ph.D. theses. The *order* of the hurdles and conditions in Table 4.1 and Table 4.2 resulted from the literature survey and is arbitrary. The *numbers* in the first column of Table 4.1 and Table 4.2 are only for identification purposes. They do not reflect the relative relevance of the hurdles and conditions to each other, which was of no concern yet. This stage of the research focussed on identifying variables, rather than on classifying their relevance, which has been performed at later research stages.

Table 4.1 Hurdles for implementing innovations, identified in Ph.D. theses.

No.	Hurdles for implementing innovations	Source
1	Preoccupation with supporting tools.	Van Aken (1996)
2	Organizational culture is not supporting in sustaining the innovation.	De Vries (2002)
3	Lack of compatibility of the innovation with direct stakeholders.	De Vries (2002)
4	Resistance by managers who loose power by use of the innovation.	De Vries (2002)

Table 4.2 Conditions for implementing innovations, identified in Ph.D. theses.

No.	Conditions for implementing innovations	Source
1	Cognizance with clear recognition and understanding of threats.	Bea (2006)
2	Appropriate capabilities to address uncertainties.	Bea (2006)
3	Commitment to continuous improvement processes.	Bea (2006)
4	Appropriate organizational culture with trust and integrity.	Bea (2006)
5	Counting innovation outcome by its costs and benefits.	Bea (2006)
6	Integration of the innovation in the existing business processes.	Olsson (2006)
7	Explicit management responsibility about the implementation process.	Olsson (2006)
8	Delegation of responsibilities from managers to functional experts.	Olsson (2006)
9	Providing assistance to users of the innovation.	Olsson (2006)
10	Regular reporting of implementation progress to senior management.	Olsson (2006)
11	Directive and goal-oriented leadership.	Van Aken (1996)
12	Clear relative preventive advantage.	Halman (1994)
13	Additional relative usefulness, compared with existing alternatives.	Halman (1994)
14	Reduced user complexity by support of tools and consultants.	Halman (1994)

Next, the top five scientific journals, according to ISI 2007 impact factor, of the category *management* in the ABI-Inform database have been considered.[115] Initially the search term *implementation* was used. For refining the search, terms such as *experiences*, *success*, *innovation*, and *risk management* were added. From the search, it became clear that only a few papers focus on the implementation of innovations in organizations, such as new business processes and tools. The majority of these papers are not of recent origin. Furthermore, none of the top five scientific journals included papers about the implementation of risk management.

The literature search amongst the top five scientific top journals resulted in eight papers that were considered relevant within the context and objective of this research. These papers cover a variety of organizations and innovations, such as the safety innovations within the nuclear power industry, implementing total quality management (TQM) in organizations, and implementing information technology (IT) in hospitals. Most studies applied a multi-level approach, by differentiating individual and organizational levels. Within the papers, rational, cognitive, as well as emotional aspects are related to implementing innovations. Table 4.3 and Table 4.4 present 6 hurdles and 8 conditions that have been identified from the selected scientific top journals. Once again, the *order* of the hurdles and conditions in Table 4.3 and Table 4.4 resulted from the literature survey and is arbitrary. The *numbers* in the first column of Table 4.3 and Table 4.4 are only for identification purposes. They do not reflect the relative relevance of the hurdles and conditions to each other, which was of no concern yet. This stage of the research focussed on identifying variables, rather than on classifying their relevance, which has been performed at later research stages.

Table 4.3 Hurdles for implementing innovations from scientific top journals.

No.	Hurdles for implementing innovations	Source
1	High innovation complexity.	Swanson and Ramiller (2004)
2	Organizational mindlessness.	Swanson and Ramiller (2004)
3	User resistance.	Lapointe and Rivard (2006), Klein and Sorra (1996)
4	Rule-bound organizational culture.	Marcus (1988)
5	Neglecting emotional intelligence and emotional capability	Huy (1999)
6	Weak innovation climate.	Klein and Sorra (1996)

115 These journals are, ranked from number 1 to number 5, *MIS Quarterly, Academy of Management Review, Academy of Management Journal, Organisation Science, and Strategic Management Journal.*

Table 4.4 Conditions for implementing innovations from scientific top journals.

No.	Conditions for implementing innovations	Source
1	Organizational mindfulness with characteristics of high reliability organizations (HROs).	Swanson and Ramiller (2004), Weick (1995) and Weick and Sutcliffe (2001)
2	Understanding time effects of user resistance.	Lapointe and Rivard (2006)
3	Autonomous organizational culture.	Marcus (1988)
5	Acknowledging emotional intelligence and emotional capability.	Huy (1999), Klein and Sorra (1996)
6	Innovation-values fit together with a strong innovation climate.	Klein and Sorra (1996), Lewis and Seibold (1993)
7	Multi-level approach at individual and at organizational level.	Huy (1999), Danserau et al. (1999), Klein and Sorra (1996), Lapointe and Rivard (2006), Lewis and Seibold (1993), Swanson and Ramiller (2004)
8	Appropriate values of the eight dimensions of organizational culture.	Detert et al. (2000), Marcus (1988)

Moreover, Table 4.5 and Table 4.6 present 10 hurdles and 22 conditions that have been identified from additional literature. The *order* of the hurdles and conditions in Table 4.5 and Table 4.6 is also arbitrary and the *numbers* in the first column of Table 4.5 and Table 4.6 are only for identification purposes.

Table 4.5 Hurdles for implementing innovations, identified in additional literature.

No.	Hurdles for implementing innovations	Source
1	Unreliable and imperfectly designed innovations, with restricts their relative usefulness.	Klein and Knight (2005)
2	A higher complexity of the innovation than the technology or practices that are replaced.	Klein and Knight (2005)
3	A lack of values and beliefs compatibility.	Klein and Knight (2005)
4	A knowing-doing gap of using the innovation, because of existing organizational norms.	Klein and Knight (2005), Pfeffer and Sutton (2000)
5	The required investment in costs and time, together with a short term decrease in organizational performance, is an unwanted innovation outcome.	Klein and Knight (2005), Repenning and Sterman (2002)
6	Innovation decisions are made by authorities and based on persuasion and edict, rather than by reaching consensus with the targeted users.	Klein and Knight (2005)
7	The organization's inability to evaluate the implementation of an innovation by financial or other criteria.	Counte and Meurer (2001)

Table 4.5 Continued

No.	Hurdles for implementing innovations	Source
8	Over-emphasizing the attention to individual attitude and behaviour, while neglecting the characteristics of the social system.	Fiske and Taylor (1978), Lefcourt (1973), Reason (1997)
9	Persistent attitude and behaviour of learned helplessness of the organizational members, who consider any attempt to change the organization as fruitless.	Peters and Waterman (1982), Reason (1997)
10	Persistent anxiety-avoidance of the organizational members that generates a repetition of measures for reducing the organizational anxiety.	Bate (1992), Reason (1997)

Table 4.6 Conditions for implementing innovations, identified in additional literature.

No.	Conditions for implementing innovations	Source
1	Employees share perceptions about the innovation importance, which creates a top priority for using the implementation and demonstrates need compatibility.	Klein and Knight (2005)
2	Explicit management support by providing financial resources and demonstrating patience with a long-term time orientation.	Klein and Knight (2005)
3	Fostering organizational norms with a strong learning orientation.	Klein and Knight (2005)
4	Applying a set of implementation practices and policies.	Klein and Knight (2005)
5	Time commitment for being able to apply the innovation completely for using its full benefits.	Keizer et al. (2002)
6	Establishing compatibility with the user practice by re-inventing the innovation.	Keizer et al. (2002)
7	Triability, for pilot testing with volunteering participants.	Keizer et al. (2002)
8	Planned awareness creation among the potential users by different communication methods and media.	Keizer et al. (2002)
9	Providing training for the users of the innovation.	Keizer et al. (2002)
10	Providing support to the users of the innovation.	Keizer et al. (2002)
11	Demonstrating relative advantage and relative usefulness of the innovation by repetitive evaluations with its users.	Keizer et al. (2002)
12	Differences between the types of motivation and commitment of the potential innovation users are acknowledged.	Malhorta and Galetta (2002)
13	Understanding of the empirical benefits and costs or economic advantage of an innovation.	Counte and Meurer (2001)
14	A high degree of organizational receptivity towards change within the organizational structure and norms.	Holahan et al (2001), Klein et al. (2001)

Table 4.6 Continued

No.	Conditions for implementing innovations	Source
15	Knowledge about the human, technical, organizational, and environmental factors of the innovation by those people who manage and operate the innovation,	Reason (1997)
16	Preparedness to report about the innovation, including its errors and near misses, which requires a feeling of trust, easy of making report and rapid feedback.	Reason (1997)
17	Drawing clear lines between acceptable and unacceptable behaviour with regard to implement ting the innovation.	Reason (1997)
18	Flexibility to switch between conventional hierarchical, and flat and professional structures, whenever required, as within high reliability organizations (HROs).	Reason (1997)
19	Ability to learn, by the willingness and competencies for evaluation during the innovation implementation process, and to apply reforms when required.	Reason (1997)
20	Willingness to know about all uncertain consequences of the innovations.	Roberts and Bea (2001)
21	Balancing reward and incentive systems with the characteristics of the innovation.	Roberts and Bea (2001)
22	Consistent communication about the objectives of implementing the innovation.	Roberts and Bea (2001)

Many other sources of literature present hurdles and conditions that are related to successfully implementing organizational changes in general, and organizational innovations in particular. Examples with series of hurdles and conditions for successfully implementing *change* in organizations are for instance presented in Boonstra (1996: 8-20), Boonstra and Steensma (1996: 22-34), Daft (1998: 310, 312-4), Jick (1993: 195-195), Kotter (2000: 61), Kotter and Cohen (2002: 82), Piercy (1997: 574-592), Sirkin et al. (2005: 111), Tanner and Sternin (2005: 75), and Thomson (1997: 584-586), who merely presents the work of Owen (1982).

Also in additional sources of literature, hurdles or conditions for successfully implementing *organizational process type of innovations* in organizations have been identified. For instance, Choi and Price (2005) focus on the effects of the person-innovation fit on individual responses to innovation, by distinguishing between individual value fit and individual ability fit. Van der Panne et al. (2003) present ten generally agreed success factors for innovative projects, based on examining 43 recent papers. Ensminger et al. (2004: 63-64, 68-69) empirically tested eight conditions for successfully implementing technology innovations, as developed by Ely (1999) and mentioned in Ph.D. research by Bauder (1993), Jeffery (1993), Ravitz

(1999), Read (1994), and Stein (1997). Based on an extensive literature research, Kamal (2002: 217) presents 42 critical success factors for IT innovation adoption. Most of these factors are similar to Roger's (2003) social system characteristics and innovation attributes. Furthermore, a lot of the success factors from Kamal (2002) seem too generic for being useful, such as market knowledge and community size. Other examples are Jackson (2001:160-3), who did research about successfully implementing total quality management tools within the health care sector, Johnson (2000: 59), who studied successfully implementing information technology in higher education, and Anderson and West (1998: 249), who developed a questionnaire for measuring the innovation climate for teams. The latter questionnaire has been validated in some 150 teams, ranging from health care teams and social service teams to oil company teams.

Exploring these additional literature sources did not reveal new aspects, but rather repeated and thus supported the already acknowledged hurdles and conditions, often in some more generic terminology. Given the qualitative approach of this literature survey, rather than a quantitative one by counting the number of sources in which a certain factor is present, this additional literature is not presented in more detail.

4.2.5 Variables from field research

Based on the results of the literature study, *field research* has been performed by interviewing seven organizational implementation experts from The Netherlands. The objective of the field research was adding and confirming hurdles and conditions for implementing innovations.

Hurdles and conditions for implementing innovations from interviews

The objective of the interviews was adding and confirming hurdles and conditions for implementing innovations that were retrieved from the literature research.[116] In total seven Dutch experts in implementing innovations in organizations have been interviewed. Six of them are professor at the Erasmus University Rotterdam, the VU University Amsterdam, the Eindhoven University of Technology (two of them), the University of Groningen, and the University of Twente. Four of the professors work also in the private sector, as advisor to the board and consultant.

116 Yin (2003) considers the *interview* as one of the most important data sources, because it will confirm, complement, or provide rival explanations to the literature data. Knowledge from interviews is more recent than the knowledge from literature and can be in-depth explored by dialogue during an interview.

The one remaining expert is professional risk manager in a public organization. Five experts concentrate their activities on implementing organizational change, including adopting and implementing process innovations. Two of the experts have a financial background. The experts work in a variety of sectors, such as infrastructure planning and management, finance, consumer electronics, and the health care sector. Moreover, they have extensive experience in private as well as public organizations.

The interviewed persons provided knowledge as an *expert*, personal opinions and experiences as a *respondent*, and additional information about other people, objects, situations or processes as an *informant* (Verschuren and Doorewaard, 2000). Similar to the interviews with the risk management experts, it was decided not to record the interviews. In addition, an open and semi-structured interview approach has been selected. Interview protocols were prepared and three main questions were based on the results from the literature research:

4

1. What is a successful implementation of a process innovation?
2. Which are the hurdles that obstruct the implementation of a process innovation?
3. Which are the conditions that should be set to overcome these hurdles?

Sub-questions concerned asking about the role of actors, any differences in hurdles and conditions that are specifically related to implementing risk management, and any differences between public and private organisations. Furthermore, the experts were asked for providing examples and any additional relevant aspects.

Of each of the interviews, a report have been prepared. The interview reports have been verified, sometimes provided with additional comments, and approved by the interviewees. The qualitative interviews results have been analyzed according to the method of Baarda et al. (1996), which involved labelling and categorization of key aspects. By investigator triangulation (Patton, 1987 in Yin, 2003), all labelled interview results have been carefully analyzed and, when showing large similarities, clustered into similar hurdles and conditions. In total 35 hurdles and 49 conditions, for implementing innovations in organizations, were identified.

Table 4.7 and Table 4.8 present these hurdles and conditions. The *order* of the hurdles and conditions in Table 4.7 and Table 4.8 resulted from the field research process and is arbitrary. The *numbers* in the first column of Table 4.7 and Table 4.8 are only for identification purposes. They do not reflect the relative relevance of the hurdles and conditions to each other, which was of no concern yet. This stage of the research focussed on identifying variables, rather than on classifying their relevance, which has been performed at later research stages.

Table 4.7 Hurdles for implementing innovations from interviews with experts.

No.	Hurdles for implementing innovations
1	Lack of innovation knowledge and awareness.
2	Lack of required social competencies for dealing with non-technical aspects of innovations.
3	Insufficient empathy.
4	Insufficient insight in one's self and inability to change one's own ineffective attitudes, such as fight responses.
5	Inability to reflect on situations from some distance.
6	Only awareness of the conflict mode and missing a more harmonious cooperative mode.
7	Lack of management competencies to deal with the inherent uncertainty of multi-actor processes.
8	Over-emphasis on fixed project management techniques and documentation, without fostering flexibility.
9	Lack of new voices and entrepreneurship within decision making.
10	The individual clinical view of professionals, using own expert judgements rather than new rules and protocols.
11	Technical rationality rules over social aspects.
12	Reduced attention and energy during long implementation processes, resulting in change immunity.
13	Not having sufficient time for implementing the innovation, particularly within small and medium enterprises.
14	Lack of supportive behavioural attitude towards the innovation.
15	Difficulty to find effective triggers for motivating individuals or groups to use the (risk management) innovation.
16	Lack of trust and openness between organizational members.
17	Operating the conflict mode in case of different interests, instead of a more harmonious cooperative mode.
18	Prescription of innovations is not sufficient for guaranteeing its use.
19	Innovation resistance because of perceived undesirable outcomes.
20	Reduced job satisfaction, as experienced by risk adverse people who apply risk management.
21	Applying the innovation reveals that decision making is not as informed and rational as assumed.
22	Lack of an attractive picture of the aimed innovation results.
23	Initial efficiency reduction, because of disturbances and required learning, before achieving benefits.
24	Lack of direct relations between the implemented innovation and its results over time, because of many variables.
25	Fear for the unknown consequences of the innovation.
26	Not achieving anticipated risk management results, because these were not feasibly defined.
27	Perceived conflicting outcomes for different actors or stakeholders are not clear.
28	Lack of economic benefits of the innovation.
29	No incentives for changing the professional's conservative attitudes.

Table 4.7 Continued

No.	Hurdles for implementing innovations
30	The implementation process and related change management actions do not fit the organizational norms.
31	Innovation benefits remain undervalued because of a lack of innovation drive in the industry.
32	Negative image and meaning of the terms risk and risk management.
33	Too large complexity of the innovation, generated by perfectionism of the involved specialists.
34	Measuring process innovation performance is not possible with traditional performance indicators.
35	Clients do not want to hear about the innovation.

Table 4.8 Conditions for implementing innovations from interviews with experts.

No.	Conditions for implementing innovations
1	Intrinsic motivation for the process innovation.
2	Competences beyond technical one's: the ability to fundamentally change mindsets, attitudes, and behaviour.
3	The required degree of uncertainty tolerance, together with an effective mindset and attitude.
4	Demonstrating vision, loyalty, integrity, and character.
5	Excellent communication skills to implement the innovation in line with the organization's maturity level.
6	Competences to create trust and commit people for effectively implementing the innovation.
7	Knowledge and ability to use the process innovation, in combination with in-depth knowledge of its own discipline.
8	In-depth expertise, which allows professionals to see the consequences of the innovation.
9	Risk responsibility at all organizational levels.
10	Points of no return during the implementation process.
11	Very explicit decision making about the implementation of the innovation.
12	Presence of a organization-wide innovation framework and process.
13	Professional registration of innovation users(such as accountants), for example of risk managers.
14	Transformational leadership at the start, followed by transactional leadership in later stages.
15	Attention to the adaptation and learning capabilities at all levels in the organization.
16	Allowing flexibility during the implementation process of the innovation, with all stakeholders and over time.
17	Awareness and similar understanding about the process innovation.
18	Thinking "and-and" instead of "or-or".
19	Systematic thinking and acting at all organizational levels.
20	Need for multiple, shared and in some way similar end-pictures for multiple actors.
21	Continuous attention to the innovation process, at all organizational levels by maintaining strategic momentum.

Table 4.8 Continued

No.	Conditions for implementing innovations
22	Allowing sufficient time with effective dosing, by small innovation implementation steps and periods of stability.
23	Acceptance that process innovations are never finished.
24	Acknowledgement of differences in motivation and commitment between persons for using the innovation.
25	An innovation prone attitude.
26	Expressing new professional proud, such as “together we know better”.
27	Guts and pleasure in dealing with the inherent uncertainties of multi-actor processes.
28	Acknowledgement of the benefits of the innovation, in case of inherently irrational decision making.
29	Presence of measurable objectives and outcomes, before starting the implementation of the innovation.
30	Quick wins during the implementation process of the innovation.
31	Acknowledgement of the interfaces between disciplines effected by the innovation.
32	Clear benefits by increased (operational) efficiency, less time, and less costs required.
33	Increased competitive advantage, either material or immaterial.
34	A chief risk officer (CRO) at board level, who is responsible for risk management implementation.
35	Implementing risk management increases risk sensitivity within the organization.
36	Explicit top management commitment.
37	Acknowledgement of the context-dependency of innovation implementation.
38	Sense making by transparent innovations.
39	Increased employee satisfaction.
40	Availability of tools for applying the innovation.
41	An integral and holistic approach for implementing the innovation.
42	Acknowledgement of the need for risk management when applying innovations.
43	A uniform standard of innovation terminology.
44	Using successful business cases as examples.
45	Measuring results with traditional performance indicators (time, money) and additional performance indicators (cooperation).
46	External pressures from society forcing the implementation of an innovation (such as risk management in the health care sector).
47	Applying effective and robust innovation processes.
48	The innovation is independent of the risk propensity of its users and therefore generically applicable.
49	The innovation generates quality data with good benchmarks.

4.2.6 Summary of identification results

Main *concepts* about organizations, innovations, and implementing innovations in organizations have been identified and discussed in the preceding sections of this chapter. Furthermore, a large number of *variables*, hurdles as well as conditions, for implementing innovations were identified. Table 4.9 presents the numbers of hurdles and conditions retrieved from the different data sources during the literature survey and field research. In total 55 hurdles and 93 conditions were identified.

Table 4.9 The numbers of identified hurdles and conditions for implementing innovations in organizations.

Research type	Data source	Hurdles for implementing innovations in organizations (number)	Conditions for implementing innovations in organizations (number)
Literature research	Ph.D. theses	4	14
	Scientific top journals	6	8
	Additional literature	10	22
Field research	Interviews with 7 experts	35	49
Total		55	93

4

4.3 Data analysis

All of the identified concepts and variables have been *analyzed*. Two steps of *analysis* have been executed. Step 1 resulted in four key definitions for the terms social system, organization, innovation, and implementation of an innovation. Step 2 provided a theoretical framework for implementing innovations in organizations. The following two sub-sections describe these steps of analysis in some more detail.[117]

117 Unlike the interview results in Chapter 3 about applying risk management, a Delphi analysis proved to be not appropriate for a further analysis of the interview results about implementing innovations. The answers of the implementation experts on the questions about the hurdles and conditions for implementing innovation began ususally with the words "it depends". Apparently, implementing any organizational innovation is largely context-dependant. The *contingency theory* (Daft, 1998) seems to rule in the discipline of implementating innovations in organizations. Therefore, rating hurdles and conditions on importance within a Delphi analysis has been judged inadequate.

4.3.1 Providing key definitions

Step 1 of the data analysis involved theory triangulation, as suggested by Patton (1987) in Yin (2003). By analyzing and combining the identified definitions for social systems, organizations, innovations, and implementation of innovations, which were identified in Section 4.2, the following *key definitions* were derived:

- A *social system* is a set of interrelated units involved in joint problem solving to accomplish a common goal;[118]
- An *organization* is structured and stable set of social systems with individuals who work together for achieving common goals;
- An *innovation* is an idea, practice or object that is perceived as new by an individual, team or other organizational unit;
- The *implementation* of an innovation in an organization involves executing all required activities for routinizing the application of the innovation within that organization.

According the first two definitions, an organization consists of a number of social systems. The four key definitions are used throughout this thesis.

4.3.2 Selecting and combining innovation management concepts

Step 2 of the data analysis involved theory triangulation (Patton, 1987, in Yin, 2003) by analyzing and comparing the identified theoretical frameworks for implementing innovations. The search in the top five scientific journals only provided a limited number of concepts and models for implementing innovations in organizations. Moreover, these models were either rather complicated with a lot of variables, or quite simple with only a few variables. However, innovation frameworks as proposed by Lewis and Seibold (1993), Klein and Sorra (1996), Klein et al. (2001), and Holahan et. al (2004) confirmed the remarkable completeness and relevance of the innovation diffusion model by Rogers (2003). For instance, factors such as fidelity, similarity, the climate for implementation, and organizational receptivity towards change, are represented by the social system characteristics in the innovation diffusion model. In addition, the innovation-values fit (Klein and Sorra, 1996) corresponds well with values and beliefs compatibility, which is a category of innovation attributes in the

118 This definition for social systems is from Rogers (2003: 476).

innovation diffusion model after Rogers (2003). Furthermore, characteristics of innovation users are included in the five innovation adopter categories, as proposed by Rogers (2003).[119]

Nevertheless, a number of additional variables have been identified. Detert et al. (2000) presented a qualitative content analysis of the existing literature about the concept of organizational culture. Their research generated eight generic dimensions of organizational culture. These seem to correspond with two social systems characteristics, as suggested by Rogers (2003).[120] Table 4.10 shows how these eight generic organizational culture dimensions are classified into the social system characteristics of social structure and norms. This presentation provides in fact a break-down of the usually fuzzy meaning of the term organizational culture.

4

Table 4.10 Relation of social systems characteristics with generic dimensions of organizational culture.

Social system characteristics (Rogers, 2003)	**Generic dimensions of organizational culture (Detert et al., 2000)**
Social structure	– Control, coordination, and responsibility – Stability versus change, innovation, and personal growth – Orientation focus, internal or external
Norms	– Basis of truth and rationality – Nature of time and time horizon – Motivation and commitment* – Orientation to work, task, and co-workers – Isolation versus collaboration and cooperation

* Commitment, as derived from Malhorta and Galetta (2002), has been added to motivation.

119 Reason (1997) presents three distinct models with different perspectives of *human error*, which originate from Lucas (1992, 1990). These models are (1) the *person model*, (2) the *engineering* model and (3) the *organizational* model. There seems to be a striking similarity between these three distinct models about human error and the three main dimensions of the innovation diffusion model by Rogers (2003). The person model aligns with the individual adopter categories, the engineering model relates to the attributes of innovations in relation to its users and other stakeholders, and the organizational model matches with the social system characteristics, including the social structure and norms of the organizational system. Therefore, by coincidence or not, the three models or perspectives of human error seem to be closely related to the dimensions for successfully implementing innovations in organizations. Because human error and managing risk are tight closely as well, once again the relationship between risk management and innovation management has been confirmed.

120 Detert et al. (2000) tried to establish which values would ideally support the successful implementation of a total quality management (TQM) program in an organization. By using a TQM expert panel, consisting of fifteen business persons and educators and applying the nominal group technique, typical TQM values were attributed to each of the eight cultural dimensions. Together, these normative values present the ideal organisational cultural setting for successfully implementing TQM. As stated by Detert et al. (2000), it is important to realize that these TQM values do not cover the entire domain of the eight general dimensions. The values are program-specific and for other systemic change programmes another normative value system is likely being present.

Furthermore, by the direct and indirect network externalities adoption model (DINAM), Song (2006) suggested another four attributes, which seem to supplement the innovation attributes of Rogers (2003). These additional attributes are (1) direct network externality, (2) indirect network externality, (3) price, and (4) relative usefulness. Including *networks externalities* acknowledges the effects of the external environment on the implementation of an innovation within an organization. The *price* of acquiring an innovation, as well as the *relative usefulness* of the innovation, when compared alternatives, are also considered potentially significant variables that need to be addressed. Therefore, the analysis of theoretical frameworks for implementing innovations resulted in combining three models:

1. The innovation diffusion model (Rogers, 2003);
2. The model with ideal cultural values for implementing total quality management (Detert et al., 2000);
3. The direct and indirect network externalities adoption model DINAM (Song, 2006).

Combining these models generated two main categories for hurdles and conditions: (1) those related to the *innovation* itself, and (2) those related to *social system* of the organization, in which the innovation will be implemented. Both categories have a number of characteristics and subcharacteristics. Table 4.11 and Table 4.12 present these characteristics and sub-characteristics of respectively *innovations* and *social systems*, together with explanations. These are derived from and Detert et al. (2000), Rogers (2003), and Song (2006). Explanations have been slightly modified, when required in view of this research. The *order* of the characteristics and sub-characteristics Table 4.11 and Table 4.12 is arbitrary. Their *numbers* in the first column of Table 4.11 and Table 4.12 are only for identification purposes. They do not reflect the relative relevance of the (sub)characteristics to each other, which was of no concern yet. This stage of the research focussed on selecting and combining concepts with their characteristics, rather than on classifying their relevance.

Table 4.11 Innovation characteristics and subcharacteristics, after Rogers (2003) and Song (2006).

Innovation *characteristics* and subcharacteristics	**Explanations**
1 *Relative advantage*	The degree to which an innovation is perceived as giving advantages over the situation of not using the innovation.
1.1 Economic advantage	The economic profitability as generated by using the innovation.
1.2 Social status advantage	The social status as generated by using the innovation.
1.3 Over-adoption	The degree to which an innovation is adopted by individuals, because some (sub-)characteristics are considered as highly desirable, while experts feel that the innovation should be rejected.
1.4 Preventive advantage	The degree to which an innovation is adopted for reducing the probability of occurrence of unwanted events in the future.
1.5 Incentive advantage	The degree to which use of the innovation is encouraged by direct or indirect payments in cash or in kind to its diffusers or adopters.
1.6 Government mandate	The government mandates the use of the innovation, usually when there is strong public resistance to voluntary incentives.
2 *Compatibility*	The degree to which the innovation is perceived as consistent with existing values, past experiences, and needs of potential adopters.
2.1 Values and beliefs compatibility	The degree to which the innovation is compatible with the socio-cultural values and beliefs of its adopters.
2.2 Previous ideas compatibility	The degree to which the innovation is compatible with the previous ideas and practices of its adopters.
2.3 Needs compatibility	The degree to which the innovation meets the felt needs of its adopters.
2.4 Technology cluster compatibility	The degree to which the innovation is part of a technology cluster with related innovations that is perceived as useful by the adopters.
2.5 Name compatibility	The degree to which the name of the innovation is perceived as appropriate by its adopters.
2.6 Position compatibility	The degree to which the innovation is positioned at distance from competing innovations, without loosing ideas compatibility, which creates a niche for the innovation.
3 *Complexity*	The degree to which an innovation is perceived as relatively difficult to understand and to use by the members of the social system.
4 *Triability*	The degree to which it is possible to experiment with the innovation on a limited basis.
5 *Observability*	The degree to which the results of innovation use are visible to others.
6 *Direct network externality*	The degree to which colleagues within the social system and competitors outside the social network also use the innovation.
7 *Indirect network externality*	The degree to which clients demand the use of the innovation.
8 *Price*	The degree to which the price of the applying the innovation is perceived as reasonable.
9 *Relative usefulness*	The degree to which the innovation is useful to the user.

Table 4.12 Social system characteristics and subcharacteristics, after Detert et al. (2000) and Rogers (2003).

Social system *characteristics* and subcharacteristics	**Explanations**
1. *Social structure*	Patterned arrangements of the units in a system for giving stability and regularity to individual behaviour within a social system, which are formally established by management or informally developed by individuals in interpersonal networks.
1.1 Control, coordination, responsibility	Ideas about the required degrees of control, coordination and the delegation of responsibilities within an organization vary between people.
1.2 Stable or change and innovation prone	People have different propensities to stability and change. Innovating requires some sort of change and is a continuous and never-ending process.
1.3 Internal or external focus	The orientation and focus of an organization may be either mainly internally or mainly externally.
2. *Norms*	Established behaviour patterns for the members of the social system that define the range of tolerable behaviour and therefore serve as guide for their behaviour.
2.1 Basis of truth and rationality	Within organizations people hold various ideas about what is true and real or not. In addition, people have different ideas about rationality and irrationality or intuition.
2.2 Nature of time and its horizon	The time orientation and horizon varies between, and even within, organizations. Innovating requires long-term orientation and a strategic management approach.
2.3 Motivation and commitment	Beliefs about what motivates people, and how people are motivated, vary between and within organizations. It effects for instance the systems of rewards in an organization.
2.4 Work, task, co-worker orientation	Beliefs about the role of work in human life, work as a production activity or work as a social activity and work as a mean for a comfortable life or work as an end in itself.
2.5 Isolation or cooperation	Work can be accomplished by individuals or in teams. Internal and external cooperation and collaboration may be required for implementing innovations
3. *Innovation roles*	Supporting roles of the actors within the innovation diffusion process.
3.1 Change agents	Individuals, outside the social system, who influence innovation decisions.
3.2 Opinion leaders	Individuals within the social system, who are able to influence the attitudes of others in an informal way.
3.3 Champions	Individuals within the social system, who are able to overcome indifferences or rejections within the social system by using their charisma.

Table 4.12 Continued

Social system *characteristics* and subcharacteristics	**Explanations**
4. *Innovation decision*	Choice to adopt or reject an innovation.
4.1 Optional innovation decision	Choice to adopt or reject an innovation that is made by an individual, independently of other members of the social system.
4.2 Collective innovation decision	Choice to adopt or reject an innovation that is made by consensus among the members of the social system.
4.3 Authority innovation decision	Choice to adopt or reject an innovation that is made by only a few individuals within the social system who posses (a combination of) power, status, or technical expertise.
4.4 Contingent innovations decision	Choice to adopt of reject an innovation in relation to an earlier made innovation decision.
5. *Innovation consequences*	A change that occurs to an individual or social system as a result of the adoption or rejection of an innovation.
5.1 Desirable or undesirable	Depending on whether the effects of an innovation are functional or dysfunctional to an individual or social system.
5.2 Direct or indirect	Depending on whether the effects of an innovation, to an individual or social system, occur as an immediate response or as some secondary effect.
5.3 Anticipated or unanticipated	Depending on whether the effects of innovation are anticipated or not by the members of the social system.
5.4 Increasing or decreasing equality	Depending on whether the effects of the innovation influence the existing degree of equality between the members of the social system.

4.4 Data classification

By analyzing all data from the literature survey and field research, two main categories of characteristics for implementing innovations have been derived: (1) characteristics of *innovations* itself and (2) characteristics of *social systems*, in which innovations will be implemented. A number of characteristics were divided in subcharacteristics. For implementing innovations in organizations, these two main categories of characteristics should be acknowledged.

In this section, all of the 55 hurdles and 93 conditions have been *classified* by the characteristics and sub-characteristics of innovations and social systems. These variables resulted from multiple data sources, literature surveys and interviews. This exercise involved data triangulation, as suggested by Patton (1987) in Yin (2003).

The results of this classification are presented in tables in Appendix 5 and Appendix 6. In both appendices, hurdles and conditions, represented by their numbers, are attributed to characteristics and sub-characteristics that are considered most closely related to each other. Appendix 5 shows the numbers of hurdles and conditions that correspond with the characteristics and subcharacteristics of *innovations*. Appendix 6 shows the numbers of hurdles and conditions that correspond with the characteristics and subcharacteristics of *social systems*. This classification resulted in a well-structured overview of categories of hurdles and conditions that seem significant for *implementing* innovations. This result of the exploration research about implementing innovations in organizations raised the following research question:

- Do the characteristics and subcharacteristics of the hurdles and conditions for *implementing innovations* correspond with those for *applying risk management*, as derived in the previous research step in Chapter 3?

Therefore, the 7 key hurdles and 10 key conditions for *applying* risk management were also classified by the characteristics and sub-characteristics for *implementing* innovations. This exercise involved applying different theoretical perspectives, a risk management perspective and an innovation management perspective, to the data set with hurdles and conditions for applying risk management. Therefore, theory triangulation (Patton, 1987, in Yin, 2003) has been applied. Similar to the classification of hurdles and conditions for implementing innovations, the two main categories of innovations and social systems have been used. The last column in the tables in Appendix 5 and Appendix 6 shows the classification of key hurdles and key conditions for applying risk management into the characteristics and sub-characteristics for implementing innovations. The numbers of these key hurdles and key conditions correspond with the numbers in respectively Table 3.10 and Table 3.11 in Chapter 3. Table 4.13 and Table 4.14 show the results of the data classification for the two main categories of innovation characteristics, respectively the innovation category and the social system category.

Table 4.13 shows the results for the innovation category. Data set 1 consists of hurdles and conditions for *implementing innovations*. All identified hurdles and conditions of Data set 1 are classified in 7 out of 9 characteristics and in 11 out of 12 subcharacteristics of *innovations*. Data set 2 includes hurdles and conditions for *applying risk management*. All identified hurdles and conditions of Data set 2 are classified in 4 out of 9 characteristics and in 4 out of 12 subcharacteristics of *innovations*.

Table 4.13 Classification of hurdles and conditions in *innovation* (sub)characteristics.

Innovation category		**Classification of hurdles and conditions**	
Innovation characteristics after Rogers (2003) and Song (2006)	**Innovation subcharacteristics after Rogers (2003)**	**Data set 1: Classification of hurdles and conditions for *implementing innovations* in (sub)characteristics of innovations (yes / no)**	**Data set 2: Classification of hurdles and conditions for *applying risk management* in (sub)characteristics of innovations (yes / no)**
1. Relative advantage	1.1 economic advantage	yes	yes
	1.2 social status advantage	yes	no
	1.3 over adoption advantage	yes	no
	1.4 preventive advantage	yes	no
	1.5 incentive advantage	yes	yes
	1.6 mandate advantage	yes	no
2. Compatibility	2.1 values and beliefs c ompatibility	yes	no
	2.2 previous ideas compatibility	yes	no
	2.3 needs compatibility	yes	yes
	2.4 technology cluster compatibility	yes	yes
	2.5 name compatibility	yes	no
	2.6 position compatibility	no	no
3. Complexity	-	yes	yes
4. Triability	-	yes	no
5. Observability	-	yes	yes
6. Direct network externality	-	no	no
8. Price	-	no	no
9. Relative usefulness	-	yes	no

Similarly, Table 4.14 shows the results for the social system category. Data set 1 includes hurdles and conditions for *implementing innovations*. All identified hurdles and conditions of Data set 1 are classified in 4 out of 5 characteristics and in 12 out of 19 subcharacteristics of *social systems*. Data set 2 consists of the hurdles and conditions for *applying risk management*. All identified hurdles and conditions of Data set 2 are classified in 3 out of 5 characteristics and in 5 out of 19 subcharacteristics of *social systems*.

Table 4.14 Classification of hurdles and conditions in *social system* (sub)characteristics.

Social system category		**Classification of hurdles and conditions**	
Social system characteristics after Rogers (2003) and Detert et al. (2000)	**Social system subcharacteristics after Rogers (2003) and Detert et al. (2000)**	**Data set 1: Classification of hurdles and conditions for *implementing innovations* in (sub)characteristics of social systems (yes / no)**	**Data set 2: Classification of hurdles and conditions for *applying risk management* in (sub)characteristics of social systems (yes / no)**
1. Social structure	1.1 control, coordination, responsibility	yes	yes
	1.2 stable or change and innovation prone	yes	no
	1.3 internal or external focus	no	no
2. Norms	2.1 basis of truth and rationality	yes	yes
	2.2 nature of time and its horizon	yes	no
	2.3 motivation and commitment	yes	no
	2.4 work, task, co-worker orientation	yes	yes
	2.5 isolation or cooperation	yes	yes
3. Innovation roles	3.1 change agents	no	no
	3.2 opinion leaders	no	no
	3.3 champions	no	no
4. Innovation decision	4.1 optional	no	no
	4.2 collective	no	no
	4.3 authority	yes	no
	4.4 contingent	no	no
5. Innovation consequences	5.1 (un)desirable	yes	yes
	5.2 (in)direct	yes	no
	5.3 (un)anticipated	yes	no
	5.4 (un)equal	yes	no

These classifications demonstrated that exploration research of hurdles and conditions for *implementing innovations* provides significantly more relevant characteristics and sub-characteristics of innovations and social systems than similar exploration research about *applying risk management*.

Table 4.15 summarizes Table 4.13 and Table 4.15, by expressing the number of (sub)characteristics of innovations and social systems identified in Data set 1 (about implementing innovations) and Data set 2 (about applying risk management).

Table 4.15 Comparing (sub)characteristics for implementing innovations according to hurdles and conditions.

Exploratory research	**Combined theories for implementing innovations from Rogers (2003), Detert et al. (2000), and Song (2006)**			
	Innovations		**Social systems**	
	Number of characteristics*	**Number of subcharacteristics***	**Number of characteristics***	**Number of subcharacteristics***
DATA SET 1: Hurdles and conditions from research about *implementing innovations*	7 out of 9	11 out of 12	4 out of 5	12 out of 19
DATA SET 2: Hurdles and conditions from research about *applying risk management*	4 out of 9	4 out of 12	3 out of 5	5 out of 19
DIFFERENCE: Hurdles and conditions that remain hidden by only considering the hurdles and conditions for *applying risk management*	3 out of 9	7 out of 12	1 out of 5	7 out of 19

* Combining the theories for implementing innovations from Rogers (2003), Detert et al. (2000), and Song (2006) resulted into:
In total 9 characteristics for innovations
In total 12 subcharacteristics for innovations
In total 5 characteristics for social systems
In total 19 subcharacteristics for social systems

The difference-row in Table 4.15, shows that if only considering hurdles and conditions for *applying* risk management, a considerable number of characteristics, which appeared to be relevant for *implementing* innovations, would be neglected. This seems to confirm the need to implement risk management in organizations by using an innovation perspective, which has been formulated as Key Proposition 1.

4.5 Results and next research step

Research results

The research presented in this chapter generated innovation management concepts and variables. The exploration research of innovation management *concepts* generated four *key definitions*:

- A *social system* is a set of interrelated units involved in joint problem solving to accomplish a common goal;
- An *organization* is structured and stable set of social systems with individuals who work together for achieving common goals;
- An *innovation* is an idea, practice, or object that is perceived new by an individual, team, or other organizational unit;
- The *implementation* of an innovation in an organization implies executing all required activities for routinizing the application of the innovation within that organization.

Furthermore, the innovation diffusion model (Rogers, 2003), the model with ideal cultural values for implementing total quality management (Detert et al., 2000), and the direct and indirect network externalities adoption model DINAM (Song, 2006) have been synthesized. Combining these models generated two main categories with hurdles and conditions for implementing innovations in organizations: (1) those related to the *innovation* itself, and (2) those related to *social systems* of the organization, in which the innovation will be implemented. Both of these categories have a distinct number of characteristics and subcharacteristics.

The exploratory research of innovation management *variables* generated 55 hurdles and 93 conditions for implementing innovations in organizations. These hurdles and conditions for implementing innovations, as well as those for applying risk management from Chapter 3, have been classified into the characteristics and subcharacteristics of innovations and social systems. The results of this chapter highlight the value of considering risk management implementation as a sort of innovation implementation within an organization. If only considering hurdles and conditions for *applying* risk management, a considerable number of characteristics, which appeared to be relevant for *implementing* innovations, would be neglected. These latter characteristics and subcharacteristics of innovations and social systems need to be acknowledged for implementing innovations, including risk management, within organizations. This confirms Key Proposition 1: Implementing risk management requires innovation management.

The results of the exploratory research within this chapter considerably reduced the research limitations, which emerged in the previous chapter about applying risk management in organizations. By adding the innovation management perspective to the risk management perspective, the number of relevant (sub) characteristics for risk management methodologies and social systems increased about three times. Therefore, it seems that relevant hurdles and conditions, which where lost in the filtering process by the Delphi analysis of the results of *applying risk management* in the previous chapter, returned via the front door by considering the hurdles and conditions for *implementing innovations* in this chapter. Adding the innovation management perspective to the risk management perspective generated therefore a much more *complete* series of hurdles and conditions for *applying* risk management. Therefore, the classification of hurdles and conditions into the three categories of motivation, training, and tools, which lacked a sound theoretical basis, has been replaced by a categorization in (sub)characteristics of innovations and social systems. The latter categorization is rooted in well-established theories and models about innovation management.

Research limitations

Nevertheless, also the research results of this chapter generated a research question, which has been formulated as follows: How to reduce or even eliminate hurdles and to generate conditions for realizing the relevant characteristics and subcharacteristics of innovations and social systems?

Next research step

Hurdles, as well as conditions, can be considered as *situations* within an organization. *Changing* these situations by well-planned actions or interventions would be required, for reducing the hurdles and generating appropriate conditions. Therefore, a second key proposition has been formulated:

Key Proposition 2: *Reducing hurdles and generating conditions require interventions by change management*.

Interventions are needed for *changing* unfavourable hurdles into favourable conditions. This applies to implementing innovations in general, and to risk management in particular. Therefore, the next step of the explorative research considered *change management*.

5

EXPLORING CHANGE MANAGEMENT

5.1 Introduction

According to the findings in the previous chapter, innovations and social systems have a number of distinct characteristics and subcharacteristics. For implementing innovations in social systems, it seems that at least a number of these characteristics need to be present, to some degree. This requires changing existing unfavourable variables into more favourable ones. Therefore, hurdles obstructing the development of favourable characteristics of innovations and social systems have to be minimized, and conditions for generating these characteristics should be set. This chapter aims to answer *how* to *reduce* hurdles and *how* to *set* conditions for the relevant characteristics of innovations and social systems, by exploring the discipline of *change management*.

Similar to the risk management research in Chapter 3 and innovation management research in Chapter 4, the exploration of change management consisted of three subsequent steps for identifying, analyzing, and classifying relevant concepts and variables. Particularly, concepts about interventions and actors within the innovation implementation process were considered, by taking a planned organizational change point of view.

Furthermore, variables that seem related to interventions are derived from the literature survey and field research. The execution of the three research steps within the discipline of change management is reported in three distinct sections. In the last section, the main research results, research limitations, and the resulting next research step are presented. Together with the results of the preceding exploratory research, the results of this chapter provided the input for the designing research phase.

5.2 Data identification

State-of-the-art intervention concepts, from a theoretical and practical point of view, as well as main types of interventions have been *identified* from an additional *literature survey*. Next, by revisiting the *field research*, a considerable number of suggested interventions have been identified from the interviews with the geotechnical risk management experts and the organizational implementation experts.

5.2.1 Concepts from literature research about change, interventions, and actors

Within this section, the main and relevant concepts about *interventions* and *actors* have been identified by a literature survey, after presenting a brief introduction about planned organizational change.

Planned organizational change

In section 4.2.2. of the previous chapter about innovation management, already several sources of change management literature have been mentioned. This literature presents hurdles and conditions for implementing organizational change in general, which seem relevant for implementing organizational innovations as well. Examples are presented by Boonstra (1996), Boonstra and Steensma (1996), Daft (1998), Jick (1993), Kotter (2000), Kotter and Cohen (2002), Piercy (1997), Sirkin et al. (2005), Tanner and Sternin (2005), and Thomson (1997). It should be realized that these examples only present a small part of the abundant scientific and management consultancy literature about organizational change. Apart from being nearly impossible, presenting a complete overview of concepts about organizational change is beyond the scope of this research.

The objective of this very chapter about change management is revealing concepts and variables that are particularly relevant for reducing hurdles and setting conditions for implementing risk management in organizations. In view of this objective, the concept of *planned organizational change* needs a brief introduction. Van Aken (2008b) considers planned organizational change as a well-researched subject that once started as organizational development (OD). Pioneering work has been presented by for instance Bennis (1966) and Bennis et al. (1970). According to Daft (1998), during the 1970s organizational development evolved as a separate discipline of the behavioural sciences. Knowledge and methodologies from these sciences have been used for improving organizational performance, for instance by building trust, supporting open confrontation of problems, and supporting employee empowerment. Over the years, organizational development worked out into current planned organizational change (Van Aken, 2008b), with significant contributions by scholars such as Tichy (1983) and Carnall (1990).

Van Aken (2007) indicates that research in planned organizational change tends to concentrate on the change part of reorganization processes, rather than on the objectives and content of changes. Clearly, both the change process itself, as well as its objectives need consideration. In addition, Van Aken (2008b) raises that planned organizational change and organization design are usually performed from two separate worlds. While economics and business consultants are involved in strategy and designing organizational structure, are change processes commonly performed by people with a background in the social sciences. Huy (1999) seems representing the latter group of people, by proposing a multi-level theory on *emotion* and *change*. While other researchers use a *cognitive* perspective for organizational change, Huy (1999) tries to understand the role of emotion during change processes. He focuses on the attributes of *emotional intelligence* at the individual level and the *emotional capability* at organizational level. Moreover first-order change, such as altering formal structures, is distinguished from second-order or radical change, which changes the core values of organizations and their members. According to Huy (1999), radical change requires the presence of three change dynamics within the organization, both at individual and at organizational level: (1) receptivity or motivation to change, (2) mobilization or the ability to take action, and (3) learning of the change activities.[121] Huy's research stresses the importance of considering cognitive intelligence, as well as emotional intelligence during change processes.[122]

121 At individual level these three dynamics can be explained by the stress theory from Lazarus (1993), who distinguishes a two-stage appraisal process for change. First, individuals evaluate the perceived change effect on their own well-being, which indicates the degree of new pain or gain. This is related to the motivation to change. Providing incentives or disincentives may play a role here. Second, the person judges his or her own capability to deal with the change, which related to the change dynamics of taking action and learning.

122 As stated by Brunsson (1982) in Huy (1999), action calls for irrationality.

Sirkin et al. (2005) represent the other world of economics and business consultants, by concentrating on the *hard* factors of change management. These seem the be not-so-fashionable aspects of change management. Hard factors are (1) directly or indirectly measurable, (2) easily to communicate with regard to their importance, and (3) able to influence organizational performance quickly. According to Sirkin et al. (2005), four main and hard key factors for realizing planned organizational change are (1) the duration of time until the change programme is completed, (2) the integrity and ability of the project team to complete the project on time, (3) the commitment to change at top management level and at employee level, and (4) the required effort over and above the usual work the realize the change initiative.[123]
Within this research, both worlds about planned organizational change are synthesized, by applying its knowledge base for developing an integral approach for implementing risk management within organizations. The main interest is in changing organizational hurdles into favourable conditions. Two main aspects of planned organizational change seem therefore especially relevant: (1) knowledge about series of specific activities or *interventions* for turning hurdles into conditions for implementing risk management and (2) knowledge about the different *actors* playing a dominant role during the risk management implementation process. Interventions may be considered as *instruments* for realizing change, while the actors perform change as *change agents*, or are subject to change, when being targeted *risk management users* or their *managers*. Consequently, the relevant concepts and variables of these two aspects are elaborated in the remaining part of this chapter.

Interventions

Why are *interventions* anyway required for implementing innovations, including risk management, in organizations? It is because conventional instructions about using innovations are usually inadequate. Rogers (2003) presents a number of studies revealing the usually low effects of issuing practice guidelines on the implementation of innovations.[124] Apparently, only issuing guidelines is by far insufficient for

123 However, because of their rather fuzzy meaning, aspects as integrity and abilities of teams, commitment, and effort seem not as hard and unambiguously measurable, as suggeseted by Sirkin et al. (2005).

124 As mentioned by Fentener van Vlissingen (1995), guidelines may have an enforcing effect. Those professionals who do not want to apply these guidelines, even with good reasons, may have a problem with their superiors, especially when something goes wrong. He therefore recommends using questionnaires, rather than instruction books. However, a contrasting experience is reported in a study by Ray-Couquard et al. (1997) in Rogers (2003), about the successful dissipation of an innovative cancer treatment method by issuing practice guidelines about how to apply this treatment. This success is attributed to the considerable re-invention of the method in the guidelines, provided by medical doctors themselves in that particular cancer centre, who participated in writing the guidelines.

implementing innovations in organizations.[125] Implementation seems to require series of specific activities or *interventions*. These should reduce or even eliminate the hurdles and provide appropriate conditions for implementing innovations within organizations.

A number of definitions and descriptions of the term intervention have been identified in the literature. Verschuren and Doorewaard (2000) present interventions as activities for *changing practices* in organizations. Vermaak (2002) considers interventions within the four phases for realizing planned change within an organization: (1) diagnosing, (2) developing a change strategy, (3) developing a plan for interventions, and (4) executing the interventions. Rogers (2003: 400) specifies interventions as "actions with a coherent objective to bring about behaviour change in order to produce identifiable outcomes". According to him, *change agents* operate these interventions. Daft (1998) relates interventions to organizational development (OD), which focuses on the behaviour of people in their work environment. In conclusion, interventions specifically involve activities for changing people's *behaviour*.[126]

5

Intervention concepts

As raised by Vermaak (2002), there is a bulk of literature presenting all kinds of interventions. Vermaak presents thirty different interventions for individuals, groups, and organizations. For being able to structure these interventions, this sub-section identifies the main intervention concepts in the literature, from a theoretical and practical point of view.

For identifying intervention concepts form a *theoretical* point of view, the literature search in the *top five scientific* journals, as presented in Chapter 4 about innovations, has been extended towards interventions. Huy (2001) distinguishes four ideal types of change processes: (1) commanding, (2) engineering, (3) teaching, and (4) socializing. He presents typical change actions or *interventions* for each of these change processes, together with their potential limitations. Jasperson et al. (2005) summarize and present a number of specific interventions, as presented in the literature, for users, peers, experts, and managers. Examples are self-orchestrated learning, training sessions, and modifying or enhancing the innovation.

---

125 This inadequacy has been experienced by the Ph.D. researcher himself. As mentioned at the start of Chapter 1, the free availability of his book with extensively presented guidelines and exampled about applying geotechnical risk management proved to be insufficient for the actual implementation of geotechnical risk management within th organizational of a geotechnical knowledge institute.

126 Behavioural and psychological aspects seems to raise attention in the technically oriented construction sector, as for instance revealed by Bos (2005).

Additional theoretical intervention concepts were identified in other *scientific journals* and *scientific papers*. Werkman et al. (2005b) present a categorization of interventions by distinguishing (1) the power-coercive strategy, (2) the systematic change strategy, (3) the negotiation strategy, and the (4) programmatic strategy. IN view of organizational development, Bennis et al. (1976) distinguish three subsequent steps of convincing, learning, and commanding in a planned change process. Daft (1998) considers four organizational development type of interventions: (1) survey feedback, (2) off-site meetings, (3) team building and (4) inter-group activities. Checkland (2000) distinguishes interventions for hard systems and soft systems. The hard systems approach considers the world as a set of systems that can be engineered by *rational* interventions. Contrary, the soft systems approach considers the world as a set of fuzzy and ill-defined situations. By soft intervention processes of learning and inquiry, these soft systems can be explored and developed.

For identifying intervention concepts form a more *practical* point of view, the literature search has been extended by using the ABI-Inform database and including also *professional journals*. Rider (2002) presents coaching as a *strategic* intervention. This approach transforms coaching as an individual development instrument towards a strategic instrument at the organizational level for providing organizational impact. Furthermore, Blanchard (1998) presents training as an interventions. He raises the importance of three characteristics of effective training: (1) right timing by selecting the moments that the people to be trained need to use their newly gained knowledge or competencies directly in their work, (2) managers should train their own employees and (3) the need for so-called critical mass training in which large groups of people can be trained at the same time by using multimedia facilities. Another example of a series of interventions from a practical point of view, without considering theoretical concepts, is the “menu-of-your-own-choice” with nineteen pro-innovativeness interventions by Weggeman (2007). Examples of soft system type of interventions from the professional practice are sense making in interactions (Boonstra and De Caluwé, 2004), interventions for explicitly allocating responsibility and authority (Ahaus and Van de Water, 1994), the method of appreciative inquiry (AI) that reveals the organizational success factors in the past for creating a positive organizational future (Cooperrider et al., 2000), and learning histories for facilitating and measuring organizational learning (Roth, 1996). Vrakking (1995) provides fourteen lessons learned for consultants or other change agents, for maximizing the achievement of real implemented change in an organization. These lessons include interventions such as ensuring top management commitment and starting with providing clear information about the entire implementation process.

Categorizing intervention concepts

The main value of the work of De Caluwé and Vermaak (2004) is rather simply structuring the huge repertoire of intervention concepts, which has been revealed in the previous sub-section. They distinguish five fundamentally different sets of theory about change. To each of these sets, they attribute characteristics of the belief systems and convictions about how change works. Additionally, De Caluwé and Vermaak allocate interventions for changing peoples attitudes and behaviour to each of the five sets of change theories. Five colours symbolize the theories.

Rather recently developed concepts, such as chaos thinking, network theories, and complexity theories that rely on living in complex systems underlie *white-print* thinking and acting. De Caluwé and Vermaak (2004) refer to Bateson (1972) and Prigonine and Stengers (1986), who elaborated these concepts. According to De Caluwé and Vermaak (2004), the self-organization process from Stacey (1996) is a core aspect within white-print thinking and acting. In the view of this concept people interact according to his or her own norms, together with the acknowledgement that everything is changing autonomously, of its own accord. The colour white does refer to an open mind and room for evolutionary self-organization.

Blue-print thinking and acting is based on rational design and implementation of change that is rooted in the scientific management approach by Taylor (1913). A more recent concept is that of business process reengineering (BPR), as introduced by Hammer and Champy (1993), according to De Caluwé and Vermaak (2004). Within the blue-print approach, rational thinking is preceded by action according to plan. The colour blue represents emotionless rationality.

The classical Hawthorne experiments by Mayo (1933) and Roethlisberger (1941), which addresses explicitly attention to working conditions of employees, form the bases for *red-print* thinking and acting (De Caluwé and Vermaak, 2004). More recently, human resource management (HRM), as for instance worked out by Schoemaker (1994), represents red-print thinking and acting. It is about stimulating people's behaviour in the right way, by using assessments and rewards, social gatherings, and situational leadership. The red-print approach is therefore comparable with the socializing approach for change. Red symbolizes the human blood and the emotional aspects within change processes.

De Caluwé and Vermaak (2004) base *green-print* thinking and action on action learning theories by researchers such as Argyris and Schön (1978), as well as Senge's (1990) learning organization. It concerns creating learning situations.[127]

127 According to Roth (1996), capturing learning requires considering *cognitive* aspects about what people are thinking and in what ways their thinking changes, as well as *behavioural* aspects on what people are doing and in what way their actions change.

Examples are settings for creative learning processes by training and coaching, open systems planning, and gaming. The colour green represents green light for going ahead by trying, as well as growth of people in awareness, competencies, capabilities, and experiences.

Finally, De Caluwé and Vermaak (2004) found *yellow-print* thinking and acting on socio-political concepts about organizations. Interests, conflicts, and power play a dominant role within these concepts. De Caluwé and Vermaak (2004) refer to the work of scholars such as Greiner and Schein (1988) and Pfeffer (1981) who elaborated these concepts. Within the yellow-print approach, common interests are brought together by power games, such as forming coalitions, changing top structures, and policy making. Yellow represents the colour of power.

Actors

Gaining knowledge about the different *actors* playing a dominant role during the risk management implementation process was another objective of the literature survey about change management. Van Aken (2008a) describes actors generically as people who act to improve human conditions. When interventions are *instruments* for realizing change, actors actually *perform* change. Either they act as *change agents*, or are subjects to change, when being targeted *risk management users* or their *managers*.

In addition to innovation users, Rogers (2003) identifies three other types of actor playing a role when implementing innovations by executing interventions. These actors are (1) *change agents* who facilitate the innovation, (2) *opinion leaders* who support the innovation by their influence, and (3) *champions* who successfully apply the innovation and serve as a role model by using their charisma. Rogers (2003) presents seven roles of change agents for influencing client's innovation decisions in a desirable direction.[128] Opinion leadership involves influencing the attitudes and behaviour of individuals in rather informal ways. Champions are professionals that apply the innovation themselves. They use their charisma for convincing colleagues to use the innovation as well. Danserau et al. (1999) refer to Avolia and Bass (1995), who describe how *individual* persons may generate changes at organizational level by fostering transformational leadership. This confirms the importance of acknowledging the roles of individuals within the implementation processes, such as change agents, opinion leaders and champions.

128 The seven roles of change agents for influencing client's innovation decisions in a desirable direction are (1) developing a need for change, (2) establishing information exchange relationships, (3) diagnosing problems, (4) creating an intent to change, (5) translating intentions into actions, (6) stabilizing innovation adoptions and preventing discontinuances, and (7) achieving terminal relationships with the individuals or organizations wanting to implement the innovation (Rogers, 2003: 400).

Actors, commitment, and motivation

Malhorta and Galetta (2000) explored the conditions of individual commitment and motivation for implementing knowledge management system (KMS) types of innovations. They suggest that the degree of individual commitment and motivation often determine the implementation success or failure.[129] The value of their work is the *break down* of the widely encountered terms commitment and motivation. User *commitment* is by Malhorta and Galetta defined as the degree of social influences on the user behaviour. Based on Kelman's (1958) processes of social influence, they distinguish three types of commitment. First, *commitment by compliance*, which is behaviour that results from receiving incentives or disincentives. Second, *commitment by identification* that results from the fundamental human need of being accepted by peers and managers. The individual user will adopt the appropriate values and norms for obtaining this acceptance. Third, *commitment by internalization*, which implies that the values and norms are really adopted and internalized by an individual, independent of the extrinsic rewards or social acceptance. The latter are the dominating elements in the previous two types of commitment.

Furthermore, Malhorta and Galetta (2002) define user *motivation* as the degree to which the innovation use is self-determined. They present a continuum, ranging from a-motivation, via extrinsic motivation, to intrinsic motivation. While *a-motivation* represents the situation of no motivation or willingness to use an innovation at all, describe several degrees of *extrinsic motivation* the degree to which external aspects influence the willingness of an individual to use an innovation. *Intrinsic motivation* is by Malhorta and Galetta (2002) defined as the inherent tendency of being receptive to novelty and challenges, as well as to developing one's capabilities, to explore, and to learn.

However, the *illusion of free will* theory by Lefcourt (1973) in Reason (1997), which is for instance confirmed by Wilson (2002), restricts dramatically human acting as free agents. This may also reduce the degree of real intrinsic motivation of an individual, by acting as a free agent. According to the theory of the illusion of the free will, individual actions are restricted and conditioned by local circumstances or situational context.[130] Moreover, by acknowledging Blau's (1964) model of

---

129 The empirical research by Malhorta and Galetta (2000) concerned the implementation of a Windows NT-based knowledge management system in the health care sector.

130 According to Reason (1997), the illusion of free will creates a blame cycle. When people are seen as free agents, they should be able to choose between correct and wrong actions. Therefore, human errors become at least partly deliberate, which explains blaming the person(s) involved. Interventions, such as warnings, sanctions, and additional regulations and procedures are executed for avoiding repetition of the error in the future. Nevertheless, often more or less similar errors do continue to occur, because many of the interventions are being ineffective. As a result, the people involved seem even more to blame, because the error has occurred, despite the preventive actions taken. This view tempers the expectations of implementing risk management in organizations, at least when aiming to reduce the number of human errors.

exchange and power in social life, learning to use innovations require (additional) efforts. Particularly for experienced professionals, this may be not attractive as it disturbs their own trustworthy practices.

Vrakking (1995) presents the earlier mentioned change strategies by Bennis et al. (1976). These strategies of convincing, learning, and commanding may be considered as establishing or increasing the individual *motivation* for using an innovation. Boonstra (1996) presents nine tactics for *influencing* people. These also seem being interventions for raising motivation.[131] According to Boonstra (1996) using hard tactics may create resistance, while applying softer tactics may result into compliance and resignation. Particularly for complex organizational changes, combining tactics of rational convincing and consulting, together with providing inspiration proved being effective for generating support for change. However, if these tactics are combined with the hard tactics, such as enforcing pressure, resistance is likely to occur. Therefore, increasing individual motivation for routinely using innovations seem demanding carefully selected multiple interventions.

Csikszentmihalyi (1997) introduced the *concept of flow*. He describes flow as an individual experience, where a full use of competencies meets a maximum of challenge for reaching a well-defined target. Csikszentmihalyi (1997) defines intrinsic motivation as something a persons *wants* to do, contrary to extrinsic motivation when someone something *has* to do. Flow typically results from intrinsic motivation. The concept of ego-depletion (Schmeichel et al., 2003) seems in some conflict with the concept of flow. Ego-depletion occurs when individuals have to regulate their attention or to control their emotion. This consumes energy and strength and therefore reduces complex thinking *ability*, rather than influencing the thinking *willingness*.[132] Thus, even if the *motivation* for complex thinking is available, disturbances by attention regulation or emotional concerns adversely effect individual complex thinking. Then it may *appear* that the individual lacks either motivation or competencies, which is in fact not the case. It seems simply a matter of temporarily lacking energy.[133]

---

131 These interventions for raising motivation are: (1) rational convincing, (2) inspiring, (3) consulting, (4) forming coalitions to get support from others, (5) negotiation, (6) creating a positive atmosphere by complimenting people, (7) legitimate by referring to rules and procedures, (8) enforcing pressure by pushing people, and (9) ask people personally for doing a favour, by stating that the person is perfectly suitable to complete a certain task (Boonstra, 1996).

132 Complex thinking by individuals may be highly required for them, for being able to use an innovation.

133 The concept of ego-depletion by Schmeichel et al. (2003) confirms the importance for creating periods of time, with quiet conditions, for allowing motivated individuals to learn effectively and efficiently using an innovation. Those conditions demand for a minimum of disturbances of attention regulation or emotional distress. Creating such conditions seems quite a challenge in today's high-demanding and competitive business environments. This explains the recommendation for time taking in Van Staveren (2006: 82), according to an old Chinese saying: "When you are in a hurry, sit down".

5.2.2 Variables from literature research

One set of *variables* for implementing innovations have been identified during the exploration of change management: *interventions*. These variables have been identified from the change management literature survey, which also has been considered for identifying the *concepts* of interventions. Table 5.1 lists the identified series of interventions. The *order* of the interventions in Table 5.1 results from the literature survey and is arbitrary. The *numbers* of the interventions in the first column of Table 5.1 are only for identification purposes. They do not reflect the relative relevance of the interventions to each other, which was yet of no concern. This stage of the research focussed on identifying variables, rather than on classifying their relevance, which has been performed at later research stages.

Table 5.1 Interventions for implementing innovations, identified in the change management literature.

No.	Interventions for implementing innovations	Source
1	Forming coalitions, changing top structures, policy making.	(De Caluwé and Vermaak, 2004)
2	Demanding strict compliance.	(Huy, 2001)
3	Executing task, responsibilities and authorities (TRA) sessions.	(Ahaus and Van den Water, 1996)
4	Establishing a innovation board.	(Weggeman, 2007)
5	Issuing directives and mandates.	(Jasperson et al., 2005)
6	Demanding for personal commitment statements and outplacement.	(Vermaak, 2002)
7	Providing management by objectives.	(Vermaak, 2002)
8	Providing project management, strategic analysis, auditing.	(De Caluwé and Vermaak, 2004)
9	Executing business process redesign (BPR).	(Vermaak, 2002)
10	Executing work systems design and task-based skills development.	(Huy, 2001)
11	Providing sufficient time and budget for the innovation implementation.	(Jasperson et al., 2005)
12	Measuring innovativeness with questionnaires and creating organizational redundancy.	(Weggeman, 2007)
13	Organizing social gatherings and situational leadership.	(De Caluwé and Vermaak, 2004)
14	Sponsoring or championing.	(Jasperson et al., 2005)
15	Providing career development and task extension.	(Vermaak, 2002)
16	Providing training and coaching, open systems planning, gaming.	(De Caluwé and Vermaak, 2004)

5

Table 5.1 Continued

No.	Interventions for implementing innovations	Source
17	Arranging quality circles and teambuilding.	(Vermaak, 2002)
18	Providing strategic coaching.	(Rider, 2002)
19	Providing education and training.	(Huy, 2001), (Blanchard, 1998)
20	Organizing after action review sessions and (virtual) lessons learned office.	(Weggeman, 2007)
21	Designing, leading, or directing formal and informal training sessions.	(Jasperson et al., 2005)
22	Arranging open space meetings, self-steering teams, and appreciative inquiry.	(De Caluwé and Vermaak, 2004)
23	Providing learning histories.	(Roth, 1996)
24	Arranging out-of-the-box thinking workshops with group decision support systems.	(Weggeman, 2007)
25	Providing self-monitoring.	(Huy, 2001)
26	Arranging strategic dialogues.	(Roobeek et al., 1998)
27	Ensuring explicit top management commitment.	(Vrakking, 1995)
28	Including early irreversible implementation steps.	(Vrakking, 1995)
29	Executing integral implementation without experimentation.	(Vrakking, 1995)
30	Ensuring positive bottom line effects of the innovation implementation.	(Vrakking, 1995)
31	Providing support by a digital information system and an innovation newsletter.	(Weggeman, 2007)
32	Assessing and rewarding employees, organizing social gatherings, providing situational leadership.	(De Caluwé and Vermaak, 2004)
33	Including innovation use in the assessments of employees, appointing gate keepers that follow external developments of innovations, rewarding copying of external innovations.	(Weggeman, 2007)
34	Modifying and enhancing the innovation and providing incentives.	(Jasperson et al., 2005)
35	Organizing quality circles and teambuilding.	(Vermaak, 2002)
36	Providing strategic coaching.	(Rider, 2002)
37	Fostering self-monitoring.	(Huy, 2001)

5.2.3 Variables from field research

Based on the results of the literature study about applying risk management and implementing innovations, *field research* has been performed. This research involved interviewing seven risk management experts from South Africa, the United

Kingdom, and United States, and seven organizational implementation experts from The Netherlands. These interviews were already introduced, motivated, and presented in Section 3.2.3 (about risk management) and in Section 4.2.3 (about innovation management). From the interview results, a considerable number of interventions have been identified, in addition to hurdles and conditions for applying risk management and implementing innovations, which were the primary objective of the interviews. All of these interventions were considered relevant for applying risk management and implementing innovations by the interviewed experts.

Interventions for applying risk management from interviews

Table 5.2 presents 23 interventions for applying risk management, which have been identified in the interview reports of the seven risk management experts. Again, the *order* of the interventions in Table 5.2 results from the field research process and is arbitrary. The *numbers* of the interventions in the first column of Table 5.2 are therefore only for identification purposes. They do not indicate any relative relevance of the interventions to each other, which was yet of no concern. This stage of the research focussed on identifying variables, rather than on classifying their relevance, which has been performed in later research stages.

5

Table 5.2 Interventions for applying risk management, identified in interviews.

No.	Interventions for applying risk management
1	Establishing well-balanced teams by selection.
2	Providing early career-education.
3	Organizing multi-disciplinary risk workshops.
4	Enforcing risk management accreditation.
5	Setting targeted risk profiles by directors and monitoring the risk profiles during the project.
6	Enforcing targeted risk profiles in projects by clients.
7	Generating media attention about the consequences of failing risk management.
8	Generating public-private partnerships for jointly benefiting from risk management.
9	Enforcing risk management by law or financial institutions.
10	Enforcing risk management by insurance companies.
11	Providing cost-benefit software for calculating the cost-benefit ratios of risk reduction.
12	Providing financial risk-balance sheets.
13	Incorporating risk management in strategic planning and strategic management.
14	Incorporating risk management in project management.
15	Aligning risk management with developing reliable technical delivery systems (TDS) and high reliability organizations (HROs).

Table 5.2 Continued

No.	Interventions for applying risk management
16	Relating risk management to zero-accident programmes.
17	Providing simple risk management guidelines.
18	Providing the ISO 31000 Risk Management Guideline.
19	Designing contractual frameworks that allow risk management.
20	Providing support to risk owners by risk managers.
21	Organizing project risk evaluations, peer reviews, technical boards, and Dispute Review Boards for learning about project risks.
22	Executing long term monitoring programmes of projects for learning about the effectuation of estimated risks.
23	Publishing risk management success stories.

Interventions for implementing innovations from interviews

Table 5.3 presents 16 interventions for implementing innovations, which have been identified in the interview reports of the seven experts of organizational implementation of innovations. The *order* of the interventions in Table 5.3 also results from the field research process and is arbitrary. The *numbers* of the interventions in the first column of Table 5.3 are only for identification purposes. They do not indicate any relative intervention relevance.

Table 5.3 Interventions for implementing innovations, identified in interviews.

No.	Interventions for implementing innovations
1	Guaranteeing sufficient coordination at interfaces of disciplines.
2	Applying staged implementation processes.
3	Using the soft systems methodology (SSM).
4	Setting points of no return with explicit decision making.
5	Providing continuous renewal of the innovation for continuation of energy and motivation.
6	Providing motivation by transformational leadership at the start of the implementation process and setting clear objectives by transactional leadership in later implementation stages.
7	Fostering directive and goal-oriented leadership.
8	Providing courses.
9	Creating time for reflection.
10	Providing economies of learning by specialization.
11	Providing a mixture of education, training and coaching for creating the right mindset and attitude.
12	Using dialogues in the unfreezing phase of the innovation implementation process.
13	Providing co-creation of the implementation process with all actors involved.

Table 5.3 Continued

No.	Interventions for implementing innovations
14	Applying innovative intervention techniques by interaction between people that address sense-making.
15	Re-designing work processes for creating innovation fit.
16	Using case studies for convincing potential users to apply the innovation.

5.2.4 Summary of identification results

Table 5.4 presents the numbers of interventions for implementing innovations in organizations that were retrieved from the literature research and the field research. In total 76 interventions have been identified.

Table 5.4 The number of identified interventions and innovation user groups.

Research type	Data source	Interventions for implementing innovations in organizations (number)
Literature research	Change management literature	37
Field research	Interviews with 7 risk management experts	23
	Interviews with 7 implementation experts	16
Total		76

5.3 Data analysis

Based on the factual results from the literature and the field research, another research question emerged:

– Which (types of) interventions will be effective for reducing which hurdles and generating which conditions?

In other words, there emerged a need for relating the identified interventions to hurdles and conditions for implementing risk management within organizations. Preferably, some sort of theoretical framework should support such a relationship. Therefore, the identified concepts and variables have been *analyzed* in three steps.

Step 1 involved analyzing different sources of data by data triangulation (Patton, 1987, in Yin, 2003). It generated key definitions for the terms *intervention* and the main types of *actor* during the process of implementing innovations in organizations. In Step 2, different theoretical concepts were analyzed by theory triangulation (Patton, 1987, in Yin, 2003), which resulted in *five fundamental intervention perspectives* for realizing organizational change. In Step 3, an additional analysis of theoretical concepts by theory triangulation generated a theoretical framework for implementing innovations in organizations. Theoretical concepts for realizing organizational change derived from the literature served as basis for this framework. The following three sections describe these steps of analysis in more detail.

5.3.1 Providing key definitions

In Step 1, analyzing and combining the identified definitions for interventions and actors generated a set of *key definitions*. Regarding the objectives of this research, for *interventions* the following key definitions have been derived:

- *Interventions* are well-planned activities aiming to reduce hurdles and provide conditions for implementing innovations in (parts of) organizations;
- *Soft interventions* are well-planned activities for *changing behaviour* of individual members of *social systems*, for generating motivation and commitment for applying or supporting the innovation;
- *Hard interventions* are well-planned activities for *modifying* the *innovation*, for realizing a maximum fit of the innovation with the individual members of social systems.[134]

For the five main actor types during the innovation implementation process, including that of risk management, the following key definitions have been derived:

- *Managers* are individuals who are responsible for initiating, facilitating, monitoring, and continua ting the routine application of an innovation in (parts of) an organization;
- *Innovation users* are individual professionals that should routinely use the innovation in their activities;
- *Change agents* are individual professionals who realize the implementation of an innovation in (parts of) an organization;
- *Opinion leaders* are individuals who advocate innovation use in their organization, by using their authority;

134 Rogers (2003) uses the term *re-invention* for hard interventions.

- *Champions* are individuals who successfully apply the innovation in their activities and serve as a role model, by using their charisma.

Managers, who actually may or may not use the innovation by themselves, may or may not benefit by the innovation, in view of their targets. They may also realize the implementation of the innovation as a *change agent*, or support the innovation use as an *opinion leader*. In order of decreasing propensity to innovation use, *innovation users* are classified into innovators, early adopters, early majority, late majority and laggards. These key definitions are used throughout this thesis.

5.3.2 Selecting and combining change management concepts

Deriving five fundamental intervention perspectives

After deriving the key definitions, the second step of the analysis provided *five fundamental intervention perspectives* for realizing organizational change. These perspectives have been derived after comparing each of the five colours of the five-colour model for realizing organizational change (De Caluwé and Vermaak, 2004) with a number of additional theoretical and practical concepts about organizational change that were identified in the literature survey.

White-print thinking and acting, as proposed by De Caluwé and Vermaak (2004) creates space for spontaneous evaluation of dynamic processes, including dialogue, as set out in Werkman et al. (2005b). Also, the soft systems approach of Checkland (2000), which suggests for instance processes of inquiry for exploring soft systems, seems to aligns with white-print thinking and acting.

Blue-print thinking and acting seems to align well with the systematic change strategy, as proposed by Werkman et al. (2005b), and with the engineering strategy as presented by Huy (2001). This latter scholar considers for instance quality management (QM) as a typically being an element of the engineering strategy. Other examples about blue-print thinking and acting are presented by the planned change strategy (Bennis et al., 1976), the hard systems theory (Checkland, 2000) and the hard key factors for realizing change by Sirkin et al. (2005).

Red-print thinking and acting seems to correlate the socializing theory, as presented by Huy (2001). In addition, the programmatic strategy for change, as presented by Werkman et al. (2001), seems having a lot in common with red-print thinking and acting. Furthermore, the four organizational development types of intervention of survey feedback, off-site meetings, team building, and inter-group activities proposed by Daft (1998) seem to have a rather red-print character.

Green-print types of intervention align with the teaching type of change processes from Huy (2001). Moreover, the soft systems approach of Checkland (2000), which suggests for example learning processes for exploring soft systems, seems to correspond with green-print thinking and acting.
Yellow-print thinking and acting shares lot shares characteristics with the power-coercive and negotiation strategies for change, as presented by Werkman et al. (2005b), and with the commanding types of intervention from Huy (2001).
Table 5.5 presents the comparison with the five-colour model for change from De Caluwé and Vermaak (2004) with the corresponding concepts. Furthermore, Table 5.5. proposes summarizing terminology for the resulting five fundamental intervention perspectives: (1) the autonomous perspective, (2) the rational perspective, (3) the emotional perspective, (4) the learning perspective, and (5) the political perspective. These terms will be used in the remaining part of this thesis. The numbering of these intervention perspectives is only for identification purposes. It is not intended to indicate that perspective number 1 is more important than perspective number 5. Within this stage of research, each of the perspectives are considered as equally relevant, with regard to the implementation of innovations, such as risk management, in organizations.

Table 5.5 Five fundamental intervention perspectives and their origin from the literature.

Five-colour model for realizing organizational change (De Caluwé and Vermaak, 2004)	Corresponding concepts (several scholars)	Proposed terminology for five fundamental intervention perspectives for realizing change
1. *White-print* thinking and acting: Creating space for spontaneous evaluation of dynamic processes.	Dialogue strategy (Werkman, et al., 2005b) Soft systems theory (Checkland, 2000)	1. *Autonomous* perspective
2. *Blue-print* thinking and acting: Thinking first and acting according to plan by rational processes.	Engineering strategy (Huy, 2001) Systematic change strategy (Werkman, et al., 2005b) Planned change strategy (Bennis et al., 1976) Hard systems theory (Checkland, 2000) Hard key factors for realizing change (Sirkin et al., 2005).	2. *Rational* perspective

Table 5.5 Continued

Five-colour model for realizing organizational change (De Caluwé and Vermaak, 2004)	**Corresponding concepts (several scholars)**	**Proposed terminology for five fundamental intervention perspectives for realizing change**
3. *Red-print* thinking and acting: Stimulating people's behaviour in the right way by human resources management, including assessment and reward, social gatherings, and situational leadership.	Socializing strategy (Huy, 2001) Programmatic strategy (Werkman, et al., 2005b) Four organizational development types (Daft, 1998)	3. *Emotional* perspective
4. *Green-print* thinking and acting: Creating settings for creative learning processes by training and coaching, open systems planning, and gaming.	Teaching strategy (Huy, 2001) Soft systems theory (Checkland, 2000)	4. *Learning* perspective
5. *Yellow-print* thinking and acting: Bringing common interests together by power games, such as forming coalitions, changing top structures, and policy making.	Power-coercive strategy (Werkman, et al., 2005b) Negotiation strategy (Werkman, et al., 2005b) Commanding strategy (Huy, 2001)	5. *Political* perspective

Relating five fundamental intervention perspectives to additional concepts

In the third step of analysis, the five fundamental intervention perspectives for realizing organizational change were related to a number of additional theoretical concepts that have been identified in the literature.

As presented in the previous chapter about exploring innovation management, Rogers (2003) distinguishes five innovator user groups by their different rates of innovativeness. Based on their main characteristics, which were also presented in the previous chapter, these five innovation user groups have been related to the five fundamental interventions perspectives. In addition, four other theoretical frameworks have been analyzed. Their characteristics have also been classified according to their correspondence with the five fundamental intervention perspectives. These frameworks consider five degrees of motivation and commitment (Malhorta and Galetta, 2002, based on Kelman, 1958), three change strategies proposed by Vrakking, 1995 (based on Bennis et al., 1976), Technical-Political-Cultural (TPC) model for realizing planned change (Tichy, 1983), nine tactics for influencing people (Boonstra, 1996), and the model for generating flow with the dimensions competencies and challenges (Csikszentmihalyi, 1997). Table 5.6 presents the results of this analysis.

Table 5.6 Relationships of the five interventions perspectives with variables of additional concepts.

Theoretical concepts and their references	**Five fundamental intervention perspectives**				
	Perspective 1	**Perspective 2**	**Perspective 3**	**Perspective 4**	**Perspective 5**
	Autonomous perspective	Rational perspective	Emotional perspective	Learning perspective	Political perspective
Five-colour model for organizational change De Caluwé and Vermaak (2004)	White-print thinking and acting	Blue-print thinking and acting	Red-print thinking and acting	Green-print thinking and acting	Yellow-print thinking and acting
Five innovation adopter categories (main characteristic) Rogers (2003)	Innovator (venturesome)	Early adopter (respectful)	Early majority (deliberate)	Late majority (sceptical)	Laggard (traditional)
Five degrees of motivation and commitment Malhorta and Galetta (2000), based on Kelman (1958)	Intrinsic motivation		Extrinsic motivation		A-motivation
	Full commitment by self regulation	Commitment by internalization	Commitment by identification	Commitment by compliance	Non commitment
Technical-Political-Cultural (TPC) model for realizing planned change (Tichy, 1983)	-	Technical strategy for enforcing change	Cultural strategy for enforcing change	-	Power strategy for enforcing change
Three change strategies Vrakking (1995), based on Bennis et al. (1976)	-	Convincing	Learning		Commanding
Nine tactics for influencing people Boonstra (1996)	Inspiring	Rational convincing, consulting, legitimating by rules and proce-dures	Complimenting people, asking for favours	-	Negotiation, forming coalitions, enforcing pressure
Model for generating flow with two dimen-sions: competencies and challenges Csikszentmihalyi (1997)	Flow	Excitement	Fear	Concern	Apathy

Table 5.6 demonstrates that the five interventions perspectives seem to correspond with a number of distinguishing variables from several theoretical concepts about organizational change. By carefully considering these variables, it becomes clear that probably most of them, if not all of them, have to be realized by change agents within the social systems of innovation users. Rogers (2003) mentions that the intrinsically motivated innovators typically form just a few percent of the employee population of an organisation. Therefore, the analysis of the theoretical concepts, as shown in Table 5.6, seems to confirm that the majority of people need social influences for becoming committed, and thus motivated, for routinely using an innovation.

5.4 Data classification

The analysis in the previous section seems demonstrating a sound theoretical basis for the five fundamental intervention perspectives: (1) the autonomous perspective, (2) the rational perspective, (3) the emotional perspective, (4) the learning perspective, and (5) the political perspective. Next, data triangulation (Patton, 1987, in Yin, 2003) by evaluating and classifying the intervention data from the different sources have been applied.

All of the 76 identified interventions from the literature research and the field research have been *classified* in two subsequent steps. First, the interventions have been classified in those generating the required characteristics for innovations and those for providing the appropriate characteristics of social systems. Second, within each of these two categories, the interventions have been classified into the five fundamental intervention perspectives. Table 5.7 presents the results of this classification, by counting the number of interventions in each category that have been identified from the literature survey and during the field research.

Table 5.7 Numbers of identified interventions that are attributed to innovations and social systems.

Data source	Five intervention perspectives for reducing hurdles and generating conditions for implementing innovations	Number of interventions attributed to innovations	Number of interventions attributed to social systems
Literature research	Autonomous	1	5
	Rational	3	6
	Emotional	3	3
	Learning	2	6
	Political	2	6
Subtotal		11	26
Field research	Autonomous	0	4
	Rational	12	3
	Emotional	0	4
	Learning	3	5
	Political	7	1
Subtotals		22	17
Total		33	43

Table 5.7 shows that in total 33 interventions have been attributed to reducing hurdles and generating conditions for innovations. The remaining 43 interventions are related to social systems, in which the innovation have to be implemented. Table 5.8 shows the total number of innovation-related and social system-related interventions for each fundamental intervention perspective, by summing up the interventions from the literature research and those from the field research.

Table 5.8 The total number of interventions for each intervention perspective.

Five intervention perspectives for reducing hurdles and generating conditions for implementing innovations	Number of interventions attributed to innovations	Number of interventions attributed to social systems
Autonomous	1	9
Rational	15	9
Emotional	3	7
Learning	5	11
Political	9	7
Total	33	43

Table 5.9 presents the classification of the innovation-related interventions, within the five intervention perspectives. Table 5.10 presents a similar classification of the social system-related interventions within the five intervention perspectives. The *order* of the interventions in Table 5.9 and Table 5.10 results from the data classification process and is arbitrary. The *numbers* of the interventions in the second column of Table 5.9 and Table 5.10 are only for identification purposes. They do not intend to indicate the relative relevance of single interventions to each other. This stage of the research focussed on classifying variables in the five intervention perspectives. The relative relevance of interventions to each other was not yet of concern.

Table 5.9 Innovation-related interventions within the five intervention perspectives.

Five intervention perspectives	**Interventions related to innovations, particularly risk management (RM = risk management)**	
	No.	**Descriptions**
Autonomous	1	Fostering self-monitoring
Rational	1	Executing integral implementation without experimentation
	2	Ensuring positive bottom-line effects of the RM implementation
	3	Providing support by a digital information system and an innovation newsletter
	4	Providing cost-benefit software for calculating the cost-benefit ratios of risk reduction
	5	Providing financial risk-balance sheets
	6	Re-designing work processes for creating innovation fit
	7	Incorporating RM in strategic planning and strategic management
	8	Incorporating RM in project management
	9	Aligning RM with technical delivery systems (TDS) and high reliability organizations (HRO)
	10	Relating risk management to zero-accident programmes
	11	Providing simple RM guidelines
	12	Providing the ISO 31000 RM Guideline
	13	Designing contractual frameworks that allow RM
	14	Providing support to risk owners by risk managers
	15	Using RM case studies

Table 5.9 Continued

Five intervention perspectives	Interventions related to innovations, particularly risk management (RM = risk management)	
	No.	**Descriptions**
Emotional	1	Assessing and rewarding employees, organizing social gatherings, providing situational leadership
	2	Including innovation use in employees assessments, appointing gate keepers that follow external developments of innovations, and rewarding copying of external innovations
	3	Modifying and enhancing the innovation and providing incentives
Learning	1	Organizing quality circles and teambuilding
	2	Providing strategic coaching
	3	Organizing project risk evaluations, peer reviews, technical (dispute review) boards for learning about risk
	4	Executing long term monitoring programmes of projects for learning about the effectuation of risks
	5	Publishing RM success stories
Political	1	Ensuring explicit top management commitment
	2	Including early and irreversible implementation steps
	3	Enforcing risk management accreditation
	4	Setting targeted risk profiles by directors
	5	Enforcing targeted risk profiles in projects by clients
	6	Generating media attention about the consequences of failing risk management
	7	Generating public-private partnerships for jointly benefiting from RM
	8	Enforcing RM by law or financial institutions
	9	Enforcing RM by insurance companies

Given the topic of this research and the results of the literature and field research, the interventions within Table 5.9 are particularly relevant for implementing risk management in organizations. By replacing the words risk management by another sort of innovation, it is expected that a majority of interventions is also relevant for implementing other types of innovations within organizations. This is because both the literature review and the field research within this chapter concerned exploring change management for implementing innovations in general, rather than for implementing risk management only.

Table 5.10 Social system-related interventions within the five intervention aspects.

Five intervention perspectives	Interventions related to innovations, particularly risk management	
	No.	**Descriptions**
Autonomous	1	Arranging open space meetings, self-steering teams, and appreciative inquiry
	2	Providing learning histories
	3	Arranging out-of-the-box thinking workshops with group decision support systems
	4	Providing self-monitoring
	5	Arranging strategic dialogues
	6	Using dialogues in the unfreezing phase of the implementation process
	7	Providing co-creation of the implementation process with all actors involved
	8	Applying innovative interventions by interaction between people that address sense-making
	9	Organizing multi-disciplinary risk workshops
Rational	1	Providing management by objectives
	2	Providing project management, strategic analysis, auditing
	3	Executing business process redesign (BPR)
	4	Executing work systems design and task-based skills development
	5	Providing sufficient time and budget for the innovation implementation
	6	Measure innovativeness with questionnaires and create organizational redundancy (anti-efficiency)
	7	Applying staged implementation processes
	8	Using the soft systems methodology (SSM)
	9	Setting points of no return with explicit decision making
Emotional	1	Organizing social gatherings and situational leadership
	2	Applying sponsoring or championing innovation use
	3	Providing career development and task extension
	4	Providing continuous renewal of the process innovation for continuation of energy and motivation
	5	Establishing well-balanced teams by selection
	6	Providing motivation by transformational leadership at the start of the implementation process and setting clear objectives by transactional leadership in later implementation stages
	7	Fostering directive and goal-oriented leadership

Table 5.10 Continued

Five intervention perspectives	**Interventions related to innovations, particularly risk management**	
	No.	**Descriptions**
Learning	1	Providing training and coaching, open systems planning, and gaming
	2	Arranging quality circles and teambuilding
	3	Providing strategic coaching
	4	Providing education
	5	Organizing after action review sessions and establishing a (virtual) lessons learned office
	6	Designing, leading, or directing formal and informal training sessions
	7	Providing courses
	8	Creating time for reflection
	9	Providing economies of learning by specialization
	10	Providing a mixture of education, training and coaching for creating the right mindset and attitude
	11	Providing early career-education
Political	1	Forming coalitions, changing top structures, policy making
	2	Demanding strict compliance
	3	Executing task, responsibilities, and authorities (TRA) sessions
	4	Establishing a innovation board
	5	Issuing directives and mandates
	6	Demanding for personal commitment statements and outplacement
	7	Guaranteeing sufficient coordination at interfaces of disciplines

Similarly to the comments on Table 5.9, the interventions within Table 5.10 are also particularly relevant for implementing risk management in organizations. Once again, by replacing the words risk management by another sort of innovation, it is expected that a majority of interventions is also relevant for implementing other types of innovations within organizations.

5.5 Results and next research step

Research results

The exploration research of change management *concepts* generated in total seven *key definitions* for *interventions* and *actors* during the innovation implementation process:

- *Interventions* are well-planned activities aiming to reduce hurdles and to provide conditions for implementing innovations in (parts of) organizations;
- *Soft interventions* are well-planned activities for *changing behaviour* of individual members of *social systems*, for generating motivation and commitment for applying or supporting the innovation;
- *Hard interventions* are well-planned activities for *modifying* the *innovation*, for realizing a maximum fit of the innovation with the individual members of social systems.
- *Managers* are individuals who are responsible for initiating, facilitating, monitoring, and continuating the routine application of an innovation in (parts of) an organization;
- *Innovation users* are individual professionals that should routinely use the innovation in their activities;
- *Change agents* are individual professionals who realize the implementation of an innovation in (parts of) an organization;
- *Opinion leaders* are individuals who advocate innovation use in their organization, by using their authority;
- *Champions* are individuals who successfully apply the innovation in their activities and serve as a role model, by using their charisma.

Furthermore, five fundamental intervention perspectives have been derived: (1) the autonomous perspective, (2) the rational perspective, (3) the emotional perspective, (4) the learning perspective, and (5) the political perspective. These perspectives result from synthesizing a significant number of intervention-related concepts and strategies for realizing planned organizational change from Bennis et al. (1976), Boonstra (1996), Csikszentmihalyi (1997), De Caluwé and Vermaak (2004), Kelman (1958), Malhorta and Galetta, (2002), Rogers (2003), Tichy (1983), and Vrakking (1995).
The exploratory research of change management *variables* generated 76 interventions for implementing innovations in general, and risk management in particular, in organizations. These interventions aim reducing hurdles and providing

conditions for implementing innovations. All of these variables were classified into the two main categories and five fundamental interventions perspectives. The categories are innovations (with 33 interventions) and social systems (with 43 interventions). These results of the exploration research of *change management* show that it seems reasonable to relate hurdles and conditions to interventions of five intervention perspectives. Within each perspective, executing interventions should reduce hurdles by setting conditions. These conditions generate the required (sub)characteristics of the innovation itself, as well as the (sub)characteristics for the social system, in which the innovation has to be implemented. This confirms Key Proposition 2: Reducing hurdles and generating conditions require interventions by change management.

In summary, the exploration research revealed that executing interventions may reduce hurdles and generate conditions for implementing innovations, such as risk management, within organizations. In total 164 hurdles (109 for applying risk management and 55 for implementing innovations), 240 conditions (147 for applying risk management and 93 for implementing innovations), and 76 interventions were identified. Moreover, these were analyzed and classified according the several combined theoretical frameworks from the disciplines of risk management, innovation management, and change management. In conclusion, in total 480 variables, somehow related to implementing risk management in organizations, were explored.

Research limitations

Given the large numbers of identified hurdles and conditions, substantial numbers of these may overlap each other. Some clustering and structuring by classification has already been provided in the synthesizing part of the exploration research. However, more structuring seems desirable for increasing the practical relevance of the hurdles and conditions. Moreover, it is not yet clear which hurdles and which conditions are more important than others. Until this stage of research, most hurdles and conditions were considered equally important. An exception are those for applying risk management, on which a Delphi analysis has been executed for revealing the most significant hurdles and conditions. However, that exercise provided a large scatter of results. There seemed nearly no agreement between experts about which hurdles and conditions are most significant. It is also not yet clear which interventions are most effective and efficient for reducing hurdles and setting conditions for realizing the required (sub)characteristics of risk management methodologies, as well as the social systems that have to adopt the risk management methodologies. These limitations provide ample opportunities for the next research step.

Next research step

Given the limitations of the exploration research and the main objective of the entire Ph.D. research, the next research step involved starting with the development of design propositions for implementing risk management within organizations in the construction industry. All results of the exploration research served as basis for the development-oriented research phase. In addition to developing design propositions for implementing risk management, the development research phase included validating the initial design propositions, modifying the initial design propositions, and evaluating the modified design propositions. These subsequent research steps provided final design propositions for implementing risk management in organizations, by acknowledging the evaluation and validation results. These development type of research steps are reported in Chapter 6 through to Chapter 9.

6

INITIAL DESIGN PROPOSITIONS FOR RISK MANAGEMENT IMPLEMENTATION

6.1 Introduction

This chapter reports the first step of the development research part. This involved developing initial design propositions for implementing risk management within organizations. In this phase of the research, the objective was developing an initial conceptual model for risk management implementation, including the relevant key variables, as well as developing an audit instrument.

In the following section of this chapter, the design objective and the design specification for the conceptual risk management model are defined. These were based on the results of the foregoing exploration results. Next, the main design difficulties for risk management implementation are revealed and compared with designing the implementation of other types of innovation. By addressing these difficulties, as well as the design objectives and the design specification, design solutions for risk management implementation in organizations have been provided.

This chapter continues with presenting an initial conceptual *model* for risk management implementation. Furthermore, *key variables*, consisting of *key conditions* (situations) for implementing risk management within an organization and *key interventions* (actions) for generating these key conditions are derived. These key variables allow practical use of the conceptual model and served as basis for the development of the initial audit instrument. This audit instrument allows measuring and monitoring to which degree key conditions are present within an organization. Also, the audit instrument reveals to which degree key interventions for setting key conditions have been executed.
Together, the conceptual model and the audit instrument provide the initial design propositions for implementing risk management in organizations in the construction industry. This chapter concludes by presenting the main research results, the limitations, and the resulting next research step, which has been reported in the next chapter.

6.2 Development of a conceptual model for risk management implementation

Design objective for risk management implementation in organizations

The objective of the development research part, as presented in this chapter, is generating initial design propositions for realizing the entity of implemented risk management in organizations in the construction industry. This design task can be considered as providing a *realization design*, by using the terminology by Van Aken (2005b) that previously has been introduced in Section 2.4 about designing research. Within this chapter, a conceptual model with a series of key variables has been derived, together with an audit instrument for measuring and monitoring the degree and progress of risk management implementation within an organization. By recalling the concept of heuristic technological rules (Van Aken, 2005b), introduced in Section 2.2 about the design science framework, the conceptual model and the audit instrument aim to assist in finding pragmatic solutions for the problem of concern. This very problem is the practical field problem of implementing risk management in organizations. Therefore, the initial model and audit instrument aim to facilitate the context specific design of risk management implementation within an organization.

Design specification for risk management implementation

For meeting the objective, designing is usually performed on the basis of a set of specifications or requirements (Van Aken, 2008b). This approach is also followed for designing propositions for risk management implementation in organizations. By building forward on the results from the exploratory research, the risk management implementation approach should at least incorporate the two key propositions of this thesis:

Key Proposition 1: *Implementing risk management requires innovation management;*

Key Proposition 2: *Reducing hurdles and generating conditions require interventions by change management*.

Therefore, an initial risk management implementation approach that acknowledges both key propositions was required. According to Key Proposition 1, implementing risk management is similar to *implementing* an *innovation* in an organization. Furthermore, by referring to Key Proposition 2, implementation requires *interventions* for reducing hurdles and generating conditions. Therefore, by applying the principle of minimal design specification (Van Aken, 2008b), the following three *specific design criteria* have been defined:

1. The *conditions* and *interventions* for risk management implementation should be perceived *relevant* by the actors during and after the risk management implementation process;
2. There should be a *causal* and *positive relationship* between *interventions* and *conditions*, which means that executing interventions should generate the required conditions;
3. There should be a *causal* and *positive relationship* between the degree of presence of *conditions* for implementing risk management and the degree of *risk management implementation* within the organization. This implies that an increase in presence or strength of conditions, due to executed interventions, should increase the degree of risk management implementation within an organization.

Together, the three design criteria form the *design specification* for the *initial* risk management implementation proposition.

Design difficulties for risk management implementation

In view of the design of *risk management* implementation in organizations, a number of difficulties arise. These are due to the specific and merely unfavourable characteristics of risk management, when compared to other types of innovation. In Section 4.2.1, organizational, preventive, and user-based types of innovation have been introduced. The features of these types of innovation seem to correspond well with the inherent risk management characteristics.[135] First, managing risk by using risk management methodologies is an *organizational* type of innovation, because it brings a new way of thinking and working into (parts of) the organization. This will demand a certain degree of organizational adaptation. Second, managing risk is a *preventive* innovation, as it aims reducing, or even avoiding, the occurrence and negative effects of unwanted events (risks). Third, risk management is a *user-based* innovation, because of its focus on professionals (users) that have to apply risk management within their professional activities. Therefore, it has been concluded that, if new to an organization, *risk management* is an *organizational*, *preventive*, and *user-based* type of innovation. This implies presence of all of the implementation difficulties of these innovation types.

Additional concerns for the design of risk management implementation stem from Section 4.4, in which the main characteristics of innovations have been derived by synthesizing different data sources. Table 6.1 presents the assumed degree of presence of these main characteristics within risk management methodologies, based on the previously presented characteristics of risk management from an innovation management perspective. This table shows also whether low or high presence of the main innovation characteristics is favourable or unfavourable for implementation in an organization.

According to Table 6.1, only the commonly high degrees of *compatibility* (except name compatibility) and *triability* are favourable for risk management implementation. It is often very well possible to *try out* and *re-invent* or adapt generic risk management methodologies towards ones that have a good fit with social systems characteristics.[136]

The remaining characteristics of risk management methodologies, such as usually low relative advantage, low high complexity, low observablity, low indirect network externalities, and low relative usefulness, are unfavourable. For instance, regarding

135 This correspondence of the features of organizational, preventive, and user-based types of innovation supports Key Proposition 1: Implementing risk management requires innovation management.

136 An example is the GeoQ approach for geotechnical risk management. While the GeoQ risk management steps as such are rigid, the way of taking the steps is highly flexible. Taking these steps can be made fit-for-purpose within a particular construction project, which suits the degree of risk tolerance of the project stakeholders (Van Staveren, 2006).

relative advantage, the unwanted event that should be avoided by applying risk management is difficult to perceive, because it is a non-event. It is also difficult, if possible at all, to measure the direct or even indirect effects of risk management.[137] The inherent *complexity* of explicitly dealing with uncertainty, when managing risk, makes its implementation probably even more a challenge, than for instance implementing a balanced score card, or a business re-engineering programme.[138] The rather low *name compatibility* of risk management, amongst many researchers for instance revealed by Karstens et al. (2006), results from the negative meaning of the word risk for many people. Regarding *relative usefulness*, only if there is a direct relationship between the risk management user and his or her risk responsibility and liability, relative usefulness my become high and thus favourable for risk management implementation. Therefore, in conclusion, the main characteristics of risk management methodologies are largely *unfavourable*, from an implementation management point of view.

Table 6.1 Assessment of inherent risk management characteristics, from an innovation point of view.

Main innovation characteristics	Degree of presence of main innovation characteristics in risk management methodologies	Suitability of main innovation characteristics for risk management implementation
1. Relative advantage	*Low*, as risk management is a preventive innovation of which the relative advantage of using methodologies is usually not directly measurable and difficult to quantify to a reliable degree.	Unfavourable
2. Compatibility	*High*, because it is well possible to re-invent or adapt existing and generic risk management methodologies towards ones that have a good fit with social system characteristics. However, name compatibility is low, because of the rather negative meaning of the word risk.	Favourable (except low name compatibility)

137 According to Cozijnsen et al. (2002), one of the reasons for the relatively limited research about organizational implementation topics is the difficulty to measure implementation success. This seems particularly applicable for implementing risk management.

138 Considering specifically the implementation of discipline-based geotechnical risk management, there seems to be an *triple fuzziness*: (1) the inherent fuzziness of ground conditions and ground behaviour, the (2) the inherent fuzziness of the risk management methodologies, and (3) the inherent fuzziness of the social system.

Table 6.1 Continued

Main innovation characteristics	**Degree of presence of main innovation characteristics in risk management methodologies**	**Suitability of main innovation characteristics for risk management implementation**
3. Complexity	*High*, because it deals explicitly with uncertainty. Different actors will perceive the same factual information differently, because of the inherent difference in risk perception of people.	Unfavourable
4. Triability	*High*, because it is easy to try out risk management by applying its conventional and well-structured steps, which does not require specific software or otherwise large investments.	Favourable
5. Observability	*Low*, the application of risk management is only visible by rather abstract entities, like risk registers.	Unfavourable
6. Indirect network externality	*Low*, yet rising when interests of project stakeholders in risk management increase. For example, the number of clients requiring risk management within their construction projects seems to increase.	Unfavourable
7. Relative usefulness	*Low* to *high*, depending on whether the risk management user is directly responsible and liable for managing risks, or not.	Unfavourable to favourable

Furthermore, Rogers (2003) distinguishes *form*, *function* and *meaning* of innovations, which has been introduced in Section 4.2.1. These three features are significant for implementing organizational innovations in general, and for implementing *organizational*, *preventive*, and *user-based* sorts innovation, like risk management, in particular.

First, *form* is the direct observable appearance of an innovation. In general, management processes are abstract and do not have directly and clearly visible forms. Contrary to product innovations, such as new consumer electronics like MP3-players, risk management methodologies are not directly manifested by objects, other than guidelines, risk registers, or software. Therefore, in line with the discussion above, form-related features of risk management are only present to a rather limited extend.

Second, the *function* of an innovation is its contribution to social systems. The function of risk management implementation is effectively and efficiently managing risk within social systems. This functionality is also difficult to observe, because risk management has been classified as a *preventive* type of innovation. It is successful when an event is *not* happening. Therefore, the relative advantage, and thus the functionality, of adopting risk management is difficult to measure. While the objectives of preventive types of innovation are usually clear, it is difficult, if not impossible, to prove that prevention resulted solely from using the preventive innovation. Direct causal relationships between risk remediation measures and the risk of concern normally remain hidden. Because of this characteristic, the decision for adopting a preventive type of innovation, like risk management, depends largely upon the degree of risk propensity of the decision making individuals (usually managers) within social systems. Some sort of *believe* in functionality of risk management seems indispensable.

Third, according to Rogers (2003), the *meaning* of an innovation is the subjective perception of an innovation by the social system members. Because of this social construction, the meaning of risk management for its stakeholders is usually difficult to predict. It seems to be related to the foregoing mentioned believe in risk management. For preventive types of innovation, function and meaning approaches each other closely, because *perceived* functionality and *perceived* meaning are both subjective and socially constructed. By considering risk management a sort of innovation, the preventive function aligns well with the meaning of protecting individuals within their social systems against the effects of unwanted events. This may create a *feeling* of safety, which is usually difficult to translate and communicate in rational terms.[139]

In conclusion, when viewing risk management implementation from an innovation perspective, which seems to make sense, its form, function and meaning are largely intangible and subjective. These features add to the formerly raised difficulties in this sub-section. All of them largely determine the substantial design challenges for implementing risk management in organizations.

Design solutions for risk management implementation

Overcoming the previously presented difficulties with regard to designing risk management implementation in organizations requires specific design solutions. In Section 2.2 about the design science approach, the concept of *design causality* have been introduced. With reference to Numagami (1998), Van Aken (2004, 2008a) suggests applying design causality in design science, by studying how relatively

139 Particularly within financial and technical environments, its is common to *calculate* risk probability and its effects. However, according to Van Staveren (2006) and supported by others, such as Taleb (2007), any risk calculation is bounded by conscious and even unconscious assessments. Calculated risks are therefore much less objective, and thus much more subjective, than people often do realize. According to an often heard saying, Enderlie (2008:1) sais it as follows: "There are liars, damn liars, and statistics". In conclusion, risk calculations seem at best able to produce *apparent* objective figures.

invariant patterns arise and how these patterns can be changed.[140] Series of hurdles seem to form invariant patterns within organizations that are unfavourable for risk management implementation. Setting organizational conditions, by applying interventions, aim to reform unfavourable patterns into favourable ones for implementing risk management in organizations.

Also within Section 2.2, the idea of *technological rules* has been introduced. Technological rules originate from Bunge's philosophy of technology (Bunge, 1967 in Van Aken, 2004). *Heuristic technological rules* have been introduced and were compared with *algorithmic technological rules*, after Roozenburg and Eekels (1995) in Van Aken (2005b). While the latter algorithmic rules guarantee the finding of a solution by providing an instruction, heuristic technological rules do not guarantee a solution. A heuristic rule only facilitates *finding* of a solution. This seems to align well with the selected *hermeneutic* ontological position that considers the world as a *social construct* with inherent subjectivities. Therefore, heuristic technological rules may be able to suggest the appropriate series of conditions and interventions for implementing risk management in organizations.

Building forward on the concept of technological rules provided a promising design solution for implementing risk management in organizations. The technological rule by Bunge (1967) suggests logical prescription by considering context, intervention, and outcome: In context C, use intervention I, for Outcome O. Pawson and Tilley (1997) added *causality* to the intervention aspect, by considering generic mechanism(s) M of an intervention I, which produces an outcome O. Denyer et al. (2008) included this causality in Bunge's logic of prescription, by introducing the CIMO-logic. For achieving outcome O in context C, use intervention I to invoke the required generic mechanism(s) M. By incorporating the elements context and mechanisms, a *heuristic* type of causality has been developed.[141]

The difficulties for risk management implementation design, noticed in the previous sub-section, seem to be even more serious and complicated than conventional organizational design difficulties. Therefore, and particularly because of the well-structured and heuristic character of its causality, the CIMO-logic has been selected for overcoming the difficulties for risk management implementation design.

140 For instance, Romme (2003) adopted this suggestion.

141 Contrary to heuristic causality, an algorithmic rule would only incorporate intervention and outcome, which represents direct cause and effect relationships.

The CIMO-logic seems applicable for implementing risk management at two grades:

1. At single key condition grade: Intervention (I) for realizing the outcome (O) of a realized or strengthened key condition, within an organizational context (C), by triggering a mechanism (M) within one of the five intervention perspectives. Key condition = O = C (I, M);
2. At overall risk management implementation grade, which is the aggregate of the single key conditions: A set of interventions (I) for realizing the outcome (O) of implemented risk management, within the organizational context (C), by triggering a variety of mechanisms (M) within the five intervention perspectives. Risk management implementation = a series of key conditions = ∑ O = ∑ C (I, M).

The overall risk management implementation grade is applicable to the three distinct levels of risk management that resulted from the exploratory research: (1) discipline level, (2) project level, and (3) organizational level. Table 6.2 demonstrates the relationship of the CIMO-logic with related main aspects of the risk management implementation.

6

Table 6.2 CIMO-logic compared with risk management implementation.

CIMO-logic terminology and description (after Denyer et al., 2008)		**Main aspects of risk management implementation in organizations**
Context	All relevant external and internal features of an organization, including the nature of human actors that influence (change of) behaviour.	Social system in which risk management methodologies have to be implemented.
Interventions	Actions that managers can take for influencing behaviour of employees. The nature of the intervention, as well as how it is executed, are relevant.	Interventions for realizing appropriate conditions for risk management methodologies and social systems.
Mechanisms	Underlying generative forces that are triggered by the interventions and generate an outcome.	Five distinct intervention perspectives (autonomous, rational, emotional, learning, and political).
Outcome	The intended result by undertaking interventions within an organization.	Realized key conditions, which should result in implemented risk management methodologies within an organization.

Obviously, in addition to the CIMO-logic and the concept of compensating mechanisms, there are other and alternative approaches for designing propositions for risk management implementation. Examples are systems engineering (SE) and particularly soft systems methodologies (SSM), which addresses soft organizational issues. The latter has been at first introduced by Checkland (1981) and applied for product and process innovation by for instance Presley et al. (2000). Checkland (2000: 28) presents a so-called PQR causality, which he describes as root definitions: "Do P by Q in order to contribute to achieving R."[142] This PQR sequence expresses what to do, how to do it, and why to do it. However, explicit guidelines, beyond generic suggestions, seems to be missing (Pala et al., 2003). In addition, the four main activities of the soft systems methodology are rather generic. Moreover, they are too generic to serve as basis for a conceptual model for risk management implementation.[143] Therefore, while doubtless valuable in many areas of research and consultancy, the soft systems methodology proved to be no alternative for the more specific CIMO-logic. Finally, as for instance highlighted by Oliver et al. (1997), systems engineering is applicable for designing technical processes, as well as management processes. However, the rather technically and rational systems engineering approach will probably undervalue the relevance of the socio-organizational context with the complexity human agency, in which risk management has to be implemented. In conclusion, because of the well-structured and heuristic character, the CIMO-logic has been selected. It served as basis for developing the initial conceptual model for risk management implementation, for deriving key conditions and key interventions for the model, as well as for the audit instrument. The latter aims measuring and monitoring risk management implementation progress within an organization.

Conceptual model for risk management implementation

Daft (1998) describes organizational *complexity* as a situation in which diverse elements interact and influence the organization. So far, all research results indicate that implementing risk management within an organization inhibits high, probably even very high, complexity. The exploration research provided a considerable number of concepts and an even much larger number of variables. Many of these seem to interact with each other. Furthermore, there proved to be very limited agreement, if agreement at all, amongst experts on the relative degree of relevance of the variables. Moreover, the previously mentioned specific risk management characteristics and features, which resulted from the innovation management

142 Despite the similarity with PQR-causality, prescriptive technological rules are not mentioned in Checkland (2000).

143 The four main activities in applying the soft systems methodology are (1) finding out about a problem situation, (2) formulating some relevant purposeful activity models, (3) debating the situation, using the models and deriving changes for improving the situation, while accomodating conflicting interests, and (4) taking action to realize the targeted improvement (Checkland, 2000).

perspective, revealed substantial complexity for implementing risk management within organisations. Therefore, given the defined initial design criteria, it has been decided to start with developing a *conceptual model* for risk management implementation.

Van Aken (2008b) presents a *model* as an entity that by definition *reduces reality*. Only a limited number of concepts and variables of the entity of concern have to be incorporated in a model. The remaining ones are simply left out. This implies that the real entity includes many hidden properties, which are not included in the model. A good model should include only those concepts and variables that are required, as well as sufficient, for the effective and efficient realization of the entity in practice. Despite this simplification of reality, a good model is necessary, as well as sufficient, for realizing the targeted entity. Because of the demonstrated high complexity of the reality of implementing risk management in organizations, a considerable reality reduction was highly demanded. De Bono (1998) defines concepts as *mental models* for simplifying reality. Apparently, conceptual models are immaterial. This revealed the need for a *conceptual model* for risk management implementation.

The initial conceptual model for risk management implementation builds on several concepts resulting from the exploration research. The model synthesizes the framework with *hurdles* and *conditions* for implementing innovations in organizations (of Section 4.3 about analyzing innovation management) with five *intervention* perspectives (of Section 5.3 about analyzing change management). *Hurdles* and *conditions* for risk management methodologies and social systems were disinguished. For both categories, relevant characteristics and subcharacteristics were derived. Consequently, the resulting *initial* conceptual model for risk management implementation involved three main dimensions:

1. A *risk management* dimension with conditions for risk management methodologies;
2. A *social system* dimension with conditions for social systems, in which risk management methodologies are to be implemented;
3. An *intervention* dimension with five intervention aspects. These aim generating conditions for risk management methodologies and social systems.

Figure 6.1 presents the resulting conceptual model for risk management implementation. This model indicates that providing *conditions* for risk management methodologies, as well as for social systems (in which the risk management methodologies are implemented), is essential for risk management implementation

6

within (part of) an organization. These conditions can be generated by executing *interventions*. Five intervention aspects are distinguished: (1) autonomous, (2) rational, (3) emotional, (4) learning, and (5) political aspects. Interventions belonging to an intervention aspect should be able to generate conditions with dominating features of the same aspect. Conditions for risk management methodologies and social systems provide their appropriate characteristics and subcharacteristics.[144] As this research indicated so far, these favourable characteristics seem indispensable for realizing risk management implementation in an organization.

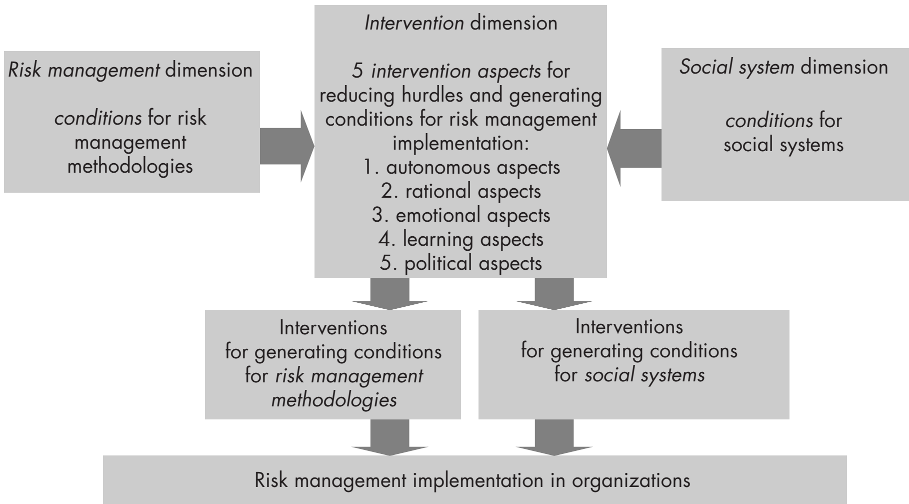

Figure 6.1 The *initial* conceptual model for risk management implementation in organizations.

Within the initial risk management implementation model, the five *intervention perspectives* of Section 5.3 have been transformed into five *intervention aspects*, because the latter seem to better represent their role from a systems thinking point of view. By referring to Checkland and Scholes (1990) and Hatch (1997), Peters and Westelaken (2008) describe a system as a collection of elements with relationships between the each other.[145] These relationships cause interaction and exchange. In addition, distinct elements influence each other. Systems can be an aggregate of a number of smaller systems. Amongst only a few scholars, Peters and Westelaken (2008) distinguish two nested types of systems: (1) subsystems and (2) aspect

144 These (sub)characteristics have been presented in Section 5.4 about the classification of all identified hurdles and conditions for implementing innovations, as well as for applying risk management.

145 These elements are either objects, such as bridges and organizations, or subjects (people).

systems.[146] In their view, *subsystems* are a *collection* of a number of *elements* of a system. All original relationships between the elements remain unchanged. When an organization is a system, its departments may be the subsystems. Moreover, Peters and Westelaken (2008) consider *aspect systems* a collection of part of the *relationships* within a system. By the same example of considering an organization as a system, marketing processes, including the parts of subsystems that are involved in marketing, may be considered an aspect system.

In view of the exploration research results and the objective of this research, a slightly different definition of subsystems and aspect systems has been chosen within this research. A *system* remains defined as a set of elements, but now with distinct *properties*, in addition to the set of *relations*. These relations connect all of the elements of the system with each other. By this revised definition, the distinct properties are the criterion distinguishing subsystems from aspects systems, rather than the relations in the approach by Peters and Westelaken (2008). Here, a *subsystem* contains a subset of the elements of a system, with their *relations* and their distinct set of *properties*. An *aspect system* contains *all* of the elements of the system, thus *all* subsystems, but with the *subset* of the original properties of only *one* subsystem. The relations between the elements within aspect systems remain the same. Figure 6.2 and Figure 6.3 show the differences between subsystems and aspect systems. These are applicable for hard technological systems, as well as for soft social systems.

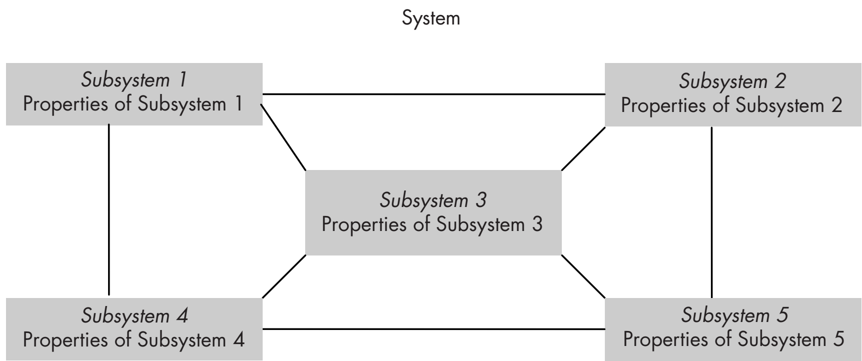

Figure 6.2 A system with five interrelated subsystems.

146 Peters and Westelaken (2008) refer to Checkland (1981), Hatch (1997), and Senge (1990) for further information about systems thinking. Remarkably, in the considerable amount of other rather recent literature about particularly soft systems thinking, including Checkland (2000), Checkland and Winter (2006), Connell (2001), Pala et al. (2003), Presley et al. (2000), Reisman and Oral (2005), the distinction between subsystems and aspect systems has not been encountered.

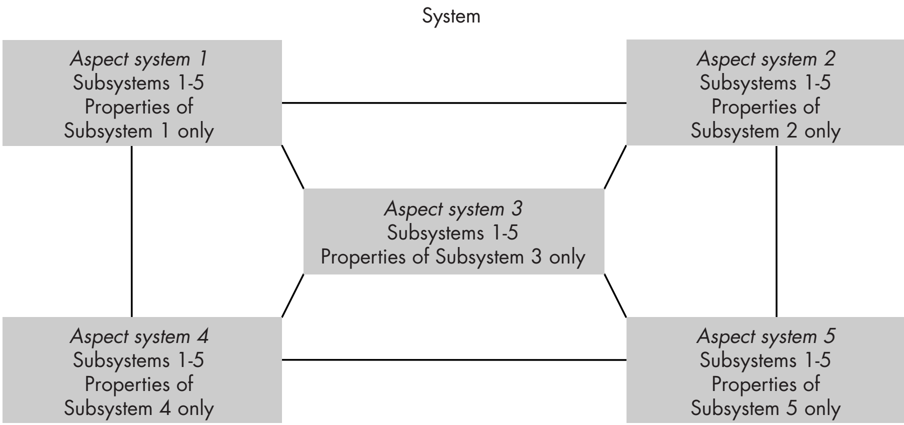

Figure 6.3 A system with five interrelated aspect systems.

Figure 6.4 shows the five intervention aspects for a system, which may be either a hard system of risk management methodologies, or a soft social system as part of an organization. This approach implies that for changing conditions within an aspect of a system, executing interventions for that particular aspect are required. Any social system has autonomous aspects, rational aspects, emotional aspects, learning aspects, and political aspects. For instance, a presentation by top management has a rational aspect (its content), an emotional one (if the presentation builds on emotions like the will to win from competition or the fear of losing) and a political one (one tends not to argue with the views of ones boss). An example of a rational intervention for changing the rational aspect system is writing and disseminating a technical report. Examples of political interventions for changing the political aspect system are orders or appointments. Therefore, interventions with strong political aspects have to change the political aspect system. Interventions for changing conditions of the rather hard system of risk management methodologies are probably mainly part belonging to rational aspects.

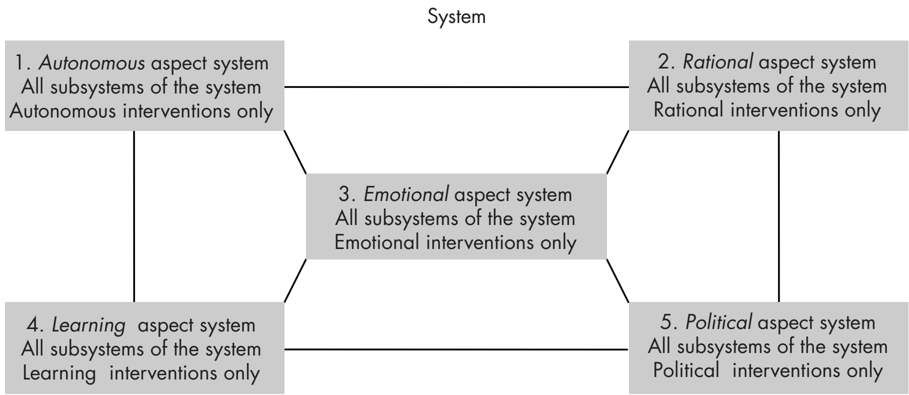

Figure 6.4 A system with five interrelated intervention aspects.

Key variables for the conceptual model

By building on the CIMO-logic (Denyer et al., 2008), the initial conceptual model for risk management implementation suggests causal relationships between risk management implementation conditions and interventions, for providing those conditions. The conditions are embedded in the risk management dimension and a social system dimension of the model. Five types of intervention have been distinguished by five intervention aspects. This causally relates conditions to interventions, within each intervention aspect. However, large numbers of hurdles, conditions, and interventions have been identified during the exploratory part of the exploration research. Therefore, for generating practical usefulness of the conceptual model for risk management implementation, a major question demanded an answer:

– Which of the 109 hurdles and 147 conditions for applying risk management, the 55 hurdles and 93 conditions for implementing innovations, and the 76 interventions can be *combined* and *clustered*, without loosing their relevance?

This very question raised a need for deriving a set of *key* hurdles, *key* conditions, and *key* interventions out of the huge data set with variables from the exploration research. These *key variables* should be considered as the most relevant hurdles, conditions, and interventions for realizing risk management implementation within an organization. Knowing the key variables would provide practical relevance of the conceptual model for risk management implementation. Only then, some sort of guidance would emerge, about which conditions are to be set by which interventions, for generating appropriate characteristics of the hard systems of risk management methodologies and of the soft social systems in organizations. Therefore, the derivation of key variables is the topic of the next section.

6.3 Derivation of key conditions and key interventions

During the exploratory research, the relevant characteristics and subcharacteristic have been derived for the risk management methodologies and social systems. The risk management methodology dimension includes 7 characteristics and 11 subcharacteristics. The social system dimension has 4 characteristics and 12 subcharacteristics. All identified hurdles and conditions were already classified according to these (sub) characteristics in Chapter 3 through to Chapter 5 about risk management, innovation management, and change management. Based on these and the previously presented conceptual model for risk management implementation, *key* conditions and *key* interventions have been derived in three subsequent steps:

1. Derivation of key conditions for the risk management methodologies and social systems;
2. Allocation of these key conditions to the five intervention aspects;
3. Derivation of key interventions for generating key conditions within each intervention aspect.

Executing these three steps, which is explained next, generated 41 *key conditions* for implementing risk management within the social system of an organization, as well as19 *key interventions* for setting these key conditions.

Step 1: Derivation of key conditions

The *key conditions* are derived by an in-depth analysis of all identified hurdles and conditions for applying risk management, as well as for implementing innovations. These variables were identified from the literature research and from the field research. During the synthesizing part of the exploratory research, all identified hurdles and conditions have been attributed to the characteristics or subcharacteristics of innovations, such as risk management, and social systems.

During this designing research step, for each characteristic or subcharacteristic the corresponding sets of hurdles and conditions have been thoroughly analyzed. By considering hurdles as the *mirror-side* of conditions, all hurdles from the previous research steps were transformed into conditions. In a formula:

$$H + C = 100\ \%$$

In this formula, C stands for a condition and H stands for the corresponding hurdle. The 100 percent value represents the total presence of a hurdle and the corresponding (mirror-side) condition in an organization. Figure 6.5 presents the assumed causal relationship between hurdles, conditions, and interventions.

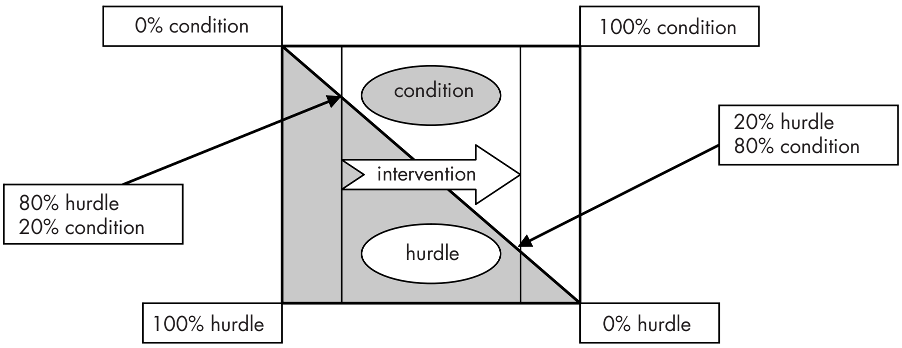

Figure 6.5 The relationship between hurdles, conditions, and interventions.

The purpose of Figure 6.5 is showing schematically that any intervention aims to transform the hurdle-side of a characteristic or sub-characteristic to the condition-side of the same characteristic or subcharacteristic. By executing interventions, hurdles of (sub)characteristics of risk management methodologies, as well as social systems, can be transformed into conditions.

Let us for example consider the subcharacteristic of *incentive advantage* for risk management methodologies. This characteristic can be a *hurdle*, when applying the risk management methodologies does not provide any incentive advantage at all, or only a (too) small incentive advantage that does not motivate potential risk management users. The same subcharacteristic can become a *condition*, when framed as providing sufficient incentives for motivating targeted users for applying risk management methodologies. Such incentives generate benefits for individual

users. Therefore, the presence of incentives within an organization may contribute to the routinized application or implementation of risk management methodologies.
Obviously, Figure 6.5 presents a theoretical situation, in which a hurdle-side of a (sub)characteristic is present for 80 percent.[147] The condition-side of the (sub) characteristic is already present for 20 percent. This example implies that some favourable aspects for creating incentive advantage are present within the organization. Executing an intervention, presented by the arrow in the figure, reduces the hurdle to only 20 percent, and consequently increases the condition up to 80 %.[148] However, in practice this seems not feasible in most situations, given the complexity and interrelatedness of the many factors that together determine implementation success.
Next, all of the single hurdles and conditions from different data sources, which have been classified by the same characteristics or subcharacteristic of the risk management dimension and the social system dimension within Section 4.4, have been compared. If hurdles and conditions within one subcharacteristic could be considered similar, then these were clustered into one condition. This exercise combined three types of triangulation presented by Patton (1987) in Yin (2003):

1. *Methodology triangulation*, by comparing and clustering hurdles and conditions that were retrieved from exploring risk management methods and innovation management methods;
2. *Data triangulation*, by comparing and clustering the variety of hurdles and conditions from the literature and the field research data;
3. *Investigator triangulation*, by comparing and clustering the results from of the interviewed experts in applying risk management and implementing innovations.

In other words, by using the characteristics and subcharacteristics of risk management methodologies and social systems as classification criteria, the 109 hurdles and 147 conditions for *applying risk management*, together with the 55 hurdles and 93 conditions for *implementing innovations* have been transformed into 41 *key* conditions for *implementing risk management* within an organization. The analysis resulted in deriving at least one key condition for each characteristic or subcharacteristic of the two main dimensions of risk management methodologies and social systems. In view of the conceptual model for risk management

147 In reality, these percentages are at best assessments.

148 In an ideal situation, even percentages of a zero percent hurdle and a hundred percent condition would be possible.

implementation, the resulting key conditions should be acknowledged when implementing risk management within an organization. In total 18 key conditions were related to risk management methodologies and in total 22 key conditions were related to social systems. Figure 6.6 presents the process followed for deriving key conditions that are required for implementing risk management within organizations.

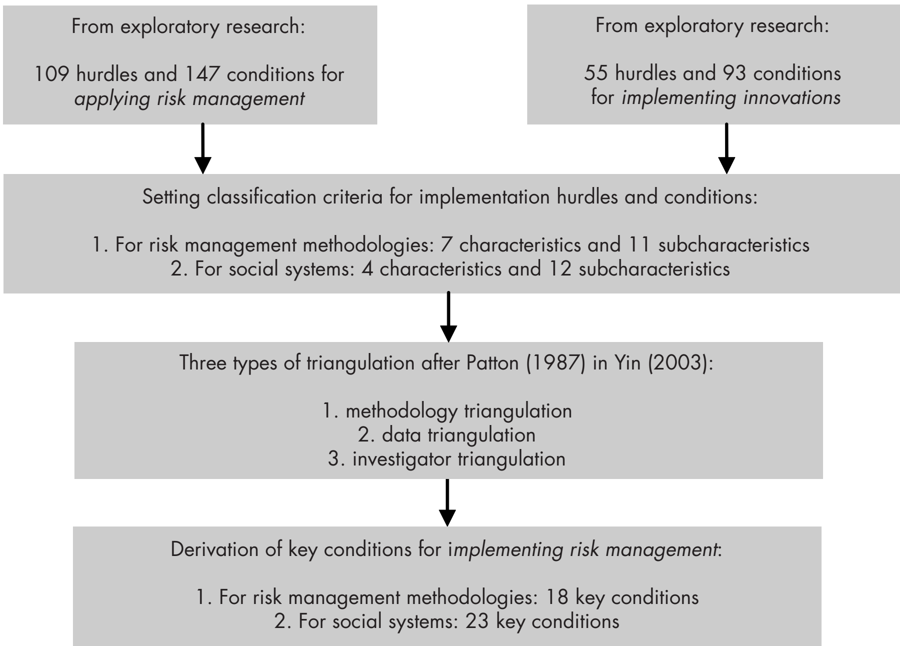

Figure 6.6 Process for deriving key conditions for the initial risk management implementation model.

A number of examples have been provided to demonstrate how key conditions have been derived for risk management methodologies and social system dimensions. Appendix 7 starts with an overview of the numbers of tables with descriptions of hurdles and conditions serving as basis for deriving key conditions for *risk management methodologies*. Furthermore, Appendix 7 presents an example for deriving a key condition for the relative advantage characteristic and the economic relative advantage sub-characteristic of risk management methodologies. Similarly, Appendix 8 gives an overview with the numbers of tables with descriptions of hurdles and conditions, which served as basis for deriving key conditions for *social systems*. In addition, Appendix 8 presents an example for deriving key conditions for the social system characteristic of social structure and its sub-characteristic of control, coordination, and responsibility.

By this process, in total 18 key conditions for risk management methodologies and 23 key conditions for social systems have been derived. Table 6.3 and 6.4 present the derived key conditions for respectively the characteristics and sub-characteristics of risk management methodologies and social systems. The *order* of the key conditions in Table 6.3 and Table 6.4 stems from the arbitrary numbering (thus without decreasing relevance) of the characteristics and sub-characteristics of risk management methodologies and social systems. The *numbers* of the key conditions in the outer right column of Table 6.3 and Table 6.4 are only for identification purposes. They do not reflect any relative relevance of the key conditions to each other, which was considered of no concern anymore. Because they were considered *key* conditions, *each* of the entire set is relevant for risk management implementation and should therefore be acknowledged during the implementation process.

Table 6.3 Key conditions for characteristics and subcharacteristics of risk management methodologies.

Risk management methodologies		Key conditions	
Characteristics	**Subcharacteristics**	**Description**	**No.**
1. Relative advantage	1.1 economic advantage	Applying risk management methodologies increases effectiveness or efficiency.	1
	1.2 social status advantage	Applying risk management methodologies increases social status.	2
	1.3 over adoption advantage	Avoidance of tool pre-occupation of the risk management methodologies.	3
	1.4 preventive advantage	Applying risk management methodologies generates preventive advantage by increased risk sensitivity.	4
	1.5 incentive advantage	Applying risk management methodologies generates supportive attitudes by its users.	5
	1.6 mandate advantage	Top management mandates applying risk management methodologies.	6
2. Compatibility	2.1 values and beliefs compatibility	Applying risk management methodologies fits with values and beliefs.	7
	2.2 previous ideas compatibility	Applying risk management methodologies is integrated in existing organizational practices.	8
	2.3 needs compatibility	Applying risk management methodologies fulfils needs of actors and stakeholders.	9
	2.4 technology cluster compatibility	Applying risk management methodologies increases organizational innovativeness.	10
	2.5 name compatibility	Applying risk management methodologies generates a positive meaning for actors and stakeholders.	11
3. Complexity	-	Applying risk management methodologies has an acceptable complexity for its users.	12
4. Triability	-	Risk management methodologies are easy to try out by the targeted users.	13
5. Observability	-	Availability of benchmarks during the risk management implementation progress.	14
		Availability of business cases that demonstrate results of applying risk management methodologies.	15
6. Indirect network externality	-	External parties request the application of risk management.	16
7. Price	-	Applying risk management methodologies has an acceptable cost.	17
8. Relative usefulness	-	Applying risk management methodologies is useful and reliable for its targeted users.	18

Table 6.4 Key conditions for characteristics and subcharacteristics of social systems.

Social systems		**Key conditions**	
Characteristics	**Subcharacteristics**	**Description**	**No.**
1. Social structure	1.1 control, coordination, and responsibility	Presence of organization-wide risk management methodologies.	1
		Presence of formalized risk management responsibility.	2
		Presence of lowest-level risk management responsibility.	3
		Presence of formalized risk management reporting to senior management.	4
	1.2 stable or change and innovation prone	Presence of flexibility to risk management improvements.	5
	1.3 internal or external focus	Inclusion of the external environment in risk management processes.	6
2. Norms	2.1 basis of truth and rationality	Presence of shared risk awareness and understanding.	7
		Co-existence of risk rationality and emotions.	8
		Understanding of risk management interfaces.	9
	2.2 nature of time and its horizon	Permanent attention to risk management resistance.	10
	2.3 motivation and commitment	Acceptance of different risk management motivations.	11
	2.4 work, task, and co-worker orientation	Presence of institutionalized risk management learning behaviour.	12
	2.5 isolation or cooperation	Institutionalized sharing of risk information.	13
		Understanding of different risk perceptions.	14
3. Innovation roles	3.2 opinion leaders	Presence of risk management opinion leaders.	15
	3.3 champions	Presence of risk management champions.	16
4. Innovation decision	4.2 collective	Shared decision making about risk management implementation.	17
5. Innovation consequences	5.1 (un)desirable	Acceptance of risk management consequences.	18
	5.2 (in)direct	Acceptance of initial efficiency reduction.	19
		Acceptance of lacking direct risk management results.	20
		Presence of risk management implementation milestones.	21
	5.3 (un)anticipated	Acceptance of unanticipated risk management results.	22
	5.4 (un)equal	Understanding of conflicts arising from applying risk management.	23

Step 2: Allocation of key conditions to five intervention aspects

Next, the 18 key conditions for risk management methodologies and the 23 key conditions for social systems have been allocated to the five intervention aspects, which have been introduced and motivated in Section 6.2. The roots of these interventions aspects, the five intervention perspectives, have been presented in discussed in Section 5.3 in Chapter 5 about exploring change management. These five intervention aspects are:

1. The *autonomous* aspect;
2. The *rational* aspect;
3. The *emotional* aspect;
4. The *learning* aspect;
5. The *political* aspect.

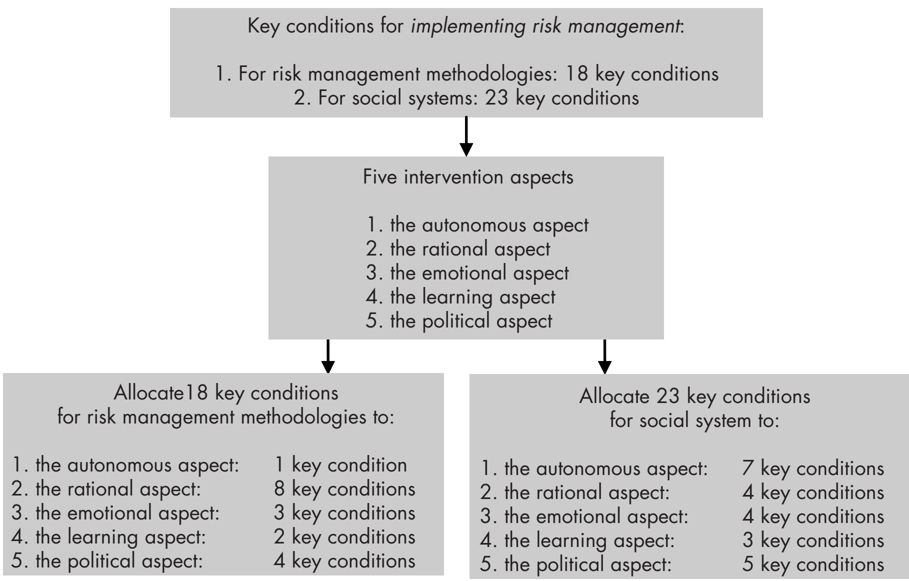

Figure 6.7 Process of allocating key conditions to five intervention aspects.

By considering their characteristics and sub-characteristics, each key condition has been allocated to the most suitable intervention aspect. For instance, the social system key condition of the presence of formalized risk management reporting to senior management (key condition number 4 in Table 6.3) belongs to the social system characteristic of social structure, and particularly to the sub-characteristic of control, coordination, and responsibility. This sub-characteristic is attributed to the rational aspect, because control, coordination, and responsibility are more closely related to the logical way of thinking and acting of the rational aspect, than to the features of the remaining intervention aspects. Figure 6.7 (previous page) presents the allocation process of all derived key conditions to the five intervention aspects.

Table 6.5 and Table 6.6 show the allocation of the key conditions to intervention aspects for respectively risk management methodologies and social systems. The numbers of the key conditions in the outer right columns of Table 6.5 (about risk management methodologies) and Table 6.6 (about social systems) correspond with the numbers of the key conditions in respectively Table 6.3 (about risk management methodologies) and in Table 6.4 (about social systems). Because of the fact that the key conditions have been related to their corresponding intervention aspects, the increasing order of the numbers in Table 6.3 and in Table 6.4 is disturbed in Table 6.5 and in Table 6.6.

Table 6.5 Allocation of key conditions to intervention aspects for risk management methodologies.

Intervention aspects	**Key conditions for risk management methodologies**	
	Description	**No.**
Autonomous	Applying risk management methodologies generates preventive advantage by increased risk sensitivity.	4
Rational	Applying risk management methodologies increases effectiveness or efficiency.	1
	Avoidance of tool pre-occupation of the risk management methodologies.	3
	Applying risk management methodologies is integrated in existing organizational practices.	8
	Applying risk management methodologies has an acceptable complexity for its users.	12
	Risk management methodologies are easy to try out by its targeted users.	13
	Availability of benchmarks during the risk management implementation progress.	14
	Availability of business cases that demonstrate results of applying risk management methodologies.	15
	Applying risk management methodologies has an acceptable cost.	17
Emotional	Applying risk management methodologies generates supportive attitudes by its users.	5
	Applying risk management methodologies fits with values and beliefs.	7
	Applying risk management methodologies fulfils needs of actors and stakeholders.	9
Learning	Applying risk management methodologies increases organizational innovativeness.	10
	Applying risk management methodologies is useful and reliable for its targeted users.	18

Table 6.5 Continued

Intervention aspects	Key conditions for risk management methodologies	
	Description	**No.**
Political	Applying risk management methodologies increases social status.	2
	Top management mandates applying risk management methodologies.	6
	Applying risk management methodologies generates a positive meaning with actors and stakeholders.	11
	External parties request the application of risk management.	16

Table 6.6 Allocation of key conditions to the intervention aspects for social systems.

Intervention aspects	Key conditions for social systems	
	Description	**No.**
Autonomous	Inclusion of the external environment in risk management processes.	6
	Co-existence of risk rationality and emotions.	8
	Understanding of risk management interfaces.	9
	Understanding of different risk perceptions.	14
	Acceptance of lacking direct risk management results.	20
	Acceptance of unanticipated risk management results.	22
	Understanding of conflicts arising from applying risk management.	23
Rational	Presence of organization-wide risk management methodologies.	1
	Permanent attention to risk management resistance.	10
	Acceptance of initial efficiency reduction.	19
	Presence of risk management implementation milestones.	21
Emotional	Acceptance of different risk management motivations.	11
	Institutionalized sharing of risk information.	13
	Shared decision making on risk management implementation.	17
	Acceptance of risk management consequences.	18
Learning	Presence of flexibility for risk management improvements.	5
	Presence of shared risk awareness and understanding.	7
	Presence of institutionalized risk management learning behaviour.	12
Political	Presence of formalized risk management responsibility.	2
	Presence of lowest-level risk management responsibility.	3
	Presence of formalized risk management reporting to senior management.	4
	Presence of risk management opinion leaders.	15
	Presence of risk management champions.	16

Step 3: Derivation of key interventions for generating key conditions

Finally, according to the initial conceptual model for risk management implementation, executing *key interventions* should generate the required *key conditions* for implementing risk management in organizations. In Section 5.4 of the exploratory research about change management, identified interventions from literature and field research have been classified by the five intervention perspectives. The classification has been performed for the two dimensions of risk management methodologies and social systems. The five intervention perspectives became five intervention aspects in Section 6.2: (1) the autonomous aspect, (2) the rational aspect, (3) the emotional aspect, (4) the learning aspect, and (5) the political aspect.

Within this Step 3, the 18 key conditions for risk management methodologies and the 23 key conditions for social systems have been allocated to the five intervention aspects. For each of the key conditions within an intervention aspect, one or more key interventions have been derived. Figure 6.8 and Figure 6.9 present the process for deriving key interventions for respectively risk management methodologies and social systems dimension.

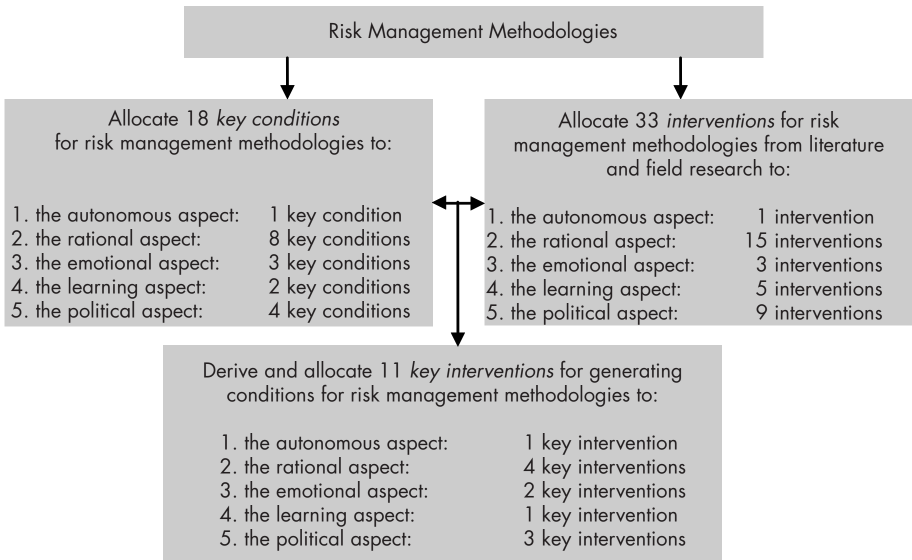

Figure 6.8 Process for deriving key interventions for risk management methodologies.

For reasons simplicity, the number of key interventions for each set of key conditions within an intervention aspect is kept as limited as reasonable. Obviously, individual interventions, which have been merged into the key interventions, may be useful for the execution of context specific key interventions during the risk management implementation process. Nevertheless, the *key* interventions provide the main intervention directions within each of the five intervention aspects. The underlying single and originally derived interventions from the literature survey and field data can be used as some sort of knowledge base for further specifying the execution of key interventions within specific organizational contexts.

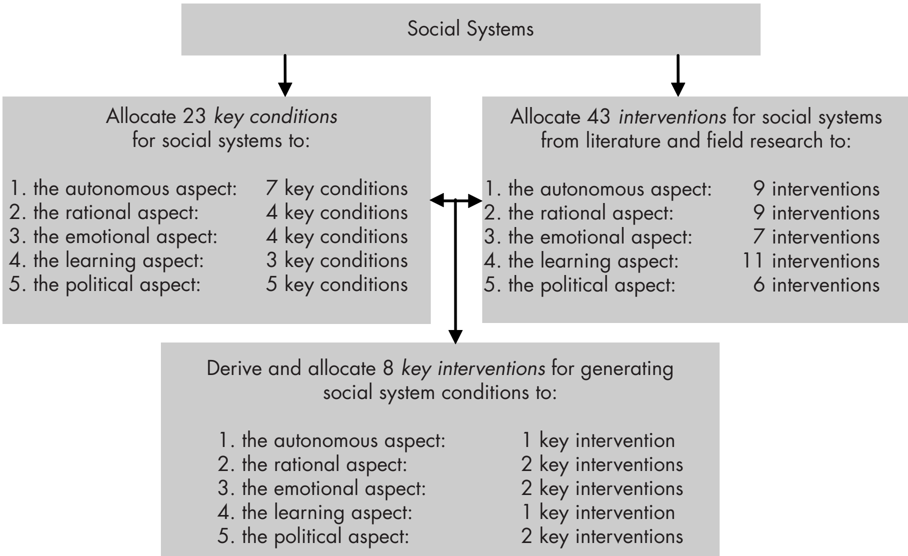

Figure 6.9 Process for deriving key interventions for social systems.

A similar in-depth analysis for deriving key interventions, as previously described for deriving key conditions in Step 1 has been applied. The 76 interventions from the literature survey and field data in the exploratory research served as the data source for the key interventions. Two assumptions for deriving the key interventions were:

1. Key interventions with dominating features of one of the five intervention aspects would be able to set or strengthen key conditions with similar dominating features;

2. One key intervention within an intervention aspect may set or strengthen more than one key condition that has been attributed to the same intervention aspect.

The following example aims to motivate these assumptions. A set of key conditions for risk management methodologies (in Step 1) has been attributed to the *rational* intervention aspect (in Step 2). Rational aspects, such as rational thinking, are the most significant features of these key conditions. By recalling the CIMO-logic of context-intervention-mechanism-outcome (Denyer et al, 2008), this implies that *rational mechanisms* would be required for setting or strengthening these key conditions. Therefore, execution of *rational* types of key intervention would be required. In Section 5.4 about the classification of interventions, 3 rational types of intervention were retrieved from the literature. Moreover, in total 13 rational interventions were derived from the field data. From the aggregate of 16 available interventions that could be classified rational, 4 key interventions have been derived.

Appendix 9 shows an overview with numbers of previously presented tables with descriptions of interventions for risk management methodologies. For an example, this appendix also shows the 16 interventions from the literature survey and field data, as well as the derived four key interventions that are part of the rational intervention aspect.[149] Similarly, Appendix 10 presents an overview of the numbers of previously presented tables with descriptions of interventions for social systems. These also served as basis for the derived key interventions. Moreover, Appendix 10 presents an example for deriving an autonomous type of key intervention for setting social system key conditions.

Table 6.7 and Table 6.8 list the derived key interventions for setting key conditions for respectively risk management methodologies and social systems. The *order* of the key interventions within each intervention aspect in Table 6.7 and Table 6.8 is arbitrary and stems from the followed research process. Therefore, the *numbers* of the key interventions in the outer right column of Table 6.7 and Table 6.8 are for identification purposes only. They do not reflect any relative relevance of key interventions to each other, which was considered of no concern anymore. Because of being *key* interventions, *each* of them is relevant for risk management implementation and should be acknowledged during the implementation process.

149 The key interventions from the rational intervention aspect are numbered from 2 to 5. This is because key intervention number 1 belongs to the autonomous intervention aspect.

Table 6.7 Key interventions for setting conditions for risk management methodologies.

Intervention aspect	Key interventions for setting conditions for risk management methodologies	
	Description	**No.**
Autonomous	Foster self-monitoring and self-evaluation of risk management processes	1
Rational	Ensure positive financial bottom line effects of the risk management implementation	2
	Create risk management fit by re-designing existing work processes and by risk management inclusion in existing management practices	3
	Generate RM support by appropriate methodologies, tools, and assistance	4
	Set, monitor, and communicate risk profiles	5
Emotional	Assess and reward risk management use by employees	6
	Adapt the risk management methodology	7
Learning	Explicitly demonstrate and communicate the value of applying risk management	8
Political	Enforce risk management accreditation	9
	Ensure explicit top management commitment by defining targeted risk profiles	10
	Mobilise external forces that require risk management application	11

Table 6.8 Key interventions for setting conditions for social systems.

Intervention aspect	Key interventions for setting conditions for social systems	
	Description	**No.**
Autonomous	Arrange out-of-the-box thinking sessions	1
Rational	Provide sufficient time and budget for risk management implementation with sufficient organizational redundancy	2
	Apply a staged implementation process with measurable objectives, explicit decision making, and points of no return	3
Emotional	Combine situational leadership with well-balanced teams	4
	Organise social gatherings	5
Learning	Provide education by a mixture of courses, training, coaching, and after action review sessions	6
Political	Execute task, responsibilities, and authorities (TRA) sessions	7
	Establish a risk management board	8

Table 6.9 summarizes the numbers of resulting key interventions and corresponding key conditions, for each of the five intervention aspects, in the risk management methodologies and the social system dimension.

Table 6.9 The number of key conditions and key interventions for the risk management implementation model.

Main dimension	Five intervention aspects for generating key conditions for implementing risk management		Key interventions (number)	Key conditions
Risk management methodologies	Autonomous aspect		1	1
	Rational aspect		4	8
	Emotional aspect		2	3
	Learning aspect		1	2
	Political aspect		3	4
		Subtotal	11	18
Social systems	Autonomous aspect		1	7
	Rational aspect		2	4
	Emotional aspect		2	4
	Learning aspect		1	3
	Political aspect		2	5
		Subtotal	8	23
		Total	19	41

In summary, *key conditions* are connected with *key interventions* within each of the five intervention aspects. In total 11 key interventions were related to 18 key conditions for the risk management methodologies. In total 8 key interventions were related to 23 key conditions for the social systems, in which the risk management methodologies will be implemented. Based on the research so far, presence of these key conditions seemed essential for establishing appropriate characteristics and subcharacteristics of risk management methodologies and social systems. This has been considered indispensable for risk management implementation in organizations.

6.4 Development of an audit instrument for risk management implementation

Next, an initial *audit instrument* for risk management implementation has been developed. The instrument allows measuring and monitoring to which degree the 41 key conditions are present in an organization. In addition, the instrument allows measuring and monitoring to which degree the 19 key interventions are executed within an organization.

According to the presented relationship between key conditions, key interventions, and risk management implementation, by following the CIMO-logic by Denyer et al. (2008), measuring the degree of presence of key conditions in an organization should provide insight in the degree of risk management implementation within that organization. By measuring to which degree key interventions of the five intervention aspects have been executed, additional information will be gained about the effectiveness of these interventions for generating the targeted levels of key conditions. By considering the theories of planned change underlying the five intervention aspects, insight will be gained about whether different types of interventions, with their different types of underlying mechanisms, are required for realizing the implementation of risk management in an organization. This latter aspect seems particularly important because organizations in the construction industry are inherently technically oriented. These types of organization tend to focus on rational and political intervention types. However, also, and perhaps even to a larger extend, emotional, learning and autonomous aspects are required for risk management implementation in an organization.

By adding a five-point scale to the tables with key conditions (Table 6.3 and Table 6.4) and key interventions (Table 6.7 and Table 6.8) an initial audit tool emerged. Two sets of two questionnaires have been derived. One set of questionnaires aims judging the degree of presence of key conditions for risk management methodologies and the degree of execution of the related key interventions in an organization. The other set of questionnaires can be used for judging the degree of presence of social system-related key conditions, as well as the degree of execution of the related interventions.

In summary, the initial audit instrument for risk management implementation consisted of four questionnaires for assessing:

1. The degree of presence of 18 key conditions for risk management methodologies;
2. The degree of presence of 23 key conditions for social systems;

3. The degree of execution of 11 key interventions in risk management methodologies;
4. The degree of execution of 8 key interventions in social systems.

Within each questionnaire, the degree of presence of each key condition and the degree of execution of each key intervention could be assessed, by marking one of the five cells of the five-point scale. This scale ranges from very low to very high.
The resulting questionnaires have been used during the validation of the initial risk management implementation design, which as been reported in the next chapter. Based on the results, the questionnaires have been adapted. For avoiding confusion, only the final questionnaires of the audit instrument are presented in these theses. These are presented in Appendix 11 through to 13, and presented in Section 9.4 of Chapter 9 with final design propositions for risk management implementation in organizations.

6.5 Results and next research step

Research results

In view of the objective of the development research part, and by acknowledging the principle of minimal design specification (Van Aken, 2008b), three initial design criteria were defined. These served as *specification* for the *initial design propositions* for implementing risk management within organizations in the construction industry. A number of very specific difficulties for designing risk management implementation emerged, after comparing the inherent features of risk management with those of other types of innovation. From this analysis, it is concluded that risk management is an *organizational*, *preventive*, and *user-based* type of innovation. Moreover, when viewing risk management implementation from an innovation perspective, its form, function and meaning are largely intangible and subjective.

Because of these unfavourable implementation characteristics, designing risk management implementation seems even more of a challenge than designing the implementation of other types of innovation. Overcoming the design difficulties required a specific approach, for which the CIMO-logic (Denyer et al, 2008) of context-intervention-mechanism-outcome has been purposefully selected and applied. This approach assumes heuristic causal relationships between hurdles, conditions, and interventions. After executing the first step of the development research part, this chapter presented the following research results:

6

1. An initial *conceptual model* for risk management implementation with:
   a. 3 dimensions for risk management methodologies, social systems, and interventions;
   b. 41 key conditions for risk management methodologies and social systems;
   c. 19 key interventions for realizing the 41 key conditions.
2. An initial *audit instrument* for measuring and monitoring risk management implementation progress, consisting of four questionnaires with:
   a. 18 key conditions for risk management methodologies;
   b. 11 key interventions for risk management methodologies;
   c. 23 key conditions for social systems;
   d. 8 key interventions for social systems.

The *key conditions* (situations) for implementing risk management within an organization and *key interventions* (actions) for generating these key conditions have been derived in three subsequent steps:

1. Deriving *key conditions* for implementing risk management in organizations;
2. Allocating *key conditions* to five intervention aspects;
3. Deriving *key interventions* for generating key conditions for each intervention aspect.

The in total 41 key conditions and 19 key interventions are the synthesized and significant conditions and interventions for realizing risk management implementation within organizations. These are derived out of the in total 480 identified variables during the exploration research, consisting of 164 hurdles, 240 conditions, and 76 interventions.
According to the applied CIMO-logic, five *intervention aspects* served as linking pins between the key conditions and the key interventions. The intervention aspects are the generative *mechanisms* of *interventions*, providing the *outcome* of implemented risk management in the *context* of an organization. The five intervention aspects are, in arbitrary order, (1) the autonomous aspect, (2) the rational aspect, (3) the emotional aspect, (4) the learning aspect, and (5) the political aspect. These intervention *aspects* result from the formerly derived five intervention *perspectives*. The latter were provided in Chapter 5 about change management. However, intervention aspects seem better able to represent the organizational features of aspect systems, than the former intervention perspectives. According the definition of aspect systems, as derived in this chapter, this means that in systems and their subsystems, all of the five intervention aspects are relevant. Therefore, for hard systems such as risk management methodologies, as well as for soft social systems, each of the five intervention aspects should be addressed, for being able to set appropriate conditions for implementing risk management in organizations.

Research limitations

The *initial* conceptual model and audit instrument for risk management implementation within organizations were developed by synthesizing the relevant concepts from risk management, innovation management, and change management. Key Proposition 1 (considering the implementation of risk management as an organizational innovation), as well as Key Proposition 2 (the need for reducing hurdles and generating conditions for risk management implementation by interventions) have been acknowledged within the initial design proposition.
By acknowledging Key Proposition 1, risk management has been considered an organizational, preventive, and user-based type of innovation. However, the form, function, and meaning of risk management are largely intangible and subjective, and thus fuzzy, from an innovation management point of view (Rogers, 2003).

Furthermore, from an innovation management perspective, also most of the main characteristics of risk management methodologies were considered inherently unfavourable. These unfavourable features complicate effective, efficient, and persistent implementation of risk management in organizations, when compared with other types of organizational innovations, such as information and communication technology and quality systems.

Regarding Key Proposition 2, the assumed causal relationship between key interventions and key conditions has been based upon the distinguishing features of five intervention aspects. These aspects have a sound theoretical basis. Nevertheless, the assumed causal relationships required empirical validation.

Next research step

The research results and limitations required additional research for validating the *initial* conceptual model and audit instrument for risk management implementation in organizations. Therefore, the three initial design criteria of (1) the perceived *relevance* of key conditions and key interventions by the actors of the risk management implementation process, (2) the *causal relationship* between key interventions and key conditions, and (3) the *causal relationship* between key conditions and risk management implementation within an organization, have been empirically checked in a multiple-case study in the next chapter.

7

VALIDATION OF INITIAL RISK MANAGEMENT IMPLEMENTATION DESIGN

7.1 Introduction

This chapter reports the second step of the development part of this research. The *practical* relevance of the *theoretically* grounded conceptual model and audit instrument for risk management implementation needed to be empirically checked. Initial versions of the conceptual model and audit instrument have been developed in the previous chapter. The objective of this chapter is *validating* this initial design proposition for risk management implementation. In particular, the degree of satisfying the three design criteria needed verification. These design criteria were the perceived *relevance* of key conditions and key interventions by the actors during the risk management implementation process, the *causal relationships* between key interventions and key conditions, and the *causal relationships* between key conditions and risk management implementation.

The validation has been performed by executing a multiple-case study, consisting of four single cases and a cross-case analysis. This chapter presents the approach of the multiple-case study, the execution of the single- and cross-case analyses, and the research results and research limitations. The latter provided the motivation for the next development research step.

The next section motivates the case selection and the structure of the multiple-case analysis. Moreover, protocols for the single- and cross-case analyses are presented. This chapter continues by presenting the execution of the four single-case studies. For each of the cases, the results of the desk study, the field study, the analysis, and the conclusions are reported. Next, the execution of the cross-cases analysis is presented. Subsequently, the results of comparing and contrasting the desk study results and the field study results of the single cases are reported. Finally, the main research results, the limitations, and the next research step are presented.

7.2 Approach of the multiple-case analysis

Case selection

In the period 2005-2006, four M.Sc. students of the Construction Management & Engineering Department of the University of Twente performed research on risk management in the construction industry, within four established organizations in the Netherlands. All of these four case organizations are leading, with respect to applying risk management in their operations. This research resulted in four well-documented M.Sc. studies performed by Augustijn (2006), Van der Heijden (2006), Van Schaik (2005), and Weisscher (2006).
The research by Van der Heijden (2006) concerned explicitly the implementation of risk management within a project management consultancy firm. His research generated a number of aspects for effective implementation, at management level and at user level. The remaining three M.Sc. research projects incorporated the implementation of risk management in a more implicit way within a research institute, a public client organization, and a contractor. The four M.Sc. studies are summarized, related to each other, and analyzed by Halman (2008). One of the main conclusions from the four research projects is the importance of effective *implementation* of risk management within organizations, which is also considered as one of the most relevant areas for future research (Halman, 2008). Table 7.1 presents the main characteristics of the 4 case studies.

Table 7.1 Main characteristics of the organizations of the four case studies.

Case no.	Type of organization	Type of risk management research	Risk management level	References
1	Geotechnical institute	Development of geotechnical risk management	Discipline	Weisscher (2006)
2	Consultancy	Implementation of project risk management	Project	Van der Heijden (2006)
3	Contractor	Development of a project risk management tool	Project	Van Schaik (2005)
4	Public client	Development of portfolio risk management	Organizational	Augustijn (2006)

Figure 7.1 shows that all four types of risk management development within the four case organizations were derived from RISMAN project risk management. This approach has been developed in The Netherlands, where it is widely applied. It has been thoroughly described by Van Well-Stam et. al (2003).

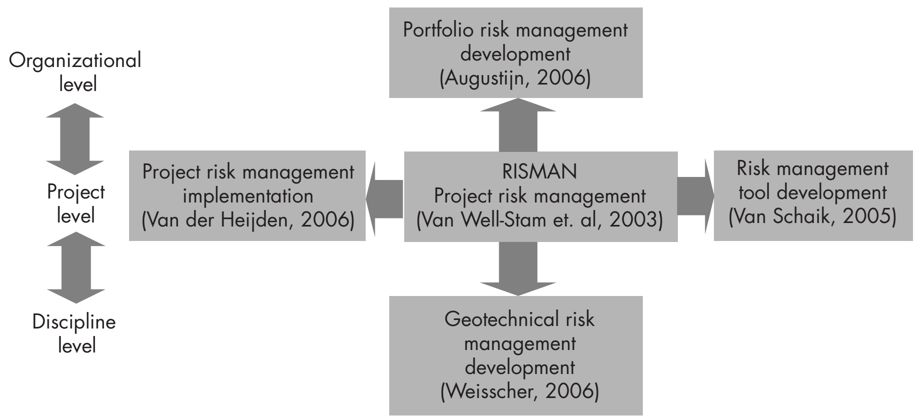

Figure 7.1 Four types of risk management that originate from RISMAN project risk management.

This Ph.D. research provided the opportunity to build forward on the four M.Sc. research projects. Identifying, analyzing, and classifying conditions and interventions in the four case organizations, according to the initial risk management implementation model, *expanded*, *deepened*, and *synthesized* the M.Sc. research. Moreover, additional *longitudinal* and *evaluation* research data could be gained by assessing the degree of risk management implementation within the case organizations, some two years after completion the M.Sc. research. The number of four single cases for testing the initial risk management implementation approach is considered as sufficient, since Yin (2003) considers two to three cases usually adequate for replication of case study research.

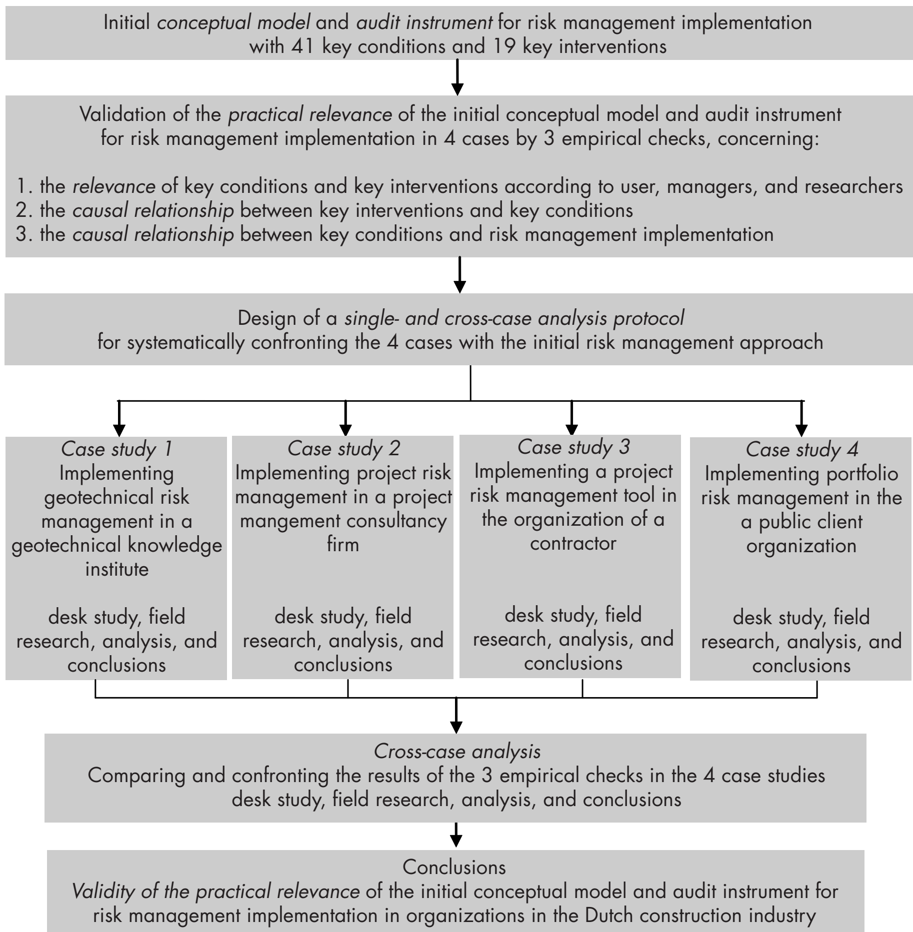

Figure 7.2 The research structure of the validation of the initial design for risk management implementation.

Structure of the multiple-case analysis

The selected structure for the multiple-case research aims validating the *practical relevance* of the *theoretically grounded* conceptual model and audit instrument for risk management implementation. Therefore, three empirical checks were executed. Figure 7.2 presents the research structure of the multiple-case study.

First, more or less parallel over time, four individual case studies have been executed by using a single-case study protocol. After the individual case studies a cross-case analysis has been executed, which is for instance suggested by Verschuren en Doorewaard (2000), and Brown and Eisenhardt (1997). The results of the individual case studies were used in the cross-case analysis. The objective of the cross-case analysis was identifying any generalities and differences between the cases. Furthermore, similarities between the cases, as well as idiosyncrasies of individual cases, could be identified. The cross-case analysis also may provide new insights with regard to the initially designed key conditions and key interventions. These insights would remain hidden by considering the individual cases only. Before executing the cross-case analysis, also a protocol has been developed. Next, by combining the results of the single- and cross-cases analyses, conclusions about the validity of the practical relevance of the initial risk management implementation *model* and *instrument* have been derived. These conclusions serve as basis for the modification of the initial proposition for risk management implementation in organizations, which is the topic of the forthcoming Chapter 8.

Single-case analysis protocol

The objective of the single case analysis protocol was guaranteeing a systematic confrontation of the initial conceptual model and audit instrument for risk management implementation with the four individual cases. For each single case the same protocol has been applied, which allows comparison and confrontation of the single case study results in the cross-case analysis. The protocol for the single-case analysis included three subsequent research steps:

1. *Desk study* of the M.Sc. reports, by establishing the context of the case and confrontation of the case study reports with the key hurdles and key conditions of the conceptual model for risk management implementation;
2. *Field research* by interviews, at managerial level and user level, by applying the audit instrument for risk management implementation;
3. *Analysis* of the desk study and field research results, by comparing the results with the three initial design criteria, which resulted in *conclusions* about the three empirical checks in each case study.

Figure 7.3 shows these three subsequent research steps.

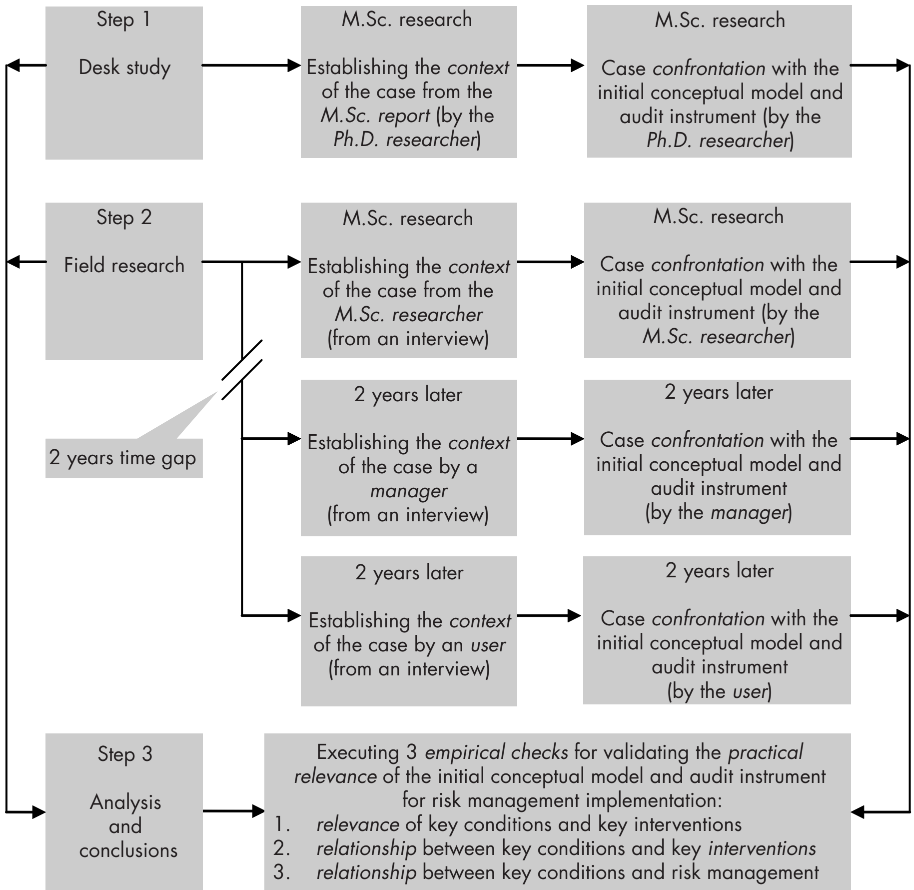

Figure 7.3 The three subsequent research steps of the single-case analysis protocol.

The case *confrontation* with the initial conceptual model and audit instrument for implementing risk management consisted of the completion of its four questionnaires by the Ph.D. researcher, by the former M.Sc. researchers, as well as by the managers and the risk management users of the case organizations. The former M.Sc. researchers were asked to consider the situation at the end of their M.Sc. research, when they left the case organization. The managers and risk management users were asked to consider the actual situation in their organizations, two years after the completion of the M.Sc. research.

Within the questionnaires, the degree of execution of each key intervention and degree of presence of each condition has been scored on the five-point scale. This scale ranges from a very low degree of execution or presence (indicating a score of one) to a very high degree of execution or presence (indicating a score of five) of key interventions and key conditions. Each person was instructed to indicate only those key conditions and key interventions that they perceived relevant, according to their own opinion and experience. Therefore, *non-relevant* key conditions and key interventions revealed by blank boxes in the questionnaires. *Relevant* key conditions and key interventions scored a minimum of one, indicating relevance but a very low presence, and a maximum of five, indicating relevance and a very high presence in the organization. By using the resulting case data, the three empirical checks have been performed as follows:

1. For validating the *relevance* of the key conditions and key interventions of the initial conceptual model and audit instrument: The *number* of the key conditions and key interventions, as indicated in the questionnaires of the audit instrument by the M.Sc. researcher, the manager and the risk management user, were compared with their *total number* of respectively 41 key conditions and 19 key interventions. It was assumed that the higher the number of indicated key conditions and key interventions, the higher the relevance of the conceptual model and audit instrument;
2. For validating the assumed *causal relationship* between key interventions and key conditions of each intervention aspect: The *scores* of the key interventions were compared with the *scores* of their targeted key conditions, as provided by the Ph.D. researcher, the M.Sc. researcher, the manager, and the risk management user. The assumption was that, in case of a relation of key interventions with targeted key conditions within intervention aspect, high scores of key interventions would result into high scores of key conditions. Reversely, low scores of key interventions would have generated low scores of key conditions;
3. For validating the assumed *causal relationship* between the presence of key conditions and the degree of risk management implementation within an organization: The average value of the *sum* of the key conditions *scores*, provided by the Ph.D. researcher, the MSc. researcher, the manager, and the risk management user, was compared with the assessed degree of risk management implementation. The latter was derived from the interviews with the manager and the risk management user. The average value has been expressed as a percentage of the *maximum* sum of all scores on the 18 key conditions for risk management methodologies and key 23 conditions for social systems. It is assumed that a high percentage of key conditions within an organization would correspond with a high degree of risk management

implementation within that organization. Contrary, a low percentage of key conditions would imply a low degree of risk management implementation in that organization.

Unfortunately, there proved to be a lack of adequate time-dependant data about the sequence of executing interventions and the resulting presence of conditions within the M.Sc. reports and the interviews results. In addition, the questionnaires of the audit instrument for risk management implementation could not reveal time-dependency of interventions and resulting conditions. The questionnaires about the interventions and the conditions were completed at the same moment in time by the respondents.
It was therefore *not* possible to directly analyze the effects of single key interventions, performed at t = 0, on the development of the targeted (sets of) key conditions, at t = 1. This would require longitudinal research, by assessing the presence of key conditions at t = 0, executing key interventions for generating or strengthening targeted key conditions at t = 1, and measuring the resulting key conditions at t = 2. This sort of future research is recommended in Chapter 10.
For overcoming the problem of lacking time dependent data, aggregated scores on key conditions and key interventions, over the period from the start of the M.Sc. research within the case studies to some two years later, have been compared for the second empirical check. Over a period of three years (one year for the M.Sc. research and two years after the M.Sc. research completion), at unknown moments in time, a number of key interventions were executed and similarly a number of key conditions have been established. These degrees of execution and presence have been revealed by the analysis of the M.Sc. reports.
Furthermore, the degrees of execution and presence of key interventions and key conditions became visible in the completed questionnaires of the audit instrument for risk management implementation. These questionnaires indicated the perceptions of the M.Sc. researchers, the managers, and the risk management users. Aggregating the scores of the individual persons for each case provided insight in the degree of execution of interventions and presence of the key conditions over the three-year period. This information has been used for judging the causal relationship between key interventions and targeted key conditions during the second empirical check.

Cross-case analysis protocol

The objective of a protocol for the cross-case analysis was providing a well-structured approach for comparing and contrasting the results of the four single-case analyses. This protocol also included three subsequent steps:

1. A cross-case analysis, based on solely the *desk study research* of the single-cases. The scores of the presence of key conditions and key interventions, for risk management methodologies as well as social systems, have been compared for each individual case. These scores were given by the Ph.D. researcher, by using the questionnaires of the initial audit instrument for risk management implementation. Only the M.Sc. reports served as basis for these scores;
2. A cross-case analysis of the three empirical checks. The results of the empirical checks of the single cases were compared and confronted with each other, by summarizing their results in one table. This exercise included all results from the *field research* for the case analyses, supplemented with relevant data from the desk study. A summary table was derived by using the approach of the partially ordered matrix (Miles and Huberman, 1994);[150]
3. An *analysis* of the desk study and field research results, by confronting these results with the three initial design criteria, which resulted in *conclusions* about the three empirical checks.

The next two sections of this chapter present the main results of executing the single- and cross-case analyses.

7.3 Execution of the single-case analyses

7.3.1 Case 1: Risk management implementation in a geotechnical institute

This section presents the highlights of the desk study and the field research of Case 1, as well as the main results of the analysis and the conclusions.

Desk study

The desk study of Case 1, risk management implementation within a geotechnical institute, consisted of two parts. First, by establishing the context of the case, by analyzing the M.Sc. report by Weisscher (2006) and the summary in Halman (2008). Second, by confronting the content of the M.Sc. report with the initial risk management implementation instrument by the Ph.D. researcher.

150 This approach was effectively applied in cross-cases analyses, such as those by Caerteling et al. (2008a, 2008b).

The M.Sc. research in the organization of Case 1 aimed revealing the added value of a risk management process, GeoQ, which has been internally developed by the institute. Within GeoQ, the Q stands for improving the overall quality of construction projects by applying geotechnical risk management to all structures that have to be constructed in, at, or with ground. At discipline level, GeoQ can be considered as a geotechnical re-invention of the RISMAN method for managing the variety of project risks in construction projects. As mentioned in Halman (2008), the specific GeoQ features, when compared with RISMAN are (1) focussing on managing ground-related risk, (2) providing specific tools for managing ground-related risk, and (3) giving explicit attention to the role of the human factor, at the levels of the individual, teams, clients, and the society.

Weisscher (2006) provided recommendations for implementing the GeoQ approach within organizations. These correspond with the key conditions for risk management methodologies. For instance, Weisscher (2006) recommends to develop and realize an implementation strategy, with due attention for management commitment and development of risk management knowledge. Furthermore, he mentions that good communication between risk management users and their managers is an important condition. Additional tools, such as risk checklists, should be developed for performing the GeoQ process. In addition, the GeoQ process itself needs some more structure, such as a prescription for the format for presenting risks, as well as guidance for classifying risks and deciding upon risk remediation measures. Furthermore, providing a clear guideline for executing the GeoQ process and a standard GeoQ reporting format is recommended. Applying GeoQ during the entire construction process requires that project clients or owners explicitly request application during the entire project.

Halman (2008) derives three generically relevant lessons from this case study, which are (1) develop context-specific tools, (2) provide good documentation of the risk management methodology, and (3) use lessons learned from applying the risk management methodology in other projects.

After analyzing the case study data, as presented by Weisscher (2006) and summarized in Halman (2008), the four questionnaires of the initial audit instrument were completed by the Ph.D. researcher. It showed that a minority of the key conditions and key interventions for implementing risk management within organizations have been explicitly recognized in Weisscher (2006) and in Halman (2008). Respectively 39 percent en 45 percent of the key conditions and key interventions for strengthening the characteristics of the risk management methodology could be identified in the M.Sc. report. Furthermore, respectively 9 percent en 25 percent of the key conditions and key interventions for strengthening the characteristics of the social system were acknowledged. Apparently, in this case social system-related key conditions and key interventions were to a substantially lower degree present or recognized in the case organization than those for risk management methodologies. This situation seems to reflect a merely technical focus of the M.Sc. research, as well as of the case organization (a geotechnical institute). Risk management implementation aspects, which are largely determined by the social system, were not explicitly part of the M.Sc. research.

Field research

The field research consisted of three interviews with (1) the former M.Sc. researcher who performed the risk management research within the case organization, (2) a manager in the case organization and (3) a risk management user in the case organization. At the end of each interview, the respondents were asked to complete the questionnaires of the audit instrument.

The former *M.Sc. researcher* of Case 1 has been interviewed for revealing highlights and additional in-depth information about the case organization during his research. The interview focussed on the main variables for implementing GeoQ risk management within the case organization, as perceived by the researcher during his research. Moreover, the extend to which risk management implementation success has been achieved at the end of his research, including the criteria for measuring that success, have been asked. According to the former M.Sc. researcher, the main condition for implementing GeoQ risk management within the case organization was shared agreement about the necessity and benefits of it. The interview suggested two main interventions to be executed for increasing GeoQ implementation: (1) providing a GeoQ guideline and (2) executing GeoQ risk management in such a way that it does not take more time than working without it within a project. For assessing risk management implementation success within the case organization, six statements were developed during the M.Sc. research. Three of them concerned the ability to apply GeoQ in practice, the other three were related to the degree to which GeoQ contributed to successfully executing geotechnical activities within a construction project. The statements did however not provide insight in the degree of GeoQ risk management implementation in the case organization during the M.Sc. research. The former M.Sc. researcher completed the questionnaires of the audit instrument, by considering the situation at the end of his research.

The objective of interviewing a unit *manager* of Case 1 was verifying the degree of GeoQ risk management implementation, some two years after the M.Sc. research has been completed. Furthermore, additional information about the main variables for implementing GeoQ risk management within the case organization, from a managerial perspective, was provided during the interview. According to the manager, the implementation success of GeoQ entered the case organization via the back door. Some 15 innovators and early adopters, which is some ten percent of the total population of engineers within the case organization, adopted GeoQ risk management. These professionals apply it in their geotechnical activities. Two main criteria for implementation success are the number of projects in which GeoQ is applied and the development of long-term relationships with clients, based on applying GeoQ within their projects. According to the manager, main conditions for implementing GeoQ risk management within the case organization are its acceptance within the entire organization, which should result from demonstrated added value and flexibility in use. Furthermore, time for learning how to apply GeoQ within projects should be provided. Additionally, managers within the organization should practice what they preach and professionals should pro-actively dare to apply risk management. In view of the manager, the main challenge within the case organization was expanding the GeoQ application to the early and late majorities of its intended users. This would increase the number of GeoQ users from the actual number of 15 towards some 50 engineers. The manager completed the questionnaires of the audit instrument, by considering the situation some two years after the completion of the M.Sc. research.

The objective of interviewing a risk management *user* of Case 1 was verifying the degree of GeoQ risk management implementation from a user perspective, some two years after the M.Sc. research has been completed. Furthermore, additional information about the main variables for implementing GeoQ risk management within the case institute has been gained during the interview. According to the risk management user, some small implementation successes were realized over the last year. Examples are responses of colleagues on the GeoQ newsletter and an increasing number of persons, who are not a member of the GeoQ team, who applied GeoQ within their projects. Establishing the newsletter and the team were interventions made. The application of GeoQ risk management resulted in new business with additional turnover, which would not have been realized without applying the GeoQ approach. The degree of GeoQ implementation was also reflected by its presence in reports for clients. Full GeoQ implementation would be realized, when the GeoQ approach is explicitly followed in nearly all reports that are prepared within the institute. This would however require more professionals actively stimulating the application of GeoQ risk management within institute's activities. At the moment of the interview, the GeoQ approach was supported by a few champions only. If these persons would leave the institute, the GeoQ implementation would probably stop. According to the user, a main condition for implementing GeoQ risk management within the institute is demonstrating respect to the targeted GeoQ user, by confirming that their usual geotechnical approaches without applying GeoQ were not wrong at all. Furthermore, the inherent simplicity and benefits of the GeoQ process need to become clear for its targeted users. The user completed the questionnaires of the audit instrument, by considering the situation some two years after the completion of the M.Sc. research.

Analysis and conclusions

The analysis of the results from the desk study and field research involved executing the three empirical checks. These checks were applied for validating the practical relevance of the initial risk management implementation approach. The completed questionnaires of the audit instrument served as data source for the three checks.

The *first empirical check* aimed verifying whether the derived key conditions and key interventions are relevant or not. Regarding the GeoQ risk management method, the former M.Sc. researcher, the unit manager, and the risk management user considered between 89 and 100 percent of the key conditions and between 82 and 100 percent of the key interventions for risk management methodologies relevant. Furthermore, between 78 and 100 percent of the key conditions and between 75 and 100 percent of the key interventions for social systems were judged relevant. No new conditions and interventions emerged from desk study and field research.

The *second empirical check* intended verifying the theoretically derived causal relationships between key interventions and key conditions of similar intervention aspects. The aggregate scores of the key interventions were compared with the aggregate scores of the targeted key conditions, as provided by the Ph.D. researcher, the M.Sc. researcher, the manager, and the user. The criterion for a proportional relationship is a maximum difference of one between an intervention and condition score in an intervention aspect. For the aggregate score by four individuals, this criterion becomes four. For risk management methodologies, as well as social systems, the majority of interventions seem proportionally related to conditions belonging to the same intervention aspect. This seems to imply a *proportional impact* of the key interventions on the targeted key conditions. Two key interventions for setting key conditions for risk management methodologies and one key intervention for setting key conditions within the social system seem under-proportionally related. This implies that executing these key interventions do have a relatively *low impact* on generating the targeted key conditions. Three interventions for setting key conditions for risk management methodologies seem over-proportionally related to the key conditions of the same intervention perspective. This indicates a relatively *high impact* of the interventions on setting conditions.

7

The *third empirical check* aims verifying the assumed causal relationships between the presence of key conditions and the degree of risk management implementation within the case organization. Therefore, the average value of the sum of all scores on key conditions, provided by the Ph.D. researcher, the MSc. researcher, the manager, and the risk management user, was compared with the assessed degree of risk management implementation, at the end of the three years period of concern. The latter has been derived from the interviews with the manager and the risk management user. The average value has been expressed as a percentage of the maximum score on key conditions. On average, 58 percent of the key conditions for risk management methodologies and 46 percent of the key conditions for the social systems seemed present within the institute, some three years after the start of the M.Sc. research. Furthermore, 54 percent of the interventions for setting conditions for risk management methodologies and 40 percent of the interventions for social systems were executed over the three years. Therefore, about half of the full potential of the key conditions appeared present within the case organization. In addition, half of the key intervention potential has been applied. This seems to indicate that the executed key interventions are slightly more than proportionally effective in generating key conditions. Despite the lack of explicit success criteria for the implementation of risk management within the case organization, the degree of GeoQ implementation within the case organization, as raised in the interviews, seems to align with the figures from the audit instrument. Based on these results it is concluded that increasing the degree of presence of the key conditions for GeoQ risk management, as well as for the social systems in the organization, by executing the key interventions to a larger extend, will increase the degree of risk management implementation within the case organization.

7.3.2 Case 2: Risk management implementation within a project management consultancy

This section presents the highlights of the desk study and the field research of Case 2, as well as the main results of the analysis and conclusions.

Desk study

The desk study of Case 2, risk management implementation within a project management consultancy, consisted of two parts. The first part involved establishing the context of the case, by analyzing the M.Sc. report by Van de Heijden (2006) and the summary in Halman (2008). The second part was confronting the content of the M.Sc. report with the initial risk management implementation instrument by the Ph.D. researcher.

The M.Sc. research in the project management consultancy of Case 2 focussed on extending the application of RISMAN project risk management, by using the INK-model for organizational change (INK, 2003). Van der Heijden (2006) combined a few concepts from risk management, knowledge management, and organizational change management. While mentioning Rogers (2003) and Song (2006) in his M.Sc. report, the attention to innovation management was limited. Van der Heijden also used the five-colour model for organizational change by De Caluwé and Vermaak (2004). [151] The resulting two-level model for implementing risk management distinguished a management level and an user level.

Van der Heijden (2006) presents a variety of aspects that require consideration for implementing risk management at management level and user level. For instance, at management level a well-planned and communicated risk management implementation plan should be developed. At individual level, there should be attention to the benefits of routinely applying risk management by individual professionals.

Halman (2008) summarized the research results into four generic lessons: (1) measuring the progress of the risk management implementation, including benchmarking with competitors, (2) revealing what (potential) users drive to apply risk management, (3) developing an integral approach of implementing risk management within an organisation and (4) considering risk management implementation a cyclic process. The latter implies continuous attention to step-by-step quality improvement of the risk management methodologies.

After analyzing the case study data, as presented by Van der Heijden (2006) and summarized in Halman (2008), the four questionnaires of the initial audit instrument were completed by the Ph.D. researcher. It showed that about half of the number of key conditions and key interventions for implementing risk management within organizations has been explicitly recognized in Van der Heijden (2006) and in Halman (2008). Respectively 67 percent en 45 percent of the key conditions and key interventions for strengthening characteristics of risk management methodologies have been identified in the M.Sc. report. Furthermore, respectively 52 percent en 50 percent of the key conditions and the key interventions for strengthening the characteristics of social systems have been acknowledged. These figures correspond with the specific focus on risk management *implementation* of this M.Sc. research, by including a managerial perspective and using concepts from organizational change management.

151 Van de Heijden (2006) classified the five colours of thinking and acting according to management style by the dimensions top-down versus bottom-up, and according to the way of knowledge development by outside-in versus inside-out. Given the organizational context of the consultancy firm with its values and beliefs, Van der Heijden considered the top-down and inside-out approach as most suitable. According to Van der Heijden (2006), in this risk management implementation approach rational (blue-print) and political (yellow-print) thinking dominates.

Field research

The field research consisted of three interviews with (1) the former M.Sc. researcher who performed risk management research within the case organization, (2) a manager of the case organization and (3) a risk management user of the case organization. At the end of each interview, the respondents were asked to complete the questionnaires of the audit instrument.

The former *M.Sc. researcher* of Case 2 has been interviewed for revealing highlights and additional in-depth information about the case organization during his research. The interview focussed on the main variables for implementing RISMAN project risk management within the case organization, as perceived by the researcher and based on his research. Furthermore, the extend to which risk management implementation success has been achieved at the end of his research, including the criteria for measuring that success, have been asked. According to the former M.Sc. researcher, the most important condition for implementing risk management within the case organization is management commitment, which makes or breaks implementation success. Main interventions raised were (1) creating a sense of urgency by communicating why risk management should be applied, (2) developing a risk management format by using a uniform language for the risk management terminology, (3) providing a risk management guideline, and (4) relating risk management to the organizational project control cycle. With regard to risk management implementation success and its criteria, the risk maturity test, developed within the M.Sc. research by building on Hillson (1997), generated a lot of enthusiasm. It allows measurement of individual risk maturity and its progress over time. The former M.Sc. researcher completed the questionnaires of the audit instrument, by considering the situation at the end of his research.

The objective of interviewing a *manager* of Case 2 was verifying the degree of risk management implementation, some two years after the M.Sc. research was completed. Furthermore, the interview delivered additional information about the main variables for implementing RISMAN project risk management within the case organization, from a managerial perspective. According to the manager, risk management implementation success was demonstrated by an improved output of the consultancy. For instance, the number of projects with negative financial results reduced and the number of invoices that is paid at once by clients increased. Therefore, in the future the risk management scope will be widened from the current attention to project management towards portfolio risk management at organizational. A main condition for implementing risk management is developing it toward a real management system, similar to quality management systems. Risk management should be implemented into the genes of the organization, by carefully integrating with the operational processes of the organization. A main social system type of intervention was establishing a risk management knowledge circle within the firm. Initially, it organized workshops for groups. Later, members of the circle provided support and coaching at individual level. This individual approach was considered necessary for increasing risk awareness of particularly project leaders within the consultancy. An intervention still under consideration was risk management accreditation of the firm's professionals for making their risk management competencies explicit to clients. The manager completed the questionnaires of the audit instrument, by considering the situation some two years after the completion of the M.Sc. research.

The objective of interviewing a risk management *user* of Case 2 was verifying the degree of RISMAN project risk management implementation from a user perspective, some two years after completion of the M.Sc. research. Furthermore, additional information about the main variables for implementing RISMAN risk management within the case organization was gained by the interview. According to the risk management user, the main indicator of implementation success was an increasing number of projects in which risk management was applied. An increasing number of clients demanded the application of risk management, which motivated professionals to apply risk management. More often, project leaders spontaneously approached members of the risk management knowledge circle for advice. Establishing this circle was a main intervention. The core task of the knowledge circle is developing unaware and implicit application of risk management within the organization towards aware and explicit risk management, yet without obligation. For instance, forcing unmotivated employees to attend risk management sessions was considered ineffective. The most important condition for implementing risk management within the project management consultancy is a high degree of user acceptance. Users should simply benefit from applying risk management, by faster completing their work, having more fun, or increasing profits within their projects. Furthermore, involving users during the implementation of risk management is a condition, according to the user. Simply providing instructions does not work in an organization with highly educated professionals. Finally, a main hurdle for implementing risk management is its preventive character. One should provide extra work for *avoiding* something to happen, while normally people put energy and time to *making* things happening. In addition, the user completed the questionnaires of the audit instrument, by considering the situation some two years after the completion of the M.Sc. research.

Analysis and conclusions

Analyzing the results from the desk study and field research involved executing the three empirical checks. These checks were applied for validating the practical relevance of the initial risk management implementation approach. The completed questionnaires of the audit instrument, supplemented with the interview results, served as data source for the three tests.

The *first empirical check* aimed verifying whether the derived key conditions and key interventions are relevant or not. Regarding the RISMAN project risk management method, the former M.Sc. researcher, the manager, and the risk management user considered between 78 and 100 percent of the key conditions and between 54 and 100 percent of the key interventions relevant. Furthermore, between 78 and 100 percent of the key conditions and between 75 and 100 percent of the key interventions for the social system were considered relevant. No new conditions and interventions emerged from desk study and field research.

The *second empirical check* was applied for verifying the theoretically derived causal relations between key interventions and key conditions of similar intervention aspects. The aggregate scores of the key interventions were compared with the aggregate scores of the targeted key conditions, as provided by the Ph.D. researcher, the M.Sc. researcher, the manager, and the user. The criterion for a proportional relationship was a maximum difference of one between an key intervention and corresponding key condition score. Both are part of the same intervention aspect. For the aggregate score by four individuals, this criterion becomes four. For risk management methodologies, as well as social systems, the majority of key interventions seem proportionally related to key conditions of an intervention aspect. This reveals a generally *proportional impact* of key interventions on targeted key conditions. Two key interventions for setting risk management conditions seem under-proportionally related. It implies that executing those key interventions do have a *relatively low impact* on setting key conditions. Three key interventions for setting risk management key conditions and three for setting social system key conditions seem over-proportionally related to conditions of similar intervention aspects. This indicates a *relatively high impact* of those key interventions on setting key conditions.

The *third empirical check* intended verifying the assumed relationship between the presence of key conditions and the degree of risk management implementation within the case organization. Therefore, the average value of the sum of all scores on key conditions, provided by the Ph.D. researcher, the MSc. researcher, the manager, and the risk management user, was compared with the assessed degree of risk management implementation. The latter has been derived from the interviews with the manager and the risk management user. The average value has been expressed as a percentage of the maximum score on all key conditions. On average, 54 percent of the key conditions for risk management methodologies and 49 percent of the key conditions for the social systems were present within the project management consultancy, some three years after the start of the M.Sc. research. Furthermore, 37 percent of the key interventions for setting risk management key conditions and 35 percent of the key interventions for social system key conditions were executed in the period of three years. Therefore, half of the full potential of key conditions appeared present within the organization, while about a third of the key intervention potential has been used. This shows that the executed interventions were over-proportionally effective. The degree of RISMAN risk management implementation within the case organization, as raised in the interviews, seems to correspond with these figures. Based on these results it is concluded that further increasing the key conditions for RISMAN risk management and the social system of the organization, by executing key interventions to a larger extend, will increase the degree of risk management implementation within the case organization. The key interventions may continue to demonstrate their over-proportional impact, which implies relatively high effectiveness and efficiency of RISMAN risk management implementation within the project management consultancy.

7.3.3 Case 3: Risk management implementation within a contractor

This section presents the highlights of the desk study and the field research of Case 3, as well as the main results of the analysis and conclusions.

Desk study

The desk study of Case 3, implementation of risk management instrument within the organization of a contractor, consisted of two parts. The first part concerned establishing the context of the case, by analyzing the M.Sc. report by Van Schaik (2005) and the summary in Halman (2008). The second part involved confronting the content of the M.Sc. report with the initial audit instrument by the Ph.D. researcher.

The M.Sc. research in the organization of Case 3 focussed on developing and implementing an electronic risk database in the project organization of a contractor, after specifying the required output for a variety of users. The risk diagnosing method (RDM), as developed by Halman (1994), proved to be the most structured and detailed method for categorizing risks within the software tool. Using the electronic risk database resulted in a more structured risk management process with an increased insight in project risks. In addition, it allowed using knowledge from previous projects. The company-specific software tool aimed saving costs and time during executing the risk management process in construction projects of the contractor.

One of the main recommendations by Van Schaik (2005) is aligning the risk management process with the organization's project management and its supporting tools, such as the PRINCE2-method for filing project information. Additionally, it was recommended to look for support for executing the risk management process by an external risk expert or project consultant. Any risk responsibility should however remain with the persons being responsible for the project.

Halman (2008) presented three generic lessons from this research: (1) the need for clear categorization of project risks, by distinguishing between project risks and risk beyond projects that occur at project portfolio or organizational level, (2) the need for carefully filing all risk-related activities in a risk database, and (3) the functionality of risk databases for generating different types of risk registers. The latter should fulfil the needs of different types of users.

After analyzing the case study data, as presented by Van Schaik (2005) and summarized in Halman (2008), the four questionnaires of the initial audit instrument were completed by the Ph.D. researcher. It showed that a minority of the key conditions and key interventions for implementing risk management within organizations were explicitly recognized in Van Schaik (2005) and in Halman (2008). Respectively 22 percent en 28 percent of the key conditions and key interventions for strengthening the characteristics of the risk management database has been identified in the M.Sc. report. Furthermore, respectively 9 percent en 13 percent of the key conditions and key interventions for strengthening the characteristics of the social system in the case organization have been acknowledged. This situation seems to reflect a merely technical focus of the M.Sc. research. This is in fact not surprising, because the main research focus was on *designing* an electronic risk database, rather than on *implementing* the system.

Field research

The field research consisted of two interviews with (1) the former M.Sc. researcher who performed risk management research within the case organization, and (2) a manager of the case organization. At the end of each interview, the respondents were asked to complete the questionnaires of the audit instrument.

The former *M.Sc. researcher* of Case 3 has been interviewed for revealing highlights and additional in-depth information about the case organization during his research.

The interview focussed on the main variables for developing and implementing the electronic risk database within the case organization, as perceived by the researcher and based on his research. Furthermore, the extend to which risk management implementation success has been achieved at the end of his research, including the criteria for measuring that success, have been asked. According to the former M.Sc. researcher, the main condition for implementing the risk database within the case organization is satisfying the different needs of different target groups, such as managers and calculators within the contractor, as well as external clients. The main hurdle proved to be the costs for professionally developing the electronic database, including the required security and its linking to systems engineering software. The main suggested intervention was connecting the risk database to the systems engineering work processes within the case organization. With regard to risk management implementation success and its criteria, the originally client-driven motivation to apply risk management transformed to an internally driven motivation during the M.Sc. research. Risk management became perceived as a method for cost control within projects. However, explicit financial benefits were not (yet) available. The former M.Sc. researcher completed the questionnaires of the audit instrument, by considering the situation at the end of his research.
The objective of interviewing a *manager* of Case 3 was verifying the degree of risk management implementation, particularly the electronic risk database, some two years after the M.Sc. research was completed. Furthermore, additional information about the main variables for implementing risk management within the case organization, from a managerial perspective, was gained during the interview. According to the manager, motivation for applying risk management increased over the last two years. Risk management became a mean for reducing failure costs and increasing efficiency of construction projects, when used in combination with systems engineering. However, using the electronic risk management database, as developed by the M.Sc. researcher, has been terminated when he left the company. Nevertheless, risks and opportunities remained identified in projects, yet without risk classification by using the electronic database. A main condition for implementing risk management is developing another attitude and way of working within the organization. Awareness should be developed about the fact that any assumption within a project involves risk. Effective handling of these uncertainties requires thinking-why and taking sufficient time for project preparation. Managers should start with adopting this new attitude and way of working. Another condition is that the one who applies risk management should directly benefit from it. For instance, applying risk management should simply generate (more) profit for the contractor. Furthermore, risk management needs to be positioned within, rather

than apart from the line organization, well aligned with systems engineering. Finally, any risk consequences, preferably quantified, need to be clear from the beginning of a project. The manager completed the questionnaires of the audit instrument, by considering the situation of risk management within the case organization some two years after the completion of the M.Sc. research. An interview at *user* level was not possible, because the electronic risk management database was not in operation anymore.

Analysis and conclusions

The analysis of the results from the desk study and field research involved executing the three empirical checks. These checks were applied for validating the practical relevance of the initial risk management implementation approach. The completed questionnaires of the audit instrument served as data source for the three tests.
The *first empirical check* aimed verifying whether the derived key conditions and key interventions are relevant or not. Regarding the implementation of the electronic risk database, the former M.Sc. researcher and the manager considered between 94 and 100 percent of the key conditions and 100 percent of the key interventions relevant. Furthermore, 100 percent of the key conditions and 100 percent of the key interventions for the social system were considered relevant. These figures may be somewhat biased by the fact of only two respondents in this case who completed the questionnaires, where the previous two cases had three respondents. This may have influenced the very high degree of agreement about the relevance of the key variables for risk management implementation, according to the initial conceptual model and audit instrument. Moreover, no new conditions and interventions emerged from desk study and field research.
The *second empirical check* intended verifying the theoretically derived causal relationships between key interventions and key conditions of similar intervention aspects. The aggregate scores of the key interventions were compared with the aggregate scores of the targeted key conditions, as provided by the Ph.D. researcher, the M.Sc. researcher, and the manager. The criterion for a proportional relationship is a maximum difference of one between a key intervention and corresponding key condition score. For the aggregate score by three individuals, this criterion becomes three. For risk management methodologies, as well as social systems, the majority of key interventions seem proportionally related to key conditions of the same intervention aspect. This implied a *proportional impact* of key interventions on key conditions of similar intervention aspects. One key intervention for setting risk management key conditions and one intervention for setting key conditions within the social system in the case organization seem under-proportionally related.

It implies that executing those key interventions do have a *relatively low impact* on setting key conditions. One key intervention for setting risk management conditions seem over-proportionally related to key conditions of the same key intervention perspective, indicating a *relatively high impact* of the key interventions on generating key conditions.

The *third empirical check* aims verifying the assumed relationship between the degree of presence of key conditions and the degree of risk management implementation within an organization. Therefore, the average value of the sum of the scores on all key conditions, provided by the Ph.D. researcher, the MSc. researcher, and the manager, was compared with the assessed degree of risk management implementation. The latter has been derived from the interview with the manager. The average value has been expressed as a percentage of the maximum score on all key conditions. On average, 51 percent of the key conditions for risk management methodologies and 43 percent of the key conditions for the social systems were present within the organization of the contractor, some three years after the start of the M.Sc. research. Furthermore, 47 percent of the key interventions for setting risk management conditions and 41 percent of the key interventions for social systems appeared being executed over the three years period. Therefore, about half of the full potential of key conditions seems present within the organization, while nearly half of the key intervention potential has been applied. This shows that the executed interventions have been slightly over-proportionally effective. However, the degree of actual risk management implementation within the case organization, as raised in the interview, appeared somewhat lower than reflected by these figures, particularly because using the electronic risk database has been terminated. Otherwise, applying project risk management without using the database continued within the case organization. Nevertheless, based on this case study it has been concluded that increasing the presence of key conditions for the risk management methodologies and the social system in the organization, by executing key interventions to a larger extend, will increase the degree of risk management implementation within the case organization.

7.3.4 Case 4: risk management implementation within a public client organization

This section presents the highlights of the desk study and the field research of Case 4, as well as the main results of the analysis and conclusions.

Desk study

Finally, also the desk study of Case 4, risk management implementation within a public client organisation, consisted of two parts. In the first part, the context of the case has been revealed, by analyzing the M.Sc. report by Augustijn (2006) and the summary in Halman (2008). The second part involved confronting the content of the M.Sc. report with the initial audit instrument by the Ph.D. researcher.
The M.Sc. research in the organization of Case 4 focussed on implementing portfolio risk management at the organizational level within a public client organization. While the organization and work procedures seemed not yet fully prepared for applying portfolio risk management, a model for controlling large projects by an integral project management (IPM) model has been developed. Parallel, a new organizational unit was being formed which should, amongst other activities, execute portfolio risk management for the public organization. Augustijn (2006) developed a three-dimensional risk management model for identifying, evaluating, and controlling risk. The model includes the dimensions of (1) frequency of risk occurrence, (2) degree of risk control, and (3) risk importance by the potential impact of risk on the objectives of the entire organization. The latter dimension lifts risk impact beyond the individual project level to the organizational portfolio level.
Augustijn (2006) recommends allocating the responsibility for active and even pro-active portfolio risk management at the organizational level, rather than at project level. It should be made explicit who is authorized for managing risks above the level of individual projects. Furthermore, organizational commitment needs to be demonstrated by providing resources, such as budgets. A number of pilot projects should be performed for showing the added value of portfolio risk management. When these pilots are sufficiently successful, portfolio risk management should be extended in a step-by-step way and become formally embedded within the organisation. It has not been defined according to what criteria pilot projects would be classified as (sufficiently) successful.
Regarding the generic lessons from this research, Halman (2008) recommends (1) providing criteria for classifying risks in main risk groups in each of the three dimensions of the portfolio risk management model, (2) determining risk remediation strategies for each risk group, and (3) establishing a clear categorization of project risks in a standard database. All of these lessons suggest re-inventing risk management methodologies.
After analyzing the case study data, as presented by Augustijn (2006) and summarized in Halman (2008), the four questionnaires of the initial audit instrument were completed by the Ph.D. researcher. It revealed that a minority of the key conditions and key interventions for implementing risk management

within organizations have been explicitly recognized in Augustijn (2006) and in Halman (2008). Respectively 39 percent en 45 percent of the key conditions and key interventions for strengthening the characteristics of the risk management methodology has been identified in the M.Sc. report. Furthermore, respectively 30 percent en 38 percent of the key conditions and key interventions for strengthening the characteristics of the social system have been acknowledged. This situation seems to reflect a rather low degree of risk management implementation in the organization at the end of the M.Sc. research, in addition to a rather technical focus of the M.Sc. research. In addition, in this case, the main research focus seemed *developing* a model for supporting portfolio risk management within the public organization, rather than *implementing* it.

Field research

The field research consisted of only an interview with the former M.Sc. researcher who performed risk management research within the case organization. At the end of each interview, the respondent was asked to complete the questionnaires of the audit instrument.

The former *M.Sc. researcher* of Case 4 has been interviewed for revealing highlights and additional in-depth information about the case organization during his research. The interview focussed on the main variables for implementing portfolio risk management within the case organization, as perceived by the researcher and based on his research. Furthermore, the extend to which risk management implementation success has been achieved at the end of his research, including the criteria for measuring that success, have been asked. According to the former M.Sc. researcher, the main condition for implementing portfolio risk management within the case organization is increasing the risk management efficiency by standardization. A common risk management language is required for such standardization. Applying portfolio risk management should provide advantages and make life easier for its users. In addition, top management push and support is essential for implementing portfolio risk management, in the view of the former M.Sc. researcher. However, the unit that should have applied the model was dismantled shortly after completion of the M.Sc. research. The employees of the case organization that participated in the research got different roles within and outside case organization. Therefore, implementation success of the developed portfolio risk management model was judged as low by the researcher. The research seemed however at least to contribute to the risk management awareness in the case organization. The former M.Sc. researcher completed the questionnaires of the audit instrument, by considering the situation at the end of his research.

Similar to the other cases, two interviews were planned, one at *managerial* level and one at *user* level. The objective was verifying the actual degree of risk management implementation, some two years after the M.Sc. research was completed. However, as already mentioned in the interview with the former M.Sc. researcher, the department that should use the developed risk management portfolio model was dismantled. Therefore, performing both interviews at managerial and user level was not possible.

Analysis and conclusions

The analysis of the results from the desk study and field research involved executing the three empirical checks. These checks were applied for validating the practical relevance of the initial risk management implementation approach. The completed questionnaires of the audit instrument served as data source for the three tests.

The *first empirical check* aimed verifying whether the derived key conditions and key interventions are relevant or not. Regarding the portfolio risk management method, the former M.Sc. researcher considered 67 percent of the key conditions and 64 percent of the key interventions relevant. Furthermore, 57 percent of the key conditions and 75 percent of the key interventions for the social system were considered relevant. No new conditions and interventions emerged from desk study and field research.

The *second empirical check* involved verifying the theoretically derived causal relations between key interventions and key conditions of similar intervention aspects. The aggregate scores on the execution of key interventions were compared with the aggregate scores on the presence of the targeted key conditions, as provided by the Ph.D. researcher and the M.Sc. researcher. The criterion for a proportional relationship was a maximum difference of one between the key intervention and key condition score, of which both belong to the same intervention aspect. For the aggregate score by two individuals, this criterion became two. For risk management methodologies, as well as social systems, the majority of key interventions seemed proportionally related to key conditions belonging to the same intervention aspects. This implies a *proportional impact* of key interventions on targeted key conditions of similar intervention aspects. Two key interventions for setting social system key conditions seem under-proportionally related. This implies that executing those key interventions do have a *relatively low impact* on setting their targeted key conditions. Two key interventions for setting risk management conditions and one key intervention for setting social system conditions seemed over-proportionally related to key conditions of the same intervention aspect, indicating a *relatively high impact* of those key interventions on generating key conditions.

The *third empirical check* intended verifying the assumed relationship between the presence of key conditions and the degree of risk management implementation within an organization. Therefore, the average value of the sum of the scores on all key conditions, provided by the Ph.D. researcher and the MSc. researcher was compared with the assessed degree of risk management implementation. The average value has been expressed as a percentage of the maximum possible score on the presence of key conditions. On average, 37 percent of the key conditions for risk management methodologies and 24 percent of the key conditions for the social systems were present within the public organization, at the end of the M.Sc. research. Furthermore, 36 percent of the key interventions for setting risk management key conditions and 31 percent of the key interventions for social system key conditions were executed in over the M.Sc. research period. Therefore, about a third of the full potential of key conditions seems present within the organization, while also a third of the key intervention potential has been applied. This shows that the executed key interventions have been proportionally effective. The actual degree of risk management implementation within the case organization, after completion of the M.Sc. research seems however lower than reflected by these figures, because the developed portfolio risk management model was never been applied in the case organization. However, according to the former M.Sc. researcher, the risk management awareness within the case organization was increased by executing the M.Sc. research. Nevertheless, this case study seems to confirm that increasing the key conditions for the risk management methodologies and the social system of the organization of the conceptual model for risk management implementation, by executing key interventions to a larger extend, will increase the degree of risk management implementation within the case organization.

7.4 Execution of the cross-case analysis

7.4.1 Cross-case analysis of the desk study results

For the cross-case analysis of the *desk study* results, all of the scores on the key conditions and key interventions for the four single cases have been compared. These scores were based on the M.Sc. reports and generated by the Ph.D. researcher by using the initial audit instrument. Each single score for a key condition or key intervention was between one and five, representing a very low to a very high degree of presence of the key conditions and key interventions within the M.Sc. reports. A zero score indicates the key condition or key intervention has not been acknowledged at all within the reports.

The scores are presented in four tables and discussed in the next four sub-paragraphs. These tables are respectively Table 7.2 (key conditions for risk management methodologies), Table 7.3 (key conditions for risk management methodologies), Table 7.4 (key interventions for risk management methodologies), and Table 7.5 (key interventions for social systems). The actual scores are presented in the cells of the tables, expressed as part of the possible maximum score. For example, for key conditions a score of 1/5 indicates an actual score of 1 (demonstrating a very low degree of presence of the key condition), out of a theoretical maximum score of 5 (indicating a very high degree of presence of the key condition). Consequently, a score of 5/5 indicates an actual score of 5 (demonstrating a very high degree of presence of the key condition) out of a theoretical maximum score of 5. The scores of key interventions are presented in a similar way. The total scores in the outer right columns of Table 7.2 through to Table 7.5 represent the sums of the scores on a single key condition or key intervention in the four individual cases. For each key condition or key intervention, the total score is thus 4 x 5 = 20. These total scores are therefore presented as for instance 6/20, indicating that the sum of the actual single scores in the four cases is 6 (for instance 1 + 2 + 3 + 0 = 6 for respectively Case 1 through to Case 4), out of the possible maximum score of 20.
Within Table 7.2 through to Table 7.5, Case 1 represents the geotechnical institute, Case 2 represents the project management consultancy, Case 3 represents the contractor, and Case 4 represents the public client organization.

Key conditions for risk management methodologies

Table 7.2 presents the scored degrees of presence of key conditions for risk management methodologies in each of the four cases.

Table 7.2 A cross-case presentation of key conditions for risk management methodologies in four cases.

No.	Description of key conditions for risk management methodologies	Scored degrees of presence of key conditions for risk management methodologies				
		Case 1	Case 2	Case 3	Case 4	Total
1	Applying risk management methodologies increases effectiveness or efficiency.	5/5	5/5	0/5	3/5	13/20
2	Applying risk management methodologies increases social status.	0/5	0/5	0/5	0/5	0/20
3	Avoidance of tool pre-occupation of the risk management methodologies.	0/5	5/5	0/5	0/5	5/20

Table 7.2 Continued

No.	Description of key conditions for risk management methodologies	Scored degrees of presence of key conditions for risk management methodologies				
		Case 1	Case 2	Case 3	Case 4	Total
4	Applying risk management methodologies generates preventive advantage by increased risk sensitivity.	5/5	0/5	0/5	5/5	10/20
5	Applying risk management methodologies generates supportive attitudes by its users.	0/5	5/5	0/5	0/5	5/20
6	Top management mandates applying risk management methodologies.	5/5	5/5	0/5	5/5	15/20
7	Applying risk management methodologies fits with values and beliefs.	0/5	5/5	0/5	0/5	5/20
8	Applying risk management methodologies is integrated in existing organizational practices.	0/5	5/5	5/5	5/5	15/20
9	Applying risk management methodologies fulfils needs of actors and stakeholders.	5/5	3/5	0/5	3/5	11/20
10	Applying risk management methodologies increases organizational innovativeness.	0/5	0/5	0/5	0/5	0/20
11	Applying risk management methodologies generates a positive meaning for actors and stakeholders.	0/5	0/5	0/5	0/5	0/20
12	Applying risk management methodologies has an acceptable complexity for its users.	5/5	1/5	5/5	0/5	11/20
13	Risk management methodologies are easy to try out by the targeted users.	0/5	5/5	0/5	0/5	5/20
14	Availability of benchmarks during the risk management implementation progress.	0/5	3/5	0/5	0/5	3/20
15	Availability of business cases that demonstrate results of applying risk management methodologies.	0/5	5/5	5/5	5/5	15/20
16	External parties request the application of risk management.	5/5	5/5	5/5	0/5	15/20
17	Applying risk management methodologies has an acceptable cost.	0/5	0/5	0/5	0/5	0/20
18	Applying risk management methodologies is useful and reliable for its targeted users.	5/5	0/5	0/5	3/5	8/20
Number of key conditions in the M.Sc. reports (maximum = 18 key conditions)		7/18	12/18	4/18	7/18	30/72
Total score (maximum = 18 key conditions x maximum score of 5 = 90)		35/90	52/90	20/90	29/90	136/360
Percentage of maximum possible score ((total score / maximum of 90) x 100 %)		39	57	22	32	38

7

The following conclusions are derived from analyzing Table 7.2. The highest number of key conditions for risk management methodologies (12 out of the theoretical maximum of 18, shown as 12/18 in Table 7.2) was identified in the M.Sc. report of Case 2. This case was the only one demonstrating an explicit implementation focus. Moreover, concepts about innovation of Rogers (2003) and Song (2006) were applied. This may have contributed to this relatively high figure. In total 7 of the 18 key conditions, (the numbers 1, 6, 8, 9, 12, 15, and 16) seem rather *generic*, because these revealed in the reports of three of out of four cases. In most of the cases, these key conditions also gained the maximum scores (shown as 5/5 in Table 7.2), indicating that these conditions have been fully addressed within those cases. In total 5 of the 18 key conditions, (the numbers 3, 5, 7, 13, and 14) seem rather case *specific*. These revealed in the report of only one out of four cases. Furthermore, 4 of the 18 key conditions (the numbers 2, 10, 11, and 17) were not addressed at all in any case report (shown as 0/5 in Table 7.2). On average, 38 percent of the key conditions for setting risk management conditions were identified within the reports of the four case studies. In other words, on average 62 percent of the key conditions were not explicitly addressed in the reports of the cases.

Key conditions for social systems

Table 7.3 summarizes the scored degrees of presence of key conditions for social systems in each of the four cases.

Table 7.3 A cross-case presentation of key conditions for social systems in four cases.

No.	Description of key conditions for social systems	Scored degrees of presence of key conditions for social systems				
		Case 1	Case 2	Case 3	Case 4	Total
1	Presence of organization-wide risk management methodologies.	5/5	5/5	5/5	5/5	20/20
2	Presence of formalized risk management responsibility.	0/5	3/5	3/5	3/5	9/20
3	Presence of lowest-level risk management r esponsibility.	0/5	0/5	0/5	3/5	3/20
4	Presence of formalized risk management reporting to senior management.	0/5	5/5	0/5	5/5	10/20
5	Presence of flexibility to risk management improvements.	0/5	3/5	0/5	0/5	3/20
6	Inclusion of the external environment in risk management processes.	5/5	5/5	0/5	0/5	10/20
7	Presence of shared risk awareness and understanding.	0/5	5/5	0/5	5/5	10/20
8	Co-existence of risk rationality and emotions.	0/5	0/5	0/5	0/5	0/20

Table 7.3 Continued

No.	Description of key conditions for social systems	Scored degrees of presence of key conditions for social systems				
		Case 1	Case 2	Case 3	Case 4	Total
9	Understanding of risk management interfaces.	0/5	5/5	0/5	0/5	5/20
10	Permanent attention to risk management resistance.	0/5	5/5	0/5	3/5	8/20
11	Acceptance of different risk management motivations.	0/5	5/5	0/5	0/5	5/20
12	Presence of institutionalized risk management learning behaviour.	0/5	5/5	0/5	0/5	5/20
13	Institutionalized sharing of risk information.	0/5	0/5	0/5	0/5	0/20
14	Understanding of different risk perceptions.	0/5	0/5	0/5	0/5	0/20
15	Presence of risk management opinion leaders.	0/5	0/5	0/5	0/5	0/20
16	Presence of risk management champions.	0/5	5/5	0/5	0/5	5/20
17	Shared decision making about risk management implementation.	0/5	0/5	0/5	0/5	0/20
18	Acceptance of risk management consequences.	0/5	0/5	0/5	3/5	3/20
19	Acceptance of initial efficiency reduction.	0/5	0/5	0/5	0/5	0/20
20	Acceptance of lacking direct risk management results.	0/5	0/5	0/5	0/5	0/20
21	Presence of risk management implementation milestones.	0/5	3/5	0/5	0/5	3/20
22	Acceptance of unanticipated risk management results.	0/5	0/5	0/5	0/5	0/20
23	Understanding of conflicts arising from applying risk management.	0/5	0/5	0/5	0/5	0/20
Number of key conditions in the M.Sc. reports (maximum = 23 key conditions)		2/23	11/23	2/23	7/23	22/92
Total score (maximum = 23 key conditions x maximum score of 5 = 115)		10/115	54/115	8/115	27/115	99/460
Percentage of maximum possible score ((total score / maximum of 115) x 100 %)		9	47	7	23	22

The following conclusions are derived from analyzing Table 7.3. In the M.Sc. reports of Case 1 and Case 3, concerning respectively implementing the application of GeoQ risk management and implementing the electronic risk database, a relatively low number of key conditions were acknowledged, when compared with the reports of Case 2 and Case 4. The latter two cases focus on implementing respectively RISMAN project management and portfolio risk management. In the reports of these cases, significantly more attention was given to social system types of key condition. In total 2 of the 23 key conditions, (the numbers 1 and 2) seem rather *generic*, because these revealed in the reports of three out of four cases. In total 7 of the 23 key conditions (the numbers 3, 5, 9, 11, 12, 16, and 21) seem rather case *specific*, as these were revealed in the reports of only one out of four cases. Furthermore, 9 out of the 18 key conditions (the numbers 8, 13, 14, 15, 17, 19, 20, 22, and 23) have not been addressed in any case (shown as 0/5 in Table 7.3). On average, 22 percent of the key conditions for social systems were identified in the reports of the four case studies. In other words, 78 percent of the key conditions were not explicitly addressed in the reports of the four cases.

Key interventions for risk management methodologies

Table 7.4 presents the scored degrees of execution of key interventions, for setting key conditions for risk management methodologies, in each of the four cases.

The following conclusions are derived from analyzing Table 7.4. Remarkably, in the M.Sc. reports of Case 1, Case 2 and Case 4 the same number of 5 out of 11 *key interventions* have been addressed, while the number of *key conditions* for risk management methodologies (12/18 in Table 7.2) in the report of Case 2 was substantially higher than the numbers in the reports of Case 1 and Case 4 (for both 7/18 in Table 7.2). Perhaps, the moderate (3/5) to high (5/5) degree of execution of key interventions in Case 2 generated more key conditions than the key interventions in Case 1 and Case 4.

The report of Case 3 demonstrates a substantial lower number of executed key interventions (2/11), which corresponds with the relatively low number of key conditions for risk management methodologies within this case (4/18 in Table 7.2). In total 2 of the 11 key interventions, (the numbers 3 and 4) seem rather *generic*, as these have been revealed in the reports of three out of four cases. Moreover, 2 out of the 11 key interventions (the numbers 5 and 6) seem rather case *specific*. Both interventions revealed in only one of the four cases. In total 3 of the 11 key interventions, (the numbers 1, 2, and 9) were not at all acknowledged within the four cases. On average, 33 percent of all key interventions for risk management methodologies were addressed in the reports of the four case studies. In other words, on average 67 percent of the key interventions remained unused in the four cases, at least according to the M.Sc. reports.

Table 7.4 A cross-case presentation of key interventions for risk management methodologies in four cases.

No.	Description of key interventions for risk management methodologies	Scored degrees of execution of key interventions for risk management methodologies				
		Case 1	**Case 2**	**Case 3**	**Case 4**	**Total**
1	Foster self-monitoring and self-evaluation of risk management processes	0/5	0/5	0/5	0/5	0/20
2	Ensure positive financial bottom line effects of the risk management implementation	0/5	0/5	0/5	0/5	0/20
3	Create risk management fit by re-designing existing work processes and by risk management inclusion in existing management practices	0/5	5/5	5/5	5/5	15/20
4	Generate RM support by appropriate methodologies, tools, and assistance	5/5	3/5	5/5	3/5	16/20
5	Set, monitor, and communicate risk profiles	0/5	0/5	0/5	3/5	3/20
6	Assess and reward risk management use by employees	0/5	3/5	0/5	0/5	3/20
7	Adapt the risk management methodology	5/5	0/5	0/5	5/5	10/20
8	Explicitly demonstrate and communicate the value of applying risk management	5/5	5/5	0/5	0/5	10/20
9	Enforce risk management accreditation	0/5	0/5	0/5	0/5	0/20
10	Ensure explicit top management commitment by defining targeted risk profiles	3/5	0/5	0/5	3/5	6/20
11	Mobilise external forces that require risk management application	5/5	5/5	0/5	0/5	10/20
Number of key interventions in the M.Sc. reports (max. = 11 key interventions)		5/11	5/11	2/11	5/11	17/44
Total score (maximum = 11 key interventions x maximum score of 5 = 55)		23/55	21/55	10/55	19/55	73/220
Percentage of maximum possible score ((total score / maximum of 55) x 100 %)		42	38	18	35	33

7

Key interventions for social systems

Finally, Table 7.5 presents the scored degrees of the execution of key interventions in the four cases, for setting social system type of key interventions.

Table 7.5 A cross-case presentation of key interventions for social systems in four cases.

No.	Description of key interventions for social systems	Scored degrees of execution of key interventions for setting social systems				
		Case 1	Case 2	Case 3	Case 4	Total
1	Arrange out-of-the-box thinking sessions	0/5	0/5	0/5	0/5	0/20
2	Provide sufficient time and budget for risk management implementation with sufficient organizational redundancy	0/5	3/5	3/5	3/5	9/20
3	Apply a staged implementation process with measurable objectives, explicit decision making, and points of no return	1/5	3/5	0/5	3/5	7/20
4	Combine situational leadership with well-balanced teams	0/5	0/5	0/5	0/5	0/20
5	Organise social gatherings	0/5	0/5	0/5	0/5	0/20
6	Provide education by a mixture of courses, training, coaching, and after action review sessions	0/5	5/5	0/5	0/5	5/20
7	Execute task, responsibilities, and authorities (TRA) sessions	0/5	0/5	0/5	0/5	0/20
8	Establish a risk management board	1/5	2/5	0/5	5/5	8/20
Number of key interventions in the M.Sc. reports (max. = 8 key interventions)		2/8	4/8	1/8	3/8	10/32
Total score (maximum = 8 key interventions x maximum score of 5 = 40)		2/40	13/40	3/40	11/40	29/160
Percentage of maximum possible score ((total score / maximum of 40) x 100 %)		5	32	8	28	18

The following conclusions are derived from analyzing Table 7.5. For all of the four cases, the number of identified social system-related key interventions in the reports is rather limited. This is indicated by the number of key interventions in the M.Sc. reports in Table 7.5, which are between 1/8 and 4/8. In total 3 out of 8 key interventions, (the numbers 2, 3 and 8) seem rather *generic*, because these revealed in the reports of three out of four cases. Only 1 out of the 8 key interventions (number 6) seem rather case *specific*. This intervention was only in one of the reports of the four cases encountered. In total 4 of the 8 key interventions (the numbers 1, 4, 5 and 7) or 50 percent of the key interventions for social systems were not at all acknowledged within the reports of the four cases. On average, only 18 percent of all social system related key interventions were addressed in the reports of the four case studies. In other words, on average 72 percent of the key interventions remained unused in the four cases, at least based on the M.Sc. reports.

7.4.2 Cross-case analysis of the field study results

In this section, the cross-case analysis results of the *field* study part of the single cases are reported. The field study results of the three empirical checks of the individual cases have been compared over a three-year period. When contributing, desk study data has been incorporated. The partially ordered matrix approach after Miles and Huberman (1994) has been applied.[152] Table 7.6 summarizes the data of the cross-case analysis in three main columns, for Empirical Check 1 through to Empirical Check 3. The following conclusions are retrieved from the cross-case analysis for each of the three empirical checks.

First empirical check

The first empirical check aims verifying the *relevance* of the *key conditions* and *key interventions* of the initial conceptual model and audit instrument for implementing risk management in organizations. The columns of Empirical Check 1 in Table 7.6 show the percentages of the total numbers of key conditions and key interventions considered relevant by the M.Sc. researchers, managers, and risk management users within each case. For instance, in total number of key conditions for risk management methodologies within the audit instrument is 18. The 89-100 % figure for Case 1 in Table 7.6 indicates the that three respondents of Case 1 considered between 89 % and 100 % (between 16 and 18 key conditions) of the total number of key conditions relevant. The same approach has been followed for the social systems key conditions and two sets of key interventions.

Considerably high percentages, in general above 75 percent, indicates that a majority of key conditions and key interventions being considered relevant by the respondents of the three cases. This applies to the key variables for risk management methodologies, as well as for social systems. Within Case 1, Case 2, and Case 3, even all key conditions and key interventions were considered relevant by a number of the respondents. In Case 4, the only respondent was the former M.Sc. researcher, which explains the single figures. Apparently, this respondent judged the relevance of the key conditions and key interventions relatively low, by generating values between 57 % and 75 %, when compared with the figures of the other three cases.

152 This approach has been effectively applied in cross-cases analyses, for instance by Caerteling et al. (2008a, 2008b).

7

Table 7.6 Cross-case analysis of three empirical checks of the initial risk management implementation approach over a three-year period.

Cases	**Empirical Check 1** Relevance of key conditions and key interventions, indicated as percentage of the total numbers				**Empirical Check 2** Type of relationship between key interventions and key conditions, indicated by the key intervention numbering (key condition numbering)						**Empirical Check 3** Relationship between key conditions and risk management implementation		
	Key conditions		**Key interventions**		**Under-proportional**		**Proportional**		**Over-proportional**		**Average presence of key conditions**		**Qualitative description of risk management implementation (-)**
	RM Methods (%)	**Social System (%)**	**RM Methods (%)**	**Social System (%)**	**RM Methods (nr.)**	**Social System (nr.)**	**RM Methods (nr.)**	**Social System (nr.)**	**RM Methods (nr.)**	**Social System (nr.)**	**RM Methods (%)**	**Social System (%)**	
Case 1: institute	89-100	78-100	82-100	75-100	5(14) 8(10)	1(14,20) 7(2,4)	3(8), 4(3), 5(15), 6(5), 7(7,9) 8(18), 9(2) 10(11), 11(16)	1(8,9,14,20, 22,23) 2(10,19,) 3(21), 4(11) 5(13,17,18), 6(5,7,12), 7(3), 8(15,16)	1(4) 2(1,17) 10(6)	1(6)	58	56	*Moderate* degree of implementation: increasing organizational interest, growing turnover by using risk management in projects.
Case 2: consultant	78-100	78-100	54-100	75-100	4(13) 8(10)	-	3(8), 4(3,12) 6(5), 5(14,15), 7(7,9), 8(18), 9(2)	1(8,14,20, 22,23), 2(10,19) 3(21), 5(13,17,18), 6(5,7,12)	1(4) 10(6,11) 11(16)	1(6,9) 4(11) 8(15,16)	54	49	*Moderate* degree of implementation: growing number of projects using risk management and improved output.
Case 3: contractor	94-100	100-100	100-100	100-100	4(3,13)	2(10,19)	1(4), 2(1,17), 3(8), 4(12), 5(14,15), 6(5) 7(7,9), 8(10,18), 9(2), 10(6,11)	1(6,8,9,14, 20,22,23), 3(21), 4(11) 5(13,17,18) 6(5,7,12), 7(2,3,4), 8(15,16)	11(16)	-	51	43	*Low to moderate* implementation degree: growing use of project risk management, use of electronic risk database stopped.

Table 7.6 Continued

Cases	Empirical Check 1 Relevance of key conditions and key interventions, indicated as percentage of the total numbers				Empirical Check 2 Type of relationship between key interventions and key conditions, indicated by the key intervention numbering (key condition numbering)						Empirical Check 3 Relationship between key conditions and risk management implementation		
	Key conditions		Key interventions		Under-proportional		Proportional		Over-proportional		Average presence of key conditions		Qualitative description of risk management implementation (-)
	RM Methods (%)	Social System (%)	RM Methods (%)	Social System (%)	RM Methods (nr.)	Social System (nr.)	RM Methods (nr.)	Social System (nr.)	RM Methods (nr.)	Social System (nr.)	RM Methods (%)	Social System (%)	
Case 4: public client	67	57	64	75	-	3(21)	3(8), 4(12) 5(15), 6(12) 7(9), 9(2), 10(11), 11(16)	1(6,9,20,23), 2(10,19) 6(5,7), 7(2,3)	8(18) 10(6)	7(4)	37	24	*Low* degree of implementation: rising awareness, no use of a model.
Main conclusions	Relevant	Relevant	Relevant	Relevant	Few case-dependant key interventions relate under-proportionally to key conditions of same intervention aspects.		The majority of key interventions relate proportionally to key conditions of the same intervention aspect.		Several case-dependant interventions correlate over-proportional to key conditions of same intervention aspects.		The presence of key conditions corresponds with the risk management implementation degree, as derived from the interviews. All cases show significant opportunities for improving risk management implementation.		

7

In conclusion, based on the figures in Table 7.6, the conceptual model and audit instrument for risk management implementation in organizations has *relevant* sets of key conditions and key interventions, for risk management methodologies as well as for social systems. Moreover, these sets can be considered *complete*, because the interviews did not reveal new conditions or interventions.

Second empirical check

The second empirical check has been performed for confirming or rejecting the theoretically derived causal *relations* between *key interventions* and *key conditions* of similar intervention aspects. Within each of the individual cases, individuals scored the degree of presence of each key condition and also the degree of execution of each key intervention in their organization, by completing the questionnaires of the audit instrument for implementing risk management. Within the cross-case analysis of these field results, the *sum* of the individual scores on the degree of presence of each *key intervention* was compared with the *sum* of the individual scores on the degree of presence of the targeted *key conditions*. Key interventions for setting or strengthening key conditions are belonging to the same intervention aspect, according to the conceptual model for implementing risk management in organizations. Scores performed by the Ph.D. researcher and the M.Sc. researcher were used. If available, scores provided by the manager and risk management user were included. Also according to the conceptual model for implementing risk management, key variables (key interventions and key conditions) for risk management methodologies have been distinguished from those for social systems.

Similar to the single-case analysis, three sorts of relationship between key interventions and key conditions have been distinguished: (1) a *proportional* relationship, (2) an *under-proportional* relationship, and (3) an *over-proportional relationship*. Obviously, there is also a possibility of no empirical relationship at all, which would reject the theoretically derived relationships between both types of variable. This option would be reflected by extreme under- or over-proportional relationships.

For each of the four cases, the three main columns of Empirical Check 2 in Table 7.6 show these *under-proportional*, *proportional*, and *over-proportional* types of relationship between key interventions and their targeted key conditions. The *numbering* of the *key interventions* for setting conditions for risk management methodologies and social systems correspond with the *numbering* in respectively Table 6.7 and Table 6.8 in Chapter 6. Similarly, the *numbering* of the related *key conditions* (presented in between brackets) of the same intervention aspect correspond with the *numbering* of the key conditions for risk management methodologies in Table 6.3 and with those for social systems in Table 6.4 (also in Chapter 6). The *descriptions* of key conditions and key interventions can be derived from these four tables. For instance, Case 1 in Table 7.6 shows 1(4) in the column of over-proportional key interventions for risk management methodologies. It refers to Key Intervention 1 (foster self-monitoring and self-evaluation of risk management processes) for setting Key Condition 4 (applying risk management methodologies generates preventive advantage by increased risk sensitivity) for risk management methodologies.

A *proportional* relationship implies that key interventions have a proportional or *equal impact* on realizing the key conditions of the same intervention aspect. A certain score on the execution of a key intervention would provoke an about similar score on the targeted key condition. The chosen criterion for a proportional relationship between a key intervention and a key condition is a *maximum difference* of 1 between a key intervention and a key condition score, by one individual. Therefore, for being classified as a proportional relationship, according to this criterion a score of 3 by an individual risk management user on the execution of a key intervention (indicating a moderate degree of execution) would imply also score of also 3 by the same individual risk management user on the targeted key condition (indicating also a moderate degree of the presence of the key condition). Alternatively, a score of 2 or a score of 4 on the degree of presence would still imply a proportional relationship. However, scores of 1 or 5 would respectively imply under- or over proportional relationships, which is elaborated next. The sets of key intervention and targeted key conditions in Table 7.6 belong to the same intervention aspect. For the aggregate score by two, three or four individuals, the criterion for a proportional relationship becomes respectively a maximum difference of respectively 2, 3, or 4, between the sum of the scores on the key interventions and the sum of the scores on the key conditions.

As shown in the two columns with proportional relationships in Table 7.6, based on the available field study data, a *majority of key interventions* seem to have a *proportional impact* on the *key conditions* of same intervention aspects. This applies to key interventions for setting key conditions for risk management methodologies, as well as for those for establishing social system key conditions.

An *under-proportional* relationship indicates that key interventions have a relatively *low* impact on realizing the targeted key conditions belonging to the same intervention aspect. A certain score of an key intervention would thus provoke a considerable lower score of the targeted key condition.[153] Such interventions are *relatively ineffective*. Table 7.6 shows that in total seven interventions seem to have this under-proportional effect on one or more conditions. These intervention–conditions combinations are largely case-specific. Only two under-proportional key interventions for risk management methodologies, number 4(13) and 8(10) are present in two cases. These under-proportional interventions, generating risk management support by appropriate methodologies, tools, and assistance, and explicitly demonstrating and communicating the value of applying risk management, are slightly more generic than the remaining key interventions.

An *over-proportional* relationship indicates key interventions having a relatively *high* impact on realizing targeted key conditions of the same intervention aspect.[154] A certain score of an intervention would provoke a higher score of the targeted key condition. Consequently, these interventions are *relatively effective*. According to Table 7.6, nine interventions seem to have an over-proportional effect on setting conditions of the same intervention aspect. In addition, these relations seem largely case-specific, because only four of these nine key interventions have an over-proportional impact in more than one case (it concerns just two cases). These are number 1(4), 10(6), and 11(16) for risk management methodologies, which respectively represent fostering self-monitoring and self-evaluation, ensuring top management commitment, and mobilizing external forces requiring risk management. Also the over proportional social system key intervention 1(6) occurs in two cases. This key intervention is about arranging out-of-the-box thinking sessions. These four key interventions are slightly more generic than the remaining key interventions.

In conclusion, *within* and *in-between* the single cases there are significant differences between individually scored key interventions and key conditions. This results apparently from inherent differences in perception of individuals who completed the questionnaires of the audit instrument for risk management implementation. Within each case, two to four individuals, with different roles within

153 For the score by one individual, the difference between the score on a *key intervention* and a key condition is *more* than 1. For the aggregate score by two, three or four individuals, this difference is respectively *more* than 2, 3, or 4.

154 For the score by one individual, the difference between the score on a *key condition* and a *key intervention* is *more* than 1. Note that the order of key conditions and key inteventions is the reverse of the one in the previous footnote number 153. For the aggregate score by two, three or four individuals, this difference is respectively *more* than 2, 3, or 4. For instance, in Case 1, four individuals completed the questionnaires by scoring interventions and conditions. Therefore, the over-proportional relationship implies that the sum of the scores on Key Condition 4 by the four respondents is at least 4 points higher than the sum of the scores on Key Intervention 1. Therefore, in Case 1, Key Intervention 1 has an over-proportional and thus *relative high impact* on setting Key Condition 4, when compared with other key interventions.

the risk management implementation process, completed the questionnaires. This sample size is obviously too small for sound statistical analysis. Moreover, it should be realized that the persons completing the questionnaires were not informed, and therefore not aware, of the assumed relationships between key interventions and key conditions, according to the five intervention aspects. Together with the lack of discrete longitudinal data within the cases, this could be a reason for lacking *generic* proportional or disproportional relationships between single key interventions and key conditions. Therefore, based on the available data sets, no generic empirical relationships between key interventions and key conditions of an intervention aspect could be either confirmed, or rejected.

Third empirical check

This third and last empirical check aimed verifying the assumed *relationship* between the presence of *key conditions* and the degree of *risk management implementation* within an organization. The columns of Empirical Check 3 in Table 7.6 show the average presence of the key conditions for risk management methodologies and those for social systems, as well as a qualitative description of risk management implementation within each case. The latter information has been derived from the interviews during the field research.

The average scores on the degrees of presence of the key conditions have been calculated from the scores in the questionnaires of the audit instrument for risk management implementation. The average scores are expressed as percentages of the maximum possible scores, when all of the 18 key conditions for risk management methodologies and all of the 23 key conditions for social systems would be present to the maximum degree of very high presence within the organization. Similarly, average values for the degree of execution of key interventions have been calculated. The scores by the Ph.D. researcher and the M.Sc. researcher were used. If available, also scores by the manager and risk management user were included. It provided a judgement about the degree of presence of key conditions and the degree of execution of key interventions of each case over a three years period. Table 7.7 shows the results for each of the four cases. The average values of the scores are presented in *italic* letter type. The average values for key conditions are also presented in the overview of Table 7.6

Table 7.7 Presence of key interventions and key conditions within the case organizations.

Case	Judgement by	Execution of key interventions over a 3 years period		Presence of key conditions over a 3 years period	
		Key interventions for risk management methodologies (% of total)	Key interventions for social systems (% of total)	Key conditions for risk management methodologies (% of total)	Key conditions for social systems (% of total)
1. Institute	Ph.D. researcher	42	4	39	9
	M.Sc. researcher	64	67	57	63
	Manager	73	62	72	59
	Risk management user	36	26	66	52
	On average	*54*	*40*	*58*	*46*
2. Consultant	Ph.D. researcher	38	29	57	47
	M.Sc. researcher	35	47	40	32
	Manager	38	40	63	49
	Risk management user	36	24	57	76
	On average	*37*	*35*	*54*	*49*
3. Contractor	Ph.D. researcher	18	7	22	7
	M.Sc. researcher	71	71	71	66
	Manager	53	44	61	57
	Risk management user	-	-	-	-
	On average	*47*	*41*	*51*	*43*
4. Public client	Ph.D. researcher	35	24	32	23
	M.Sc. researcher	36	38	41	25
	Manager	-	-	-	-
	Risk management user	-	-	-	-
	On average	*36*	*31*	*37*	*24*

The average values in Table 7.7 indicate that in Case 1 and Case 3, three years after starting the M.Sc. research about risk management in the organizations, the *key interventions* and *key conditions* are executed and present between about 40 percent and 60 percent of their full potential. In Case 2 key interventions for risk management methodologies were executed for 37 percent and those for social systems for 35 percent. In Case 4, the lowest values were retrieved. These figures seem to correspond rather well with the low to moderate degree of risk management implementation within the case organizations, as *qualitatively* retrieved from the interviews. Unfortunately, *quantitative* data about the degree of risk management implementation was not available within the case organizations. None of the organizations defined objective for implementing risk management in quantitative terms. Moreover, each case organizations had different and rather vague criteria indicating the degree of risk management implementation. The relatively low presence of key conditions and key interventions in Case 4, when compared with the other cases, aligns with the fact that the developed portfolio risk management model has never been implemented. Similarly, also a rather low presence of conditions and interventions would have been expected in Case 3, where the application of the developed electronic risk management database stopped some time after completion of the M.Sc. research. However, in Case 3 a number of risk management activities continued, as mentioned by the manager in the interview.[155]

Remarkably, Table 7.7 shows that for all of the four cases risk management methodologies-related conditions and interventions are present to a higher degree than social system-related conditions and interventions. This may be caused by the rather technical approach of risk management implementation in each of the four case organizations, which all operating in the construction industry. Moreover, the M.Sc. research has been provided by technically oriented students. Nevertheless, all of the four cases demonstrate significant opportunities for improving risk management implementation within the organizations, by executing (additional) interventions for establishing or strengthening already existing conditions.

Figure 7.4 provides a graph with the relationship between the (quantitative) degree of presence of key conditions and the (qualitative) degree of risk management implementation within each case. The numbers in the ovals of each case refer to the average values of respectively the presence of *key conditions* for *risk management methodologies* and those for *social systems*.[156] These values were derived from the columns with figures for key conditions, presented in Table 7.7. Figure 7.4 shows that the degree of risk management implementation in a case organization corresponds with the degree of presence of the key conditions within the same organization. From this graph, it is concluded that a higher presence of key conditions gives a higher degree of risk management implementation. This effect is the strongest when the degree of risk management implementation is still low, which is indicated

155 This single individual may have demonstrated a rather optimistic view on the degree of risk management implementation within his organization, which could not be confirmed or rejected by a risk management user.

156 For instance, the values of 58 and 46 for Case 1 indicate an average presence of key conditions for risk management methodologies for 58 percent of the maximum possible presence and an average presence of key conditions for social systems of 46 percent of the maxium possible presence.

by the rather steep slope of the graph. When reaching a moderate degree of risk management implementation, the slope of the graph flattens, which indicates that a relative low increase in the degree of presence of key conditions within an organization provides a substantial increase in risk management implementation. This effect may be caused by favourable interactions of the different key conditions that only can occur after their moderate degree of presence.

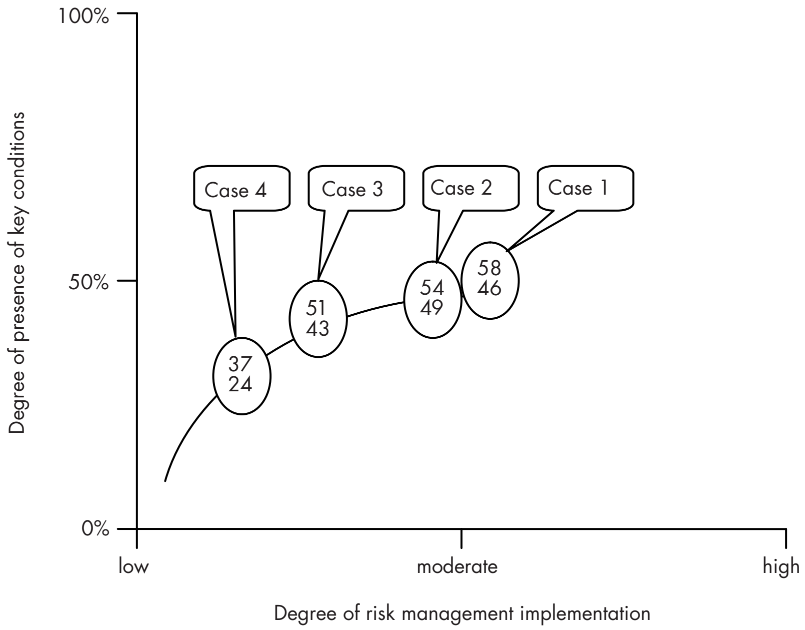

Figure 7.4 Relationship between presence of key conditions and risk management implementation.

In conclusion, from a *qualitative* point of view, the results of applying the audit instrument for risk management implementation seem to provide reasonable insight in the degree of risk management implementation within each of the case organizations. The higher the degree of presence of the key conditions within a case, the higher the degree of risk management implementation. When comparing the results of the individual cases with each other, cases with a higher degree of risk management implementation are distinguished from the cases with a lower degree of risk management implementation. These conclusions are based on the established presence of key conditions within each case, by using the audit instrument for risk management implementation, and have been confirmed by the results from the interviews. Nevertheless, from a *quantitative* point of view, the data set is yet too limited for a sound statistical analysis. A quantitative analysis would imply completion of the questionnaires of the audit instrument within one case, and preferably more than one case, by a statistically minimum required number of users and managers.

7.5 Results and next research step

Research results

Throughout this chapter, the practical relevance of the initial conceptual model and audit instrument for risk management implementation has been validated. Three empirical checks were executed in four case organizations. Single- and cross-case analyses were performed. The following main conclusions about the three empirical checks are drawn from this multiple-case analysis:

1. With regard to the first *relevance* check of the of key conditions and key interventions: all of the 41 key conditions and 19 key interventions of the risk management implementation model are perceived relevant for implementing risk management within organizations by managers, users, and researchers;
2. With regard to the second check of causal *relationships* between key conditions and key interventions: the majority of the key interventions seems to be more or less proportionally related to key conditions of the same intervention aspect. The key interventions aim to set or to strengthen these key conditions. However, adequate time-dependant data and sufficient quantitative data is lacking for confirming or rejecting this conclusion at a generic level beyond the single cases;
3. With regard to the third check of causal *relationships* between key conditions and risk management implementation: the degree of presence of the 41 key conditions within an organization relate proportionally to the degree of risk management implementation in the organization.

The first and the third empirical check confirmed the practical relevance of the developed conceptual model and audit instrument for risk management implementation. However, the second empirical check for confirming the assumed causal relationship between key interventions and their targeted key conditions of the same intervention aspect did not generate clear and generic validity. Despite the generally proportional relationships between key interventions and key conditions within each of the intervention aspects, the theoretically assumed causal relations were neither clearly empirically confirmed, nor clearly empirically rejected. This lack of clear causal relationships between interventions and conditions seems to confirm the lack of invariant laws in the organizational design sciences, as raised by Numagami (1998) in Van Aken (2008a).

Research limitations

The following limitations of the initial conceptual model and audit instrument for implementing risk management emerged during and after executing the three empirical checks in the single- and cross-case analyses:

1. For assessing the *overall usefulness* of the risk management implementation approach in the professional practice, *additional design specifications* needed to be defined and evaluated;
2. The second empirical check of the theoretically derived causal *relations* between key interventions and targeted key conditions within one of the five intervention aspects showed more or less proportional relationships. However, because of significant variations, both within and in-between the cases, these relationships could not be clearly and empirically confirmed, or rejected, at a generic level beyond the individual cases. Therefore, the assumed *effects* of key interventions on the key conditions for risk management implementation process required *reconsideration*;
3. The first *key condition* for social systems, the presence of organization-wide risk management methodologies, seems to be quite *similar* to the *main dimension* of the initial risk management implementation model: risk management methodologies. This confusing doubling needed avoidance;
4. The four *questionnaires* of the audit instrument for measuring and monitoring risk management implementation required becoming more *user-friendly*, by:
   a. Providing more to-the-point and shorter descriptions of key conditions and key interventions;
   b. Presenting the characteristics and subcharacteristics of the risk management methodologies and social systems, which need to be established for risk management implementation by setting or strengthening key conditions;
   c. Relating percentages to the five-point scale of the questionnaires of the audit instrument, for allowing more accurate judgements of the presence of key conditions and the execution of key interventions.

5. It was not yet clearly described *how to use* the initial model and audit instrument during the *process* of risk management implementation. In other words, in addition to the conceptual model a design process model for providing guidance about the risk management implementation process was considered required.

Next research step

Because of these research result limitations, the design of the initial conceptual model and audit instrument for risk management implementation required modifications. These are the topic of the next chapter.

8

MODIFIED DESIGN PROPOSITIONS FOR RISK MANAGEMENT IMPLEMENTATION

8.1 Introduction

This chapter reports the third step of the development oriented research part. Within the previous chapter, the initial design propositions for implementing risk management in organizations were validated by a multiple-case analysis. The results revealed the need for modifications of the conceptual model and the audit instrument. These should increase scientific reliability and validity, as well as usefulness in the professional practice. This chapter presents the *modified* design propositions for risk management implementation, by a revision of the conceptual model and an adaptation of the audit instrument. Moreover, it adds a proposal for a *design process model* for providing guidance of the risk management implementation process.

First, this chapter presents the *modification* of the *initial* conceptual model and audit instrument for risk management implementation, according to a series of eight additional design criteria. These *additional* criteria stem from a professional practice point of view.

The next section presents the development of a *design process model*. This model aims to provide guidance about *how* to use the conceptual model and audit instrument of the developed risk management implementation approach. The design

process model indicates which steps should be taking by which actors, during the entire *process* of risk management implementation within an organization. The target groups for the design process model are risk management, organizational, and change management consultants. The latter two types of expert assist the implementation process of risk management within the social systems of organizations.
The one but last section presents the results of the expert panel meeting. An *expert panel* has been organized for evaluating the *modified* design of the risk management implementation approach, including the added design process model. During the meeting, nine experts evaluated the modified design proposition from a practical point of view and according to the additional design specification. Finally, the main research results, the limitations, and the resulting research step for the next chapter are presented.

8.2 Modified design of the risk management implementation approach

Additional design criteria

For the *modified design* of the risk management implementation approach, a number of additional design criteria have been formulated from a professional practice point of view. In addition to the three *initial* design criteria, for providing overall usefulness the *modified* risk management implementation approach should satisfy eight additional criteria:

1. provide *state-of-the art* knowledge;
2. be *complete* with regard to conditions and interventions for implementing risk management;
3. be *suitable* for all actors involved in the implementation process;
4. be *applicable* for all types of risk management methodologies;
5. be *flexible* by allowing adaptations for context-specific use;
6. be *effective* in meeting the organizational risk management implementation objectives;
7. be *efficient* with regard to the required resources for implementing risk management;
8. be *transferable* to other persons.

These criteria are derived from combining and building forward on proposed specifications by Halman (1994) and Klein and Sorra (1996). Together, these form the additional design specification. The *order* of the eight criteria is arbitrary. The *numbering* is only for identification purposes and is not intended to reflect any differences in importance between the eight criteria. Each of them should be fulfilled to an acceptable degree, for guaranteeing a risk management implementation approach with sufficient overall usefulness.

Modification of the conceptual model for risk management implementation

According to eight additional design criteria, the initial conceptual model for risk management implementation needed *modification*. This approach of theory building from case studies is suggested by Eisenhardt and Graebner (2006). It also corresponds with the so-called synthesis-evaluation iterations by Van Aken (2008b).

The most fundamental modification of the initial conceptual model was relating the key interventions to specific risk management *user groups*. In the initial model, key interventions were directly related to key conditions of the same intervention aspect. However, the second empirical check did not generically confirm, nor reject, the assumed relations between key interventions and targeted key conditions of the same intervention aspect. This was caused by a lack of time-dependant data and quantitative data within the cases, and perhaps also by unawareness of the participants within the cases studies, as discussed in the previous chapter.

In addition, after critically reviewing the initially derived key interventions and their assumed corresponding key conditions, it became doubtful whether this correlation could be validated for a number of key interventions and their related key conditions anyway, even if sufficient time-dependant and quantitative case study date would become available. Some of the formulated initial key interventions appeared too generic for actually generating key conditions for risk management methodologies and social systems. Therefore, it has been decided to *transform* the initially designed key interventions for realizing key conditions for risk management methodologies and social systems to key interventions for implementing risk management within specific and targeted risk management user groups. The concept with five degrees of motivation and commitment from Malhorta and Galetta (2002), based on Kelman (1958), has been related to the five innovation adopter categories by Rogers (2003) and included in the modified conceptual model for risk management implementation. Therefore, intervention dimension of the initial risk management implementation model has been replaced by the risk management user dimension.

This major modification of the risk management model has one significant consequence. Generating the required key conditions for risk management methodologies and social systems has not been directly related anymore to the modified key interventions. The actual focus of the key interventions is now the distinguished risk management user groups.

It is therefore up to *risk management experts* to decide upon the required activities for generating the key conditions for the risk management methodologies to a sufficient degree. Similarly, *organizational consultants* should provide proposals for setting the required levels of social system-related key conditions. *Change management consultants* may help to execute the required interventions within the targeted risk management user groups. Obviously, these three types of expert should preferably work together in one team for realizing risk management implementation within an organization. This approach provides in fact a *multi-level* model, by distinguishing between individuals in the user groups *and* the social system of the organization in which the individuals work (Klein et al, 1999).[157]

In conclusion, *user-group selection* became the core aspect of the modified conceptual model for risk management implementation. The characteristics of the selected group(s) for routinized risk management application, which have been defined as risk management implementation, highly determine the required type of key interventions and key conditions for risk management methodologies and social systems. The resulting conceptual model is presented in Chapter 9 with the final research products.

Modification of the audit instrument for risk management implementation

The modifications of the audit instrument for risk management implementation followed the modifications of the conceptual model for risk management implementation. Most significant is the modification of the questionnaire for auditing the degree of execution of *key interventions* within an organization. For each of the five intervention aspects, all of the key interventions for risk management methodologies and those for social systems, of the initial proposition have been critically evaluated and compared. This resulted in merging a number of initial

157 Several scholars investigating the implementation processes of innovations in organizations advocate developing multi-level models, such as Danserau et al. (1999), Detert et al (2000), Holahan et al. (2004), Klein and Knight (2005), Klein and Sorra (1996), Lapointe and Rivard (2005), Lewis and Seibold (1993), Swanson and Ramiller (2004). The main benefit of a multi-level approach is the deeper and richer understanding of organizations, by acknowledging the interdependence of individuals and organizations, which remains hidden within single-level research. However, a lack of experience, caused by underdeveloped multi-level academic training and the difficulty of doing multi-level research, is a commonly approached barrier for multi-level theory building (Klein et al., 1999).

key interventions of the same intervention aspect. Furthermore, a number of key interventions have been deleted, because these appeared corresponding too closely with key conditions for either risk management methodologies or social systems. This raised confusion during the completion of the questionnaires. Finally, by using the relationship between intervention aspects and risk management users groups, as presented in the previous section, the modified key interventions have been classified according to the risk management user groups.

From the series of 19 *initial* key interventions, a series of in total 10 *modified* key interventions were derived for implementing risk management within four of the five target groups. Trying to implement risk management within the final group of laggards seemed ineffective. This group is characterized by non-commitment, while the other groups have either full commitment by self-regulation (the innovators), commitment by internalization (early adopters), commitment by identification (early majority) and commitment by compliance (late majority), by synthesizing the ideas from Rogers (2003), and Malhorta and Galetta (2002).

Table 8.1 lists the modified key interventions for the distinguished risk management user groups and the corresponding intervention aspects. The *order* of the modified key interventions within each intervention aspect stems from the initial key interventions. The *numbering* of the modified key interventions in Table 8.1 is only for identification purposes. These numbers do not reflect any relative relevance of the modified key interventions to each other. Because they were derived as modified *key* interventions, *each* of the key interventions is relevant for risk management implementation and should be acknowledged during the implementation process.

Table 8.1 Modified key interventions for risk management (RM) user groups.

Risk management user groups	Intervention aspects	Modified key interventions	
		No.	**Description**
All groups	Learning	1	Apply situational leadership and teamwork
		2	Provide risk management education and training
Innovators	Autonomous	3	Arrange out-of-the-box risk management sessions
		4	Forster self-monitoring and self-evaluation of risk management
Early adopters	Rational	5	Apply a staged risk management implementation process
		6	Facilitate the application of RM with resources (time, budget)
		7	Set, monitor, and communicate the added value of RM
Early majority	Emotional & Political	8	Organize social gatherings
		9	Organize task, responsibility, and authority sessions
Late majority		10	Enforce the application of risk management by accreditation
Laggards		-	None – do not waste resources on inherently unwilling laggards

It should be noticed that key intervention number 1 and number 2 within the learning intervention aspect is essential for all groups. Anyone involved in risk management should at least learn about teamwork and how to apply risk management. Moreover, situational leadership is required within all groups, because of their inherently different characteristics, which requires fit-for-purpose situational leadership approaches.

If risk management implementation dissipates throughout an organization, by targeting user group after user group, then the degree of risk management formalization necessarily increases. The relatively small groups of innovators and early users will find out their own ways for applying risk management. However, the early majority, and particularly the large group of the late majority will demand for well-structured risk management methodologies, including for instance risk checklists and report formats. This formalization is also required for maximizing the risk management efficiency within an organization. By implementing risk management within the next user group, interventions have to be *added* to already executed interventions.

Furthermore, also the initial *key conditions* needed some slight modification. Particularly the first key condition for social systems, which is the availability of organizational wide risk management methodologies, appeared to be rather similar to the second main dimension of the initial risk management implementation model of risk management methodologies. This doubling raised confusion and needed to be avoided. Therefore, this first key condition was eliminated in the modified audit instrument for risk management implementation, which reduced the total number of key conditions for social systems by one, from 23 to 22 key conditions. Therefore, the total number of key conditions within the modified audit instrument for risk management implementation reduced also by one, from 41 to 40 key conditions.

Finally, based on the conclusions and the research experiences during the single- and cross-case analyses the following modifications in the questionnaires of the initial audit instrument for risk management implementation have been made:

- More to the point and shorter descriptions of key conditions and key interventions;
- Including characteristics and sub-characteristics of the risk management methodologies and social systems in the questionnaires;
- Relating percentages to the five-point scale of the questionnaires. This provides five possible scores, corresponding with 0-20% presence, 20-40% presence, 40-60% presence, 60-80% presence, and 80-100% presence of key conditions and execution of key interventions in the audit instrument.

Throughout the research is became clear that these modifications were not yet the final ones. The final audit instrument for risk management implementation is presented in Chapter 9.

8.3 A design process model for implementing risk management

Introduction of a design process model

A design process model aims to guide how to use the modified conceptual model and the audit instrument for risk management implementation during the risk management implementation process. In this phase of the development research, a modified version of the innovation diffusion framework by Rogers (2003: 421) served as the design process model. It distinguishes three phases and four steps for implementing risk management within organizations. Figure 8.1 presents the proposed design process model.

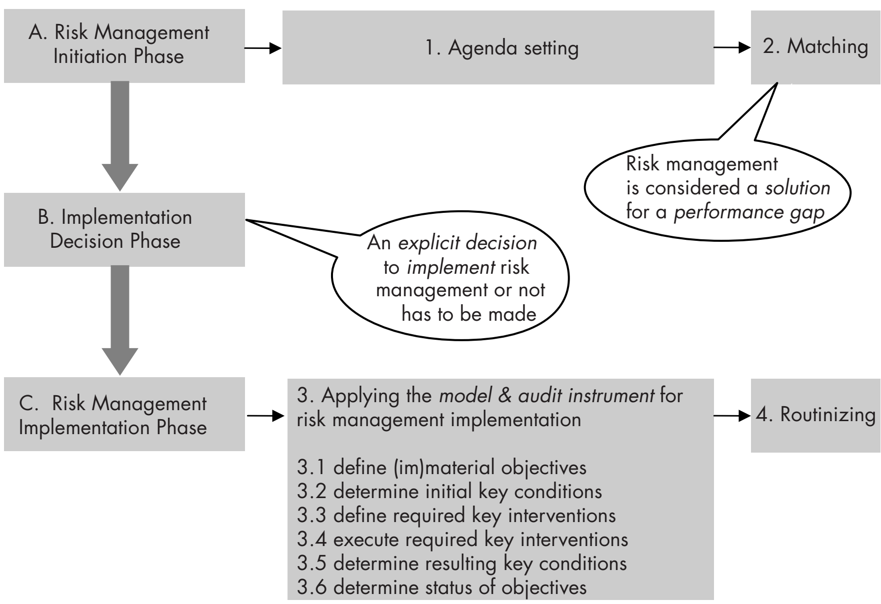

Figure 8.1 Design process model for implementing risk management within an organization.

8

Before starting with any risk management implementation within an organization, risk management should be initiated by agenda setting and matching. The initiation phase starts with *agenda setting*, when an organizational problem or performance gap arises that may create a need for an innovation. Rogers (2003: 422) defines a *performance gap* as "the discrepancy between the expectations of an organization and its actual performance". The recognition of a performance gap can trigger an innovation process. An example of a performance gap is the occurrence of (too) high failure costs within the construction projects of an organization. The desire or need for reducing these failure costs, for minimizing losses and increasing profitability, may be an important trigger for implementing risk management within an organization.[158]

The second step of the initiation phase is conceptually fitting or *matching* of the identified performance gap with one or more promising innovations. The feasibility of the innovation will be judged with regard to its potential for reducing or closing the performance gap. During the matching phase, it should become clear whether the implementation of risk management methodologies is a promising solution for the identified problem(s), or not.

Depending on the outcome of the matching phase, and definitely before moving to the implementation phase, a management decision to adopt the innovation or not should be made. For making this *explicit decision* to implement either discipline-based risk management, project risk management, or portfolio risk management within an organization, it should become clear that implementing any of these types of risk management has a fair change of closing the performance gap. Because of being a preventive type of innovation, without direct relationships between investments and benefits, matching of risk management with performance gaps is inherently difficult. To some degree, there should be a *positive belief* about the benefits of risk management. This once again confirms the need for explicit decision making about any type of risk management implementation within an organization, preferably at the highest management level for generating a maximum of management commitment. Otherwise, managers at all levels within the organization may easily find escapes for *not* investing the required resources of time and money in the tedious process of implementing risk management. Therefore, two specific requirements should be fulfilled, before starting any risk management implementation activity. These are therefore presented in the format of call-outs in Figure 8.1:

158 Also without an actual performance gap setting an innovation agenda may be fruitful. By a pro-active attitude, scientific and business environments are scanned for discovering any potential innovations, perhaps including risk management methodologies, that may further *improve* the organizational performance without the existance of a performance gap.

1. Risk management is considered an adequate *solution* for closing the *performance gap*;
2. An *explicit decision* for implementing risk management has been made by the responsible managers.

Only after a clear positive decision, any sort of risk management implementation phase should start.[159] The main part of the risk management implementation process consists of applying the designed risk management implementation approach in six subsequent and distinct steps. After taking these six steps, routinizing risk management should start, in which using the initially new risk management methodologies becomes common practice. Consequently, it will loose its innovative character and become a part of the normal operational processes within the organization.

Applying the conceptual model and audit instrument within the design process model

During the risk management implementation phase, six subsequent steps were proposed for using the conceptual model and audit instrument for risk management implementation in an organization. The previously presented Figure 8.1 shows these six steps. This subsection presents the execution of these steps in more detail.

First, the material and immaterial objectives for implementing risk management within (part of) the organization need to be defined and agreed upon by all actors. Obviously, these objectives should reduce or even close the performance gap. Nevertheless, the inherent lack of direct relationships between applying risk management and for instance bottom line results should be acknowledged and accepted. This avoids the development of any unrealistic expectations, which will become disappointments later on, about the manifested effects of risk management implementation.

Second, by using the questionnaires of the audit instrument, the initial degree of the presence of key conditions for risk management methodologies and the social system (in which the risk management methodologies have to be implemented), should be established. It is recommended to ask members of all relevant actor groups for completing the questionnaires and to discuss the main differences in the scores with them. This will reveal differences in interpretation of the terminology, as well as differences in the degree to which the key conditions are perceived present within the organisation.

159 Within the risk management implementation phase, the steps of *re-defining* the innovation and *re-structuring* the organization within the innovation process model of Rogers (2003:421) have been replaced by the step of applying the conceptual model and and audit instrument for risk management implementation, by six subsequent sub-steps.

Third, based on audit results about the presence of key conditions for risk management implementation within the organization, a set of key interventions should be defined for realizing these key conditions. Perhaps, certain types of intervention have already been executed in the past within the organization. This will be revealed by using the questionnaires of the audit instrument for specifically assessing the actual execution degree of key intervention within the organization. In addition, these questionnaires should are preferably completed by members of all actor groups, as mentioned in the previous step. Based on the audit results, a series of key interventions should be defined that corresponds with the targeted risk management user group. For instance, for innovators and early adopters other interventions are effective than those for members of the late majority. Probably, support by organizational consultants, change management consultants, and risk management consultants is required for effectively and efficiently selecting appropriate interventions for realizing an appropriate degree of key conditions for risk management methodologies, as well as the social system(s) of the organization in which the methodologies are implemented.
Fourth, all of the selected key interventions should be executed. Again, support by organizational consultants, change management consultants, and risk management consultants may be required for effectively and efficiently executing the selected interventions. These should establish or strengthen the key conditions for realizing appropriate and organizational-context dependent characteristics of the risk management methodologies. Furthermore, the key interventions should establish or strengthen the key conditions for providing appropriate and organizational-context characteristics of the social system(s) in the organization.
Fifth, any differences in the degree of presence of the key conditions, preferably increases but perhaps also non-intended decreases, should be measured. Increments in the presence of key conditions for risk management methodologies, as well as for social systems, are the targeted result of the executed key interventions. This measurement process includes once again (according to the process of the second step) completion of the questionnaires of the audit instrument, preferably by the same members of the actors groups.
Sixth and finally, based on the results of Step 5, the degree to which the risk management implementation objectives have been realized should be estimated. This will reveal the effectiveness of the previously taken risk management implementation steps. If the risk management implementation objectives have been realized to an acceptable degree, the final phase of routinizing the use of risk management will be entered. In this phase, the implementation process will become completed, when the innovative aspects of risk management will fade out

and become common practice. However, if the risk management implementation objectives have *not* been realized to an acceptable degree, either the objectives are not realistic, or the execution of the risk management implementation process has not been effective. The first situation requires reconsidering the objectives, in view of their realism and feasibility. The latter situation may require focussing on other key conditions, with corresponding interventions, by learning form the (non-)effects of the previously applied key interventions. This reveals the cyclic character of the process of organizational risk management implementation. Therefore, depending on the results, it may be required to repeat Step 1 through to Step 6.

Finally, the implementation of an organizational innovation, such as implementing risk management methodologies in the social system of an organization, is highly context-dependant. The contingency theory (Daft, 1998) flourishes. For implementing such a preventive type of innovation, a serious dilemma emerged. Clear benefits are required, for judging risk management as successfully implemented. However, because of the many variables that are out of control, it seems impossible to establish direct relationships between the implementation of risk management and the acknowledged benefits, such as improved efficiency and more employee satisfaction. There seems to be no simple and generic recipe available that guarantees success. This generates modesty about the anticipated effects of implementing organizational innovations in general, and of risk management in particular.

8.4 Expert panel evaluation

An expert panel meeting has been organized for evaluating the *modified* design proposition for risk management implementation, including the conceptual model, the audit instrument, and the design process model. During the meeting, nine experts evaluated the modified design proposition from a practical point of view, according to the eight additional design criteria (introduced at the start of this chapter). This section presents the *programme* of the expert panel meeting, the *facts* about the *experts* and their opinions, as well as an *interpretation* of their *opinions*.

Programme of the expert panel meeting

The two-hour expert panel meeting started with a brief introduction about the objective of the meeting. Next, the experts introduced themselves. Then the researcher presented the modified risk management implementation proposition by a Powerpoint presentation. The focus was on the modified audit instrument and the design process model for risk management implementation. During the presentation, questions were answered and discussions took place. After the presentation of the risk management implementation approach, discussions continued by presenting the eight design criteria for the risk management implementation approach in a format of eight statements. After discussing each statement, the experts expressed their agreement or disagreement with each statement plenary, by raising their hand. Finally, at the end of the expert panel meeting, each participant completed individually a questionnaire with in total 24 statements about the eight design criteria for the risk management implementation tool. The questionnaire included a five-point scale. By this scaling, each statement could be classified as *disagreed*, *partly disagreed*, *not disagreed and also not agreed*, *partly agreed*, or *agreed*. Moreover, the questionnaires requested some information about the experts themselves, such as the number of years of experience with applying risk management.

Facts about the experts participating in the panel meeting

The following characteristics of the experts were retrieved from the completed questionnaires. The expert panel consisted of nine participants: five consultants, two managers, and two geotechnical risk management professionals. One consultant also fulfilled a function as knowledge manager in his organization, another consultant acted also as project- and risk manager. One of the managers presented himself also as risk management professional. Three of the nine experts were already involved in this Ph.D. research. One of them has been interviewed as a risk management implementation expert and the two other persons are risk management professionals who have been interviewed in two of the case organizations. Two of the participants are working at public clients, two of them are working at engineering consultancies, and five participants classified themselves as working at knowledge institutes. Regarding the number of years of work experiences, two of the participants have over twenty years of experience, four participants have between fifteen and twenty years of experience, two participants have between ten and fifteen years of experience and one participant has up to five years of working experience. In addition, the number of years of experience with applying risk management has been registered. Two of the participants have between ten and fifteen years of risk management experience, four of them have between five and ten years of experience and two participants have up to five years of experience with applying risk management.

Facts and interpretation of the expert opinions

All experts voted plenary during the discussion and individually by completing the questionnaires. During the plenary session, the two options were agreement or disagreement with each of the eight statements. Within the questionnaires, each criterion has been divided in a number of sub-criteria, for retrieving additional and more detailed data from the experts. The expert opinions about the modified risk management implementation approach have been measured by their *degree* of agreement or disagreement with in total 24 statements about the eight criteria. Table 8.2 presents the aggregated results of the plenary and individual opinions of the experts about the eight statements, which represent the eight additional design criteria for the modified risk management implementation approach. As mentioned at the introduction of the eight criteria at start of this chapter, their numbering is only for identification purposes and is *not* intended to reflect any difference in importance.

For each of the eight statements, the sum of the plenary votes and the sum of the individual votes is 100 percent.[160] Both the plenary votes and the individual votes demonstrate that a large majority of the experts partly agree to agree with the statements about the modified risk management implementation approach. On average, 92 percent of the statements were agreed during the plenary votes. Moreover, 74 percent of the statements were partly agreed to agreed by the individual judgements.

The percentage of disagreement with the statements is about the same for the plenary and the individual votes, respectively 7 percent and 6 percent. There is however a remarkable difference between not disagreed and not agreed, reflecting no opinion, between the plenary votes and the individual votes. This difference seems to reveal a tendency of individuals to confirm to the opinion of the group. Within the group, the experts tended to vote simply for or against the statements. By completing the questionnaires individually, up to 30 percent of the experts demonstrated to have no opinion about a number of statements. Consequently, the agreement with the statements by the individual votes (74 percent) is 18 percent lower than the agreement with the statements by the plenary votes (92 percent). Nevertheless, from these figures it has been concluded that a *large majority* of the *experts* considers the *conceptual model*, *audit instrument* and *design process model* of the modified risk management implementation approach *state-of-the-art*, *complete*, suitable, *applicable*, *flexible*, *effective* and *efficient*, as well as *transferable* to other professionals.

160 For example, as shown in Table 8.2, for statement number 1, the sum of the plenary votes is 22 % + 0 % + 78 % = 100 %. Similarly, the sum of the individual votes for statement number one is 15 % + 11 % + 74 % = 100 %.

Table 8.2 The expert opinions of the statements about the modified risk management implementation approach.

No.	Statements about the modified risk management implementation approach	Plenary votes (%)			Individual votes (%)		
		Disagreed	Not disagreed and not agreed	Agreed	(Partly) disagreed	Not disagreed and not agreed	(Partly) agreed
1	The risk management implementation approach is *state-of-the art*	22	0	78	15	11	74
2	The risk management implementation approach is *complete*	0	0	100	11	25	64
3	The risk management implementation approach is *suitable* for all people involved in the implementation process	11	0	89	13	18	69
4	The risk management implementation approach is *applicable* for all types of risk management methodologies and tools	11	11	78	6	19	75
5	The risk management implementation approach is *flexible*	0	0	100	0	15	85
6	The risk management implementation approach is *effective* in meeting the implementation objectives	0	0	100	0	28	72
7	The risk management implementation approach is *efficient* with regard to the required resources	0	0	100	0	30	70
8	The risk management implementation approach is *transferable* to other persons	11	0	89	0	17	83
	Average score on all statements	7	1	92	6	20	74

8.5 Results and next research step

Research results

In this chapter, the initial conceptual model and audit instrument for risk management implementation have been modified, according to the results and limitations of the empirical validation in Chapter 7. For these modifications in total eight additional design criteria have been defined from a professional practice point of view. Moreover, a design process model for providing guidance of the risk management implementation *process* has been developed. This model was a modification of the innovation diffusion model by Rogers (2003). The resulting modified design propositions for implementing risk management within organizations have been critically evaluated by nine professional experts during an expert panel meeting. By performing the research activities of the second step of the development research part, this chapter generated the following results:

1. A *modified conceptual model* for risk management implementation in organizations with three dimensions: risk management methodologies, social systems, and risk management users groups;
2. A *modified* series of in total 40 *key conditions* and 10 *key interventions* for generating commitment and motivation in four distinguished risk management user groups: innovators, early adopters, early majority, and late majority. The fifth group of non-wanting risk management laggards were neglected by purpose;
3. A *modified audit instrument* for measuring and monitoring risk management implementation, with user-friendly questionnaires including short and to-the-point descriptions of key conditions and key interventions, the main characteristics of risk management methodologies and social systems, and a five-point scale with percentages;
4. A *design process model* for implementing risk management, with three phases, five steps, and six substeps, for providing guidance about the *process* for implementing risk management in organizations by applying the conceptual model (with key conditions and key interventions) and the audit instrument.

Nine experts from the professional practice confirmed the practical relevance of the modified conceptual model, the audit instrument, and the design process model for risk management implementation in organizations. Plenary, 92 percent of the participants agreed fully with 8 main statements. Individually, 74 percent of them agreed either fully or partly, with 24 statements representing the additional design specification with eight additional criteria. This shows that a large majority of the experts considered the modified risk management implementation approach (1) state-of-the-art, (2) complete, (3) suitable, (4) applicable, (5) flexible, (6) effective and (7) efficient, as well as (8) transferable to other professionals.

Research limitations

The *modified* design propositions for risk management implementation aimed reducing, and preferably eliminating, the five limitations of the initial approach. These emerged in Chapter 7 during and after empirically checking the *initial* design propositions for risk management implementation of Chapter 6. The results of this Chapter 8 seems to imply that the five *initial* research limitations of Chapter 7, have been reduced to an acceptable degree by the *modified* design propositions for risk management implementation in organizations. Nevertheless, despite these results, the professional experts presented five recommendations for further improving the modified risk management implementation approach:

1. Use the conceptual model and audit instrument for risk management implementation already in the *matching* phase, thus *before* the actual risk management implementation process starts;
2. Distinguish clearly between the implementation of *project* risk management and the implementation of *organizational* risk management;
3. Define sharply the *actors* and *roles* during the entire process of risk management implementation in organizations, including risk management experts, organizational consultants, as well as risk management users and their managers;
4. Explain or adapt the term *interfaces* in key condition number 9 for social systems: Understanding of risk management interfaces;
5. Provide *examples* of the application of the conceptual model and audit instrument for implementing risk management in the professional practice.

Next research step

Based on the research results, the research limitations, and the recommendations made by the professional experts, the modified design propositions for implementing risk management in organizations have been further improved. The results of the final design propositions are presented in the next chapter.

9

FINAL DESIGN PROPOSITIONS FOR RISK MANAGEMENT IMPLEMENTATION

9.1 Introduction

In the previous chapter, the *modified* design propositions for implementing risk management in organizations have been reported. The practical relevance of the modified approach has been evaluated by an expert panel, according to an additional design specification with eight criteria from a professional practice point of view. Based on the results, this chapter presents the *final* design propositions for organizational risk management implementation. This is step four and the last step in the development research part. All relevant research results of the exploration research, as well as those of the previous three development research steps, have been incorporated in this final research step.

This chapter starts with presenting the final *conceptual model* for implementing risk management in organizations. This conceptual model aims to provide insight in the relevant mechanisms that need to be acknowledged for effective, efficient, as well as persistent, implementation of risk management within organizations. Acknowledging this conceptual model is considered relevant for any researcher, manager or professional who is involved, or will become involved, in any role in the process of implementing risk management in an organization.

In the next section, the final version of the *design process model* is presented. The design process model aims to facilitate risk management consultants, as well as organizational and change management consultants, with context-specific design of risk management implementation processes in organizations.
The following section concerns the final version of the *audit instrument*. This instrument measures the degree to which key conditions for implementing risk management methodologies in social systems of organizations are perceived present by individual actors. In addition, the degree to which key interventions for establishing these key conditions have been executed can be assessed with the audit instrument.
In the one but final section of this chapter an *intervention proposition* is added, which aims providing guidance for selecting key interventions and supporting activities. These interventions and supporting activities should foster individual motivation and commitment of the members of targeted risk management user groups. Moreover, these interventions contribute to realizing the required degree of key conditions for implementing risk management methodologies in social systems of organizations. This chapter ends with presenting the main results and the revealed research limitations.

9.2 The conceptual model for risk management implementation

Introduction of the conceptual model

The objective of the *conceptual model* for risk management implementation is providing insight in the relevant mechanisms. Acknowledging this conceptual model is considered relevant for any researcher, manager or professional, who is involved, or expects to become involved, in any type of role in implementing risk management in an organization. The conceptual model consists of three dimensions: (1) risk management users, (2) risk management methodologies, and (3) social systems. The following logic connects these three dimensions: For realizing risk management implementation, risk management users should routinely apply risk management methodologies in the social system(s) of their organization. The conceptual model incorporates the heuristic causality of the CIMO-logic of context-intervention-mechanism-outcome (Denyer et al, 2008). Figure 9.1 presents the resulting conceptual model for risk management implementation in organizations.[161]

161 As raised before in Chapter 8 about the modified design proposition for implementing risk management in organizations, the *final* conceptual model differs essentially from the *initial* one. Based on the results of the validation

Figure 9.1 shows the three *dimensions* of the conceptual model. The *risk management user* dimension includes five distinct groups of risk management users. Each of these groups has different degrees of motivation and commitment to applying risk management. In an order of decreasing motivation and commitment to risk management application these groups as (1) innovators, (2) early adopters, (3) early majority, (4) late majority, and (5) laggards. Within the risk management user dimension, the concept of innovation adopter categories after Rogers (2003) have been synthesized with the five degrees of motivation and commitment by Malhorta and Galetta (2002), based on Kelman (1958). This synthesis aligns with concepts about planned organizational change by Bennis et al. (1976), Boonstra (1996), Csikszentmihalyi (1997), De Caluwé and Vermaak (2004), Tichy (1983), and Vrakking et al. (1995).

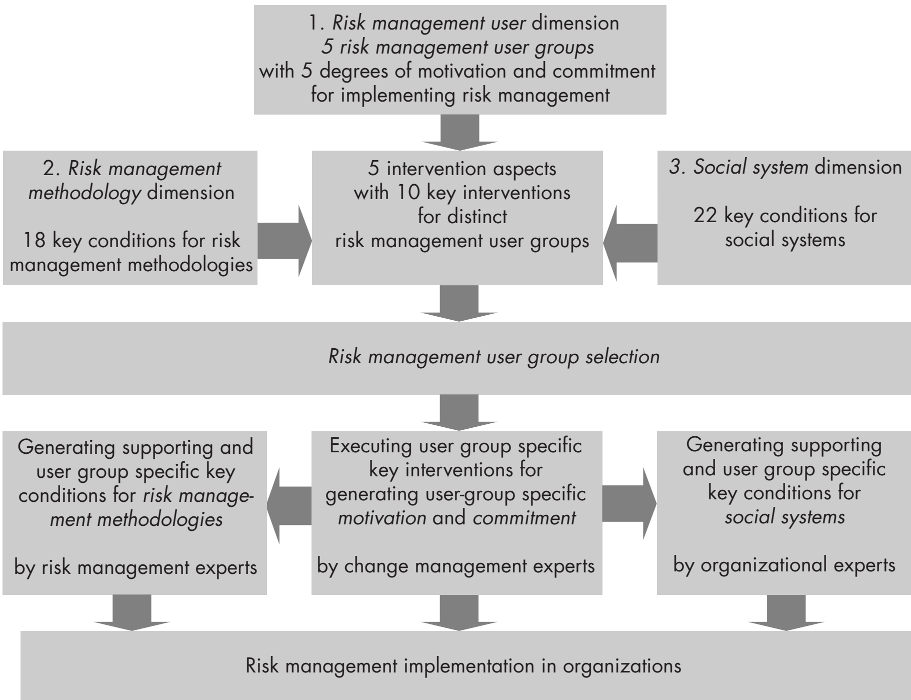

Figure 9.1 The conceptual model for risk management implementation.

of the initial model by the multiple-case analysis (reported in Chapter 7), the former *intervention* dimension of the model has been replaced by the actual *risk management* user dimension within the model. Within the initial model, key interventions were directly related to key conditions of the same intervention aspect. In the final conceptal model this direct causal relationship has been avoided, because of a yet lacking empirical confirmation or rejection of this relationship.

The *risk management methodology* dimension includes 18 key conditions for realizing appropriate main characteristics and subcharacteristics of risk management methodologies. Their acknowledgement is essential for generating the required motivation and commitment of targeted risk management users for actually and persistently using these risk management methodologies in their professional activities. The main characteristics and subcharacteristics are derived from concepts by Rogers (2003) and Song (2006) and confirmed by the literature survey and the field research of the exploration research part. The key conditions for risk management methodologies should be present to a sufficient degree. This is required for realizing appropriate characteristics and subcharacteristics of the risk management methodologies. These methodologies require a high degree of user-friendliness for being used by their targeted users, which are those professionals who should routinely apply risk management in their day-to-day activities. This situation has been defined as implemented risk management within an organization.

The *social system* dimension includes 22 key conditions for realizing appropriate characteristics and subcharacteristics within the social system(s) of the organization in which the risk management methodologies have to be implemented. The targeted risk management users are members of these social systems. The main characteristics and subcharacteristics of social systems are derived from concepts by Detert et al. (2000) and by Rogers (2003), and confirmed by the results of the literature survey and field the research during the exploration research. In the social system(s) of an organization, risk management users should routinely apply the risk management methodologies. Acknowledgement of the importance of the social system is essential for generating motivation and commitment of potential risk management users. Particularly in technically oriented organizations, the social system dimension is usually overlooked or even entirely neglected. Therefore, in addition to the key conditions for risk management methodologies, key conditions for social systems should be present to a sufficient degree within an organization for realizing risk management implementation in that organization.

The three dimensions of the conceptual risk management implementation model, risk management users, risk management methodologies and social systems, are connected to each other by five *intervention aspects*. Learning, autonomous, rational, emotional, and political intervention aspects have been distinguished. This subdivision aligns with concepts of Bennis et al. (1976), Checkland (2000), De Caluwé and Vermaak (2004), Huy (2001), Tichy (1983), and Werkman et al. (2005b). The intervention aspects are related to the five risk management user groups. This implies that within each risk management user group one intervention aspect is dominating. Therefore, for providing motivation and commitment of the individual members of a risk management user group, the interventions belonging to the specific intervention aspect for the group should be executed. In total 10 *key interventions* have been derived. Each intervention aspect includes a few of these key interventions. In addition to motivating and committing potential risk management users, key interventions establish or strengthen the appropriate conditions for the risk management methodologies and social systems for the targeted user group.

In conclusion, risk management *user-group selection* is the core of the conceptual risk management implementation model, because of the connection between risk management user groups and key intervention aspects. The selected group or groups for routinely using risk management determine the dominating intervention aspects. These intervention aspects determine the type of key interventions for (1) generating user-group specific motivation and commitment, (2) setting appropriate key conditions for the risk management methodologies, and (3) setting appropriate key conditions for the social system of the risk management users.

The conceptual model in a tabular format

For increasing its practical usefulness, the *conceptual model* for implementing risk management is presented in a *tabular format* in Table 9.1. The left column presents the five risk management user groups, together with a cell for all risk management user groups together. The learning intervention aspect is significant for all risk management user groups.[162] This implies that intervention number 1 and number 2 should be executed in all risk management implementation situations, independent of the selected user group(s). Key intervention number 1 (apply situational leadership and teamwork) is particularly relevant for managers, while key intervention number 2 (provide risk management education and training) is applicable to managers and to risk management users as well. While both types of actor need a similar basic understanding of risk management principles, the risk management users would often need to require more in-depth knowledge of actually *applying* risk management within their day-to-day activities than their managers. The latter group of managers is merely involved in facilitating the appropriate key conditions for risk management methodologies within the social systems of their organizations.

Selecting one or more user groups in Table 9.1 provides the dominating intervention aspects that should be addressed for each of the selected user groups. Each intervention aspect includes between one and three key interventions out of the

162 The importance of the learning intervention aspect for all users aligns with the dominant learning focus for organizational design. This is because real organizations inhibit a large number of hidden properties, compared with real objects (Van Aken, 2008b).

series of ten key interventions. Moreover, each intervention aspect includes some of the 18 key conditions for risk management methodologies and of the 22 key conditions for social systems. The attribution of the key conditions to five intervention aspects has been based upon the apparently *most* characteristic and dominating features of each key conditions. For instance, key condition number 3 for risk management methodologies, managing risk avoids tool pre-occupation, seems typically related to the learning intervention aspect. Potential risk management users should learn not to build too much on tools only, but also foster logical thinking. Obviously, some key conditions may have features that correspond with more than one intervention aspect. In those cases, the apparent most dominating feature determined the allocation of that key condition to an intervention aspect. Executing the key interventions and supporting activities of an intervention aspect are likely to have a positive impact on the degree of presence of the key conditions of the same intervention aspect. This applies to key conditions for risk management methodologies, as well as to key conditions for social systems. Table 9.1 shows however, that most of the key conditions for risk management methodologies are part of the rational and emotional aspects systems. The majority of key conditions for risk management methodologies are attributed to the learning, autonomous, and political intervention aspects.

Table 9.1 The conceptual model for risk management (RM) implementation in a tabular format.

RM user groups	Dominating intervention aspects	Key interventions		Key Conditions for risk management methodologies		Key Conditions for social systems	
		No.	Description	No.	Description	No.	Description
All groups	Learning	1	Apply situational leadership with teamwork	-	-	4	Organizational structure supports continuous RM adaptation
						9	Organizational structure allows inclusion of external environment
						12	Institutionalized cooperative attitude to managing risk
						19	Acceptance of short term organizational efficiency reduction
						5	Acknowledgement of differences in risk management motivation
		2	Provide RM education and training	3	Managing risk avoids tool pre-occupation	10	Understanding of relations of risk management with other disciplines
						11	Institutionalized sharing of information about managing risk
Innovators	Autonomous	3	Arrange out-of-the-box RM sessions	10	Managing risk strengthens innovativeness	21	Acceptance of unanticipated risk management consequences
						22	Acceptance of conflicting risk management consequences
		4	Forster self-monitoring and self-evaluation of risk management	-	-	6	Shared risk management awareness & understanding
						7	Understanding of ratio & emotions of managing risk
						8	Understanding of different risk perceptions

Table 9.1 Continued

RM user groups	Dominating intervention aspects	Key interventions		Key Conditions for risk management methodologies		Key Conditions for social systems	
		No.	Description	No.	Description	No.	Description
Early adopters	Rational	5	Apply a staged RM implementa-tion process	8	Managing risk fits existing practices	13	Presence of change agents for implementing risk management
						16	Shared decision making about how to implement RM
		6	Facilitate the application of RM with resources	12	Managing risk has an accept-able complexity	14	Presence of opinion leaders who advocate managing risk
				13	Managing risk is easy to try out	15	Presence of champions who support managing risk
						17	Availability of time and budget for RM implementation
		7	Set, monitor, and com-municate added value of risk management	1	Managing risk is cost-effective	20	Presence of risk management milestones and quick wins
				4	Managing risk provides preven-tive advantage		
				14	Effects of managing risk are observable		
				15	Case studies show risk management success		
				17	Costs of managing risk are acceptable		

Table 9.1 Continued

RM user groups	Dominating intervention aspects	Key interventions		Key Conditions for risk management methodologies		Key Conditions for social systems	
		No.	**Description**	**No.**	**Description**	**No.**	**Description**
Early majority	Emotional	8	Ensure identification with risk management	2	Managing risk provides social status	18	Risk management consequences are perceived as desirable
				5	Managing risk is rewarded		
				7	Managing risk fits values and beliefs		
				9	Managing risk fulfils needs of its users		
				11	Managing risk as a name has a positive meaning		
				18	Managing risk increases organizational reliability		
	Political	9	Execute task, responsibility, and authority sessions	6	Top management mandates applying risk management	1	Formal responsibilities for managing risk
						2	Formal delegation of responsibilities for managing risk
						3	Formal risk management reporting to senior management
Late majority		10	Enforce risk management application	16	External parties request risk management	-	-
Laggards		-	None	-	-	-	-

9

In conclusion, by using Table 9.1 from the left to the right, user-group selection determines the dominating intervention aspect and consequently the required type of key interventions and key conditions for risk management methodologies and social systems. For instance, if subsequently three user-groups are targeted for risk management implementation, such as the innovators, the early adopters and the early majority, then subsequently three series of interventions have to be executed, for motivating and committing these user groups and providing the supporting key conditions for risk management methodologies and social systems.

9.3 The design process model for implementing risk management

Introduction of the design process model

The objective of the design process model is assisting risk management, organizational, and change management consultants in context-specific design of risk management implementation processes in organizations. During the expert panel meeting (presented in Section 8.4 of Chapter 8), the experts raised three recommendations for improving the design process model: (1) use the conceptual model and audit instrument already in the *matching* phase, *before* starting the actual risk management implementation process, (2) define sharply the *actors* and their *roles* during the entire process of risk management implementation, and (3) differentiate between *project risk management* and *organizational risk management* in the design process model.

The first recommendation has been followed by distinguishing a process structure and a role structure part (Van Aken, 2005b). The *process structure* part of the design process model is the organizational part of the implementation process. It presents a number of logical steps in time for executing the risk management implementation process. The *role structure* part defines the roles, tasks, and responsibilities of the actors during the risk management implementation process in an organization.[163]

For addressing the second and third recommendation, alternative process design models were considered. The design process model in Chapter 8 was a modification based upon the innovation diffusion model by Rogers (2003). The choice for this model seemed obvious, because risk management has been considered as a

163 This role structure part was missing in the design process model of the modified design propositions in Chapter 8.

specific type of an *organizational innovation*, which needs *organizational innovation diffusion* for actual implementation in an organization. By referring to Evbuonwan et al. (1996), Van Aken (2005b) summarizes eleven design process models from the design literature. To this series, Van Aken (2005b) adds three models from the innovation management literature, not including the innovation adoption model by Rogers (2003). Van Aken (2005b) presents serious concerns about (1) the basis on which the models have been developed, (2) the nature of the models, and (3) any performance indicators in the models for judging the success of a design process. Due to this apparent fuzziness of existing design process models, for this research it has been decided to develop the final process design model by *refining* the earlier presented modified one. In this refinement, within the three original phases of initiation, decision, and execution, which remained unchanged, a number of additional steps and go-no go moments were included. In addition, both recommendations of the experts have been incorporated. This exercise resulted in a *prescriptive* type of design process model that is in line with the design science research approach of this thesis. Therefore, any use of the resulting design process model requires some degree of internalization by executing some sort of second redesign of the model (Van Aken, 2005b). Only then, the design process model may be fit-for-purpose for the situation at hand. One other aspect needs due attention, before one starts applying the design process model for implementing risk management implementation. As also raised in Van Aken (2005b), the structure of a process-design specifies an *undisturbed process* of, for example, implementing risk management in an organization. This is a *theoretical* assumption, because in reality, any process in general, and any organizational risk management implementation process in particular, will never entirely be executed according to plan. Therefore, the process design needs to be supplemented with effective *process management* during the execution of the plan.[164]

The process structure part of the design process model

The *process structure* part of the design process model addresses the organizational aspects of the risk management implementation process. It suggests a sequence of logical phases and steps over time, for the entire implementation process within an organization. Within the process structure part of the design process model, three phases of the risk management implementation process are separated: (1) the *initiation* phase, (2) the *decision* phase, and (3) the *execution* phase. Figure 9.2

164 As for instance mentioned by De Bruijn et al. (2002), process management is *not* project management. While project management is suitable for rather *static* and *stable* situations, process management provides much more flexibility for effectively dealing with *dynamic* and *unstable* situations.

shows the process structure part of the design process model for implementing risk management within an organization.[165]

The implementation process has two go–no go milestones. During the *initiation* phase, the process stops when risk management is considered inappropriate for reducing or closing the performance gap. During the *decision* phase, the risk management process may be terminated as well. Then it should become clear that even if risk management has been judged a good solution for reducing the performance gap, its implementation is not feasible, due to the lack of organizational readiness or sufficient resources as money and time.

The initiation phase of the risk management implementation process

In the initiation phase, a clear and agreed organizational *performance gap* should be on top of the management agenda. For instance, there are structural cost overruns in construction projects of a contractor, which results into poor financial results. This may raise serious shareholder concerns about the value of their shares.

Next, this performance gap is matched with *possible solutions*. This requires executing a *feasibility study* by (1) analyzing the problem creating the performance gap and (2) providing feasible solutions. Within the contractor example, possible solutions are upgrading the quality system, training project managers in project management techniques, changing the project portfolio, or perhaps implementing risk management within the organization. The feasibility study will recommend one or more of these alternative solutions, and may therefore be considered as some sort of *intake* for implementing risk management in an organization.

If risk management is perceived as a *bad solution*, the entire risk management implementation process stops. In such a situation only a minimum of resources are spent on risk management. On the other hand, if applying risk management is considered a *good* solution for reducing or even closing the performance gap, then the risk management implementation process continues, by *setting material* and *immaterial risk management objectives*. An example of a material objective is reducing the failure costs of construction projects with fifty percent within three years.[166] An immaterial objective is for instance strengthening the reputation of the contractor of being a reliable and profitable firm generating shareholder value.

---

165 The proces structure part of the design process model in Figure 9.2 is a refined version of the model, as presented by Figure 8.1 in Section 8.3.

166 This example is inspired by a major Dutch public organization aiming to reduce the geotechnical failures within their projects by 50 percent in seven years. This target should be realized by implementing risk management, as well as increasing their knowledge base.

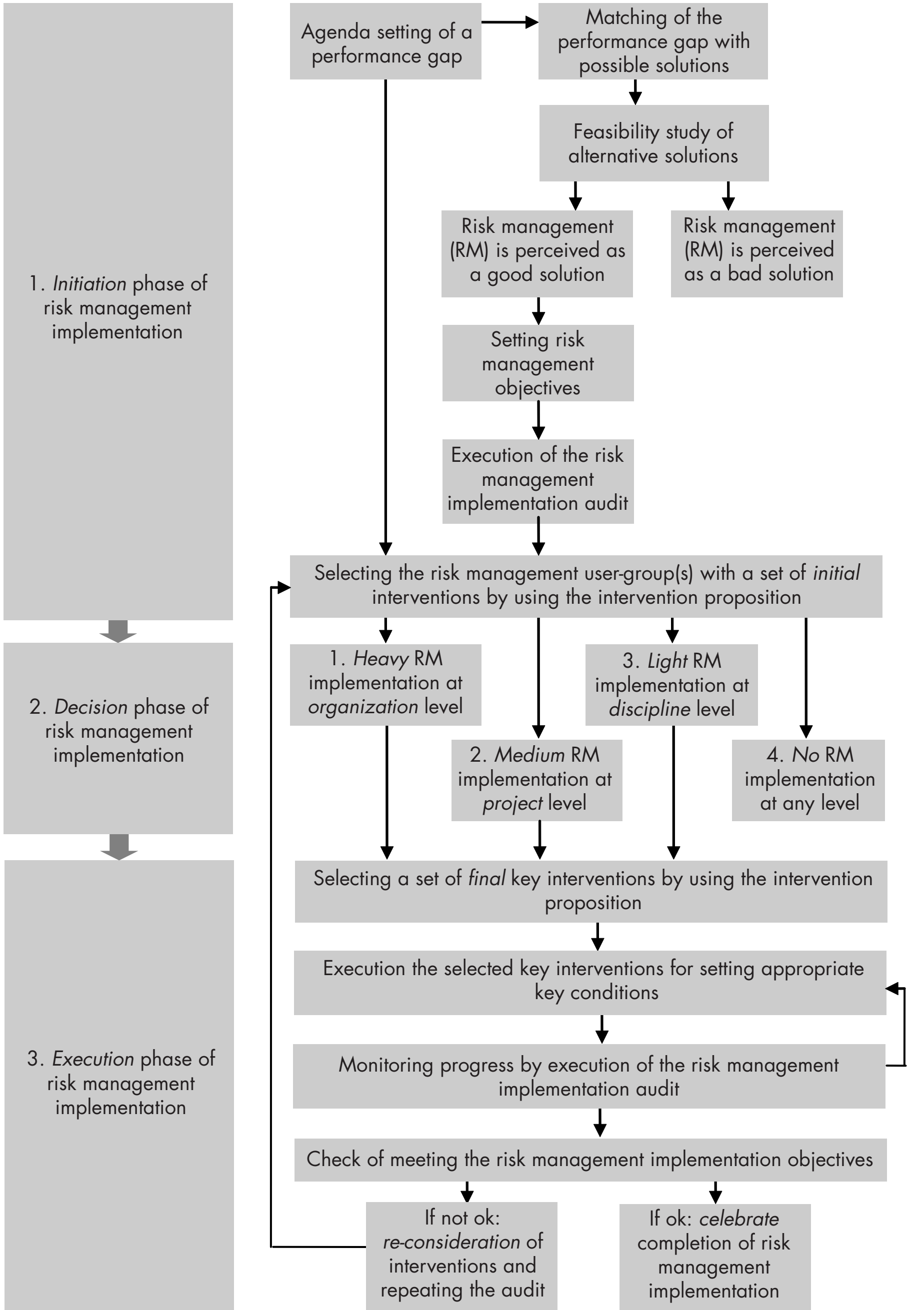

Figure 9.2 Process structure part of the design process model for risk management (RM) implementation.

9

However, by being a preventive type of innovation, with an inherent lack of direct relationships between investments and benefits, matching of risk management with performance gaps remains inherently difficult. To some degree, there always should be some sort of positive belief about the benefits of risk management.

Next, a *risk management implementation audit* should be performed, by using the *audit instrument* that will be introduced in Section 9.3. The audit reveals the degree of presence of key conditions for risk management methodologies and social systems within the organization. In addition it shows to what degree interventions for setting the key conditions have been executed already. In fact, the audit instrument measures the *organizational readiness* for implementing risk management. It is recommended to ask members of all relevant actor groups for completing the questionnaires and to discuss the main differences in the scores with them. This will reveal differences in *interpretation* of the terminology, as well as differences in *perception* about the degree to which the key conditions are present and key interventions have been executed within the organisation. Common and shared understanding about these differences between actors in an as early as possible phase may avoid a lot of misunderstanding, problems, frustration, and even conflicts, in the later stages of risk management implementation. Based on the results of the risk management implementation audit, the targeted *user groups* for risk management implementation, together with a user group-specific *set of initial interventions* can be selected by using the *intervention proposition*, which will be introduced in Section 9.4.

The decision phase of the risk management implementation process

In view of the proposed set of initial interventions and the previously made judgement that risk management seems the best solution for reducing the performance gap, management of the organization should *explicitly decide* upon one out of four risk management *implementation options*. In a sequence of decreasing complexity, these options are: (1) *heavy* risk management implementation at organizational level (such as portfolio risk management), (2) *medium* risk management implementation at project level (project risk management), (3) *light* risk management implementation at discipline level (for instance geotechnical risk management), and (4) *no* risk management implementation at all. In case of the latter option, the investments on implementing risk management are still limited, because only the feasibility study has been completed. The costs of executing such a study, even when seriously performed by hiring external consultants, will be only a fraction of the costs of an unsuccessful risk management implementation process. This apart from demotivation and even frustration that may be caused by disappointed employees involved in a failed innovation process.

For instance, if the degree of presence of the key conditions (the organizational readiness for risk management implementation) for realizing appropriate social system characteristics is very low, this would imply executing a substantial set of key interventions. Then management may decide that the required resources for executing those interventions do not sufficiently compensate for the anticipated benefits of well-implemented risk management. Such a situation may result either in cancelling any attempts for further implementing risk management, or in deciding to implement (only) a light or lighter version of risk management. The latter means for instance that instead of portfolio risk management at organizational level, management may decide to implement just project risk management within the individual projects of the organization. Alternatively, rather than implementing project management at project level, discipline-based risk management may be implemented within one or more disciplines of the organization, for instance in structural engineering or geotechnical engineering.

Obviously, selecting the *most suitable level* for risk management implementation highly depends on the characteristics of the organization-specific context. Examples are the mentioned readiness of the organization for implementing risk management (as derived by the audit), the type of material and immaterial risk management objectives of the organization, as well as the resources that the organization are willing and being able to invest in implementing risk management. There is no generic solution available for deciding upon the most suitable risk management level. Each organization should have to make its own best possible decision.

Anyhow, at the *end* of this *decision phase*, an explicit decision on one out of four options for risk management implementation should be made. The highest management level involved should make this decision. Preferably, this is top management of the organization, given the seriousness and possible impact on entire organization, depending in this go-no go decision. According to the ruling modern management principles, any decision made, either go, or no go, with implementing risk management, needs clear and careful communication within the entire organization. If management does not explicitly decide upon implementing risk management, people at all levels within the organizations will easily find escapes for not investing their own energy and time in the usually tedious process of implementing risk management within an organization.

Moreover, also the *type* of *decision making* has impact on the degree of acceptance of the decision within the organization. Decision making may be either shared with the actors within the organization, or rather autocratic by solely a top management

team. Normally, people tend to be more motivated for bearing consequences of decisions, if they feel themselves involved in these decisions.
Finally, if management explicitly decides not to implement even the lightest version of risk management, the risk management implementation process stops at the end of the decision phase.

The execution phase of the risk management implementation process

If it has been explicitly decided that the heavy, the medium or the light version of risk management will be implemented within (part of) the organization, a final set of key *interventions* and supporting activities can be *selected* from the *intervention proposition* (to be presented in Section 9.4). The selected target user groups are leading for these interventions, because, according to the conceptual risk management implementation model, they determine the dominating intervention aspects. For instance, if the targeted user group consists of early adopters, then the leading intervention aspects have a rational character. Then also, the required conditions for the risk management methodologies and social systems have a largely rational character. Support by external organizational, change management, and risk management consultants may be required for selecting effectively and efficiently appropriate interventions from the intervention proposition.
Next, the selected key interventions and supporting activities should be *executed*. Again, support by organizational, change management, and risk management consultants may be highly wanted for an effective and efficient execution, of which the implementation result should be persistent in time as well. The executed key interventions and any possible supporting activities should establish or strengthen the degree of presence of key conditions for reaching the required characteristics of the risk management methodologies. Furthermore, the key interventions should establish or strengthen the conditions for realizing appropriate characteristics of the social system of the organization.
Progress of risk management implementation can be monitored by execution of the *implementation audit* (to be presented in Section 9.3). Again, this involves completion of the questionnaires of the audit instrument, according to the process of the second step and preferably by the same members of the actors groups. Discussing the results, and particularly any differences between individual actors, may help to build a shared understanding about the progress of risk management implementation, its difficulties, and the solutions for overcoming these hurdles. It is recommended to monitor the implementation progres at regular time intervals, particularly when sets of interventions are executed subsequently. By providing the

questionnaires via an organizational Intranet, the auditing process can be executed easily and at the most suitable moments by the individual actors, even when working in different departments of organizations, all over the world.
Based on the results of the previous auditing step, the degree to which the material and immaterial risk management *objectives* are *realized* should be estimated. This will reveal the *effectiveness* of the risk management implementation process. When the objectives are realized, it is worthwhile to *celebrate* this success with all actors and stakeholders involved, because this is really an achievement! If the risk management implementation objectives are *not realized* to an acceptable degree, either the objectives are not realistic, or the risk management implementation execution has not been adequate, or a combination of both occurred. The first situation requires reconsidering the objectives, in view of their realism and feasibility. The second situation may require executing the *same* key interventions to a larger extend, or focussing on *other* key conditions with related key interventions. The latter demands learning from the effects of the previously applied key interventions on key conditions. This reveals the cyclic and learning character of the process of organizational risk management implementation. Obviously, the third situation of unfeasible objectives *and* a wrong implementation process requires combining both measures. In addition, perhaps (other) risk management, organizational, or change management consultants should be hired. Therefore, depending on the results and the likely causes of those results, repeating a number of the previous steps within the design process model of Figure 9.2 may be necessary.
Finally, for reducing any over-enthusiasm for the structure part of the design process model approach beforehand, this process model is *not* meant to be used as a *fixed protocol*. It is also not a recipe of an organizational cookbook. The design process model is only meant to provide *flexible guidance* for the change agents involved in risk management implementation processes. By fostering organization-specific *contextualization*, the design process model may need small or even larger modifications for allowing effective design of each and every unique risk management implementation process. In conclusion, the structure part of the design process model reveals guidance by suggestions for how to implement risk management within an organization. The conceptual model, the audit instrument, and the intervention proposition are the supporting tools during actually executing the implementation process.

The role structure part of the design process model

By building on Van Aken (2005b), the *role structure* part of a design process model defines the roles, tasks, and responsibilities of the actors during the entire risk management implementation process. This role structure supports the previously presented process structure. Based on the exploratory research of Chapter 4, five different sorts of actor in the risk management implementation process have been distinguished and defined:

1. *Risk management users*, which have been classified into innovators, early adopters, early majority, late majority, and laggards;
2. *Managers*, who initiate, facilitate, monitor, and continue the routine application of risk management;
3. *Change agents*, particularly risk management experts, intervention experts, and organizational experts, who jointly facilitate the implementation of risk management within (part of) an organization;
4. *Opinion leaders*, who advocate the routine application of risk management within (part of) an organization;
5. *Champions*, who serve as role model by demonstrating the successful application of risk management.

Each of these actors plays their relevant role during the implementation of risk management within a discipline, a project, or (part of) an entire organization. Table 9.2 suggests roles, tasks, and responsibilities for these actors. Particularly for *individual actors* dealing with risk management, from experience and supported by literature research, Van Staveren (2006) suggests *six principles* that may support them during the demanding implementation process of risk management. These principles were raised in the exploratory research of Chapter 3 about risk management. With some slight modifications, these principles are (1) be and act risk aware, (2) be and act risk responsible, (3) act beyond blame and claim behaviour, (4) act beyond fear, (5) acknowledge the relevance of rational, as well as emotional and even some sort of spiritual intelligence, and (6) take sufficient time. These six principles are supported by findings of for instance Blockley and Godfrey (2000) and Paine et al. (2005) regarding risk responsibility, Block (2002), Covey (1992), and Imai (1986) concerning the role of blame and claim in risk management, Van Oirschot (2003) about the role of fear, Goleman (1996) and Zohar and Marshall (2004) for the role of different types of intelligence, and Witten and Tulku (1998) about the necessity and benefits of taking sufficient time. While being ambitious, as principles in principle are, trying to apply them in the practice of implementing risk management may support risk management users, their managers, the three types of change agents, as well as opinion leaders and champions.[167]

Van Staveren (2006) highlights also the paramount importance of *teams* for risk management. For instance, bias due to the inherently subjective risk perception of individuals can be effectively neutralized by considering the different risk perceptions of team members. There is a lot to say about teams and risk management, for instance about their complexity due to social dynamics and (un)favourable interactions of team members. A more in-depth analysis would be interesting and useful, but is beyond the scope of this research. The main message is that using several types of teams, such as expert teams, multidisciplinary teams, teams of change agents, and teams of professionals acting as change agents, may contribute significantly to the effective, efficient, and persistent implementation of risk management in organizations. Finally, the presented role structure part of the design process model focuses on the actors during the risk management implementation process *within* the organization. While this focus of this research indeed is on *implementing* risk management within organizations, actually *applying* risk management stretches (far) *outside* any organizational boundaries. This is simply caused by the fact that a lot of risks, for any type of organization in the construction industry or in other industries, are caused by *external influences* on organizations. Therefore, particularly for the *learning* types of interventions, the role of *clients*, the *industry*, and a *society* on risk management, including the ever-growing impact of the (modern) *media*, should be thoroughly acknowledged (Van Staveren, 2006).

167 Probably, the champions inhibit these principles already, which could be the explanation for their acting as champions.

Table 9.2 The role structure part of the design process model for risk management implementation.

Risk management implementation and actors			
Actor roles		**Actor tasks**	**Actor responsibilities**
Risk management users		*Applying* risk management methodologies in their activities at discipline level, at project level, or at organizational level.	Managing continuously, effectively, and efficiently all identified risks of their activities at discipline level, at project level, or at organizational level.
Managers (often principals)		*Realizing* the *implementation* of risk management by initiating, facilitating, monitoring, and continueing the routine application of risk management methodologies in the activities of (a) discipline(s), project(s), or organizational unit(s) for which the manager is responsible.	Realizing the targets of the discipline(s), project(s), or organizational unit(s) within the organization, by guaranteeing routinized risk management application by the employees of the discipline(s), project(s), or organizational unit(s).
Change agents	Risk management experts	*Providing* user group specific *key conditions* for *risk management methodologies* by context-specific selecting, and when needed adapting, risk management principles, concepts, processes, guidelines, and tools. Also *training* of risk management users about risk awareness and how to effectively, efficiently, and persistently applying the selected and adapted risk management methodologies in their activities.	Availability of optimum risk management methodologies, as well as risk aware and well-trained employees, who are able using these methodologies effectively, efficiently and persistently, in their activities.
	Intervention experts	*Executing* user group specific *key interventions* for generating motivation and commitment for effectively, efficiently, and persistently applying risk management methodologies by the individual user-group members.	Optimum motivation and commitment of the individuals in the targeted user group(s) for applying risk management methodologies effectively, efficiently, and persistently in their activities.
	Organizational experts	*Generating* user group specific *key conditions* for the *social systems* in the discipline(s), project(s) or organizational unit(s), by transforming unfavourable characteristics in the social system to favourable ones.	Presence of optimum social systems in the discipline(s), project(s), or organizational unit(s) that enables effective, efficient, and persistent application of risk management by the members of the social system.
Opinion leaders		*Advocating* the *relevance* of the routinized application of risk management at discipline level, at project level, or at organizational level, by using their *authority* within the organization.	Using their authority for motivating individuals of the targeted risk management user goup(s) for applying risk management effectively, efficiently, and persistently in their activities.
Champions		*Demonstrating* the *successful application* of risk management within their activities by using their *charisma*, which aims to motivate their peers copying the application of risk management.	Acting as a role model to their peers by effectively, efficiently, and persistently applying risk management within their activities.

9.4 The audit instrument for risk management implementation

Introduction of the audit instrument

The objective of the *audit instrument* is providing a mean for well-structured measuring the *readiness* of an organization for implementing risk management. Moreover, the *progress* of risk management implementation can be monitored over time. According to the conceptual model for implementing risk management, the audit instrument measures the degree to which key conditions for implementing risk management methodologies in social systems of organizations are perceived present by the actors within those organizations. In addition, the degree to which key interventions for establishing these key conditions have been executed can be assessed by applying the audit instrument.

Using the audit instrument has already been proposed and explained in the *initiation phase* and in the *execution phase* of the process of implementing risk management in organizations. This is indicated in the structure part of the design process model in Figure 9.2. Managers and consultants preparing for, or involved in, implementing risk management in organizations may use the audit instrument. The instrument is particularly suitable for measuring the inherently subjective (differences in) *perceptions* about the degree of presence of key conditions, as well as about the degree to which key interventions have been executed in organizations. Insight in these perceptions of all types of actor before and during the risk management implementation process serve a sound basis for defining (additional) key interventions for setting or strengthening of key conditions for risk management methodologies, as well as for social systems.

The audit instrument consists of *three questionnaires* in a user-friendly format.[168] Appendix 11 and Appendix 12 present the questionnaires for auditing respectively the 18 *key conditions* for *risk management methodologies* and the 22 *key conditions* for *social systems*. Appendix 13 presents the questionnaire for auditing the 10 *key interventions* for the distinct risk management user groups. In the next three subsections, these three questionnaires are presented in some more detail.

9

168 For the *final* design of the risk management implementation audit instrument, the recommendations of the experts of the panel resulted in some minor modifications of the descriptions of the key conditions and key interventions in the questionnaires of the risk management implementation tool. These are included in Appendix 11, 12, and 13.

The questionnaire for auditing key conditions for risk management methodologies

The *questionnaire* for auditing key conditions for *risk management methodologies* (Appendix 11) includes three main columns with (1) the main characteristics and subcharacteristics of risk management methodologies, (2) the identification numbers and descriptions of key conditions that should be sufficiently present for providing the (sub)characteristics of risk management methodologies, and (3) five subcolumns for assessing the actual degree of presence of the key conditions for the risk management methodologies under consideration. A five-point scale is included for this assessment. According to this scale, any key condition can be assessed as present between 0 and 20 percent, between 20 and 40 percent, between 40 and 60 percent, between 60 and 80 percent, and between 80 and 100 percent of the maximum possible degree of presence. Any type of actor can complete the questionnaire, which should be done individually, for generating the individual (subjective) perception of each person.

Obviously, the questionnaires can be completed by different actors belonging to different groups. For instance, any differences in perception about the presence of the key conditions can be revealed between members of the innovators and the late majority for using risk management within an organization. From a series of questionnaires, average values of the assessed presence of key conditions can easily be calculated, for generating some sort of patterns about the perceived degree of presence of key conditions amongst individuals or amongst groups of people within an organization.[169]

For example, key condition number 1 in Appendix 11 (managing risk is cost-effective) should be present for providing the subcharacteristic of economic advantage. This is an element of the risk management methodology characteristic of providing relative advantage, when compared with other risk management methodologies. The relative advantage characteristic may even be compared with methodologies outside the discipline of risk management, such as quality management. Any individual completing the questionnaire has to assess by him- or herself to which degree risk management is cost-effective, with the risk management methodologies of concern. A score in the 0-20 percent cell implies that risk management is not at all perceived as cost-effective with the risk management methodologies at and. Contrary, score in the 80-100 percent cell indicates that the risk management methodologies are considered highly cost-effective, even to the maximum possible degree. Obviously, the perceived degree of presence of the key condition in between

169 This exercise has been performed during the field research part of the single case study analysis in Chapter 7.

these two extremes should be assessed by ticking 20-40 percent cell, the 40-60 percent cell, or the 60-80 percent cell. Similarly, all of the degrees of presence of the remaining 17 key conditions should be assessed.

A *key rule* for completing the questionnaire is that one only gives scores to those key conditions of which one thinks of being able to make a sensible assessment about. Consequently, if a number of key conditions are generally not scored by a group of people, then apparently these people are not able to judge those key conditions of risk management methodologies. Such a situation may reveal a serious lack of knowledge of the risk management methodologies of concern, which requires (additional) communication about its features, as well as (additional) education of the actors who completed the questionnaires.

The questionnaire for auditing key conditions for social systems

About similar to the one for risk management methodologies, the *questionnaire* for auditing key conditions for *social systems* (Appendix 12) includes also three main columns. These columns represent (1) the main characteristics and subcharacteristics of social systems, (2) the identification numbers and descriptions of key conditions that should be sufficiently present for providing the (sub) characteristics of social systems, and (3) five subcolumns for assessing the actual degree of presence of the key conditions for the social system under consideration. Also for the judgement of key conditions for social systems, a five-point scale is included, with five intervals ranging from between 0 and 20 percent to between 80 and 100 percent of the maximum possible degree of presence. Any type of actor can complete the questionnaire, which should be done individually, for generating the individual (subjective) perception of each person.

The questionnaires for auditing key conditions for social systems can be also completed by different actors belonging to different actor groups. Any differences in perception about the presence of the key conditions can be revealed between individuals (either being the same or different types of actor), as well as between groups of people, such as distinct risk management user groups. From a series of questionnaires, average values of the assessed presence of key conditions can easily be calculated, for generating some sort of patterns about the perceived degree of presence of key conditions amongst individuals or amongst groups of people within an organization.

For example, key condition number 1 in Appendix 12 (formal responsibilities for managing risk) should be present as one of the three key conditions for providing the subcharacteristic of control. This is an element of the social system characteristic of providing a social structure in the organization that is favourable for implementing risk management. In other words, for effective implementation of risk management, the social structure of the organization should foster control, which requires that formal responsibilities for managing risk are set and communicated. Any individual completing the questionnaire has to assess by him- or herself to which degree formal responsibilities for managing risk are present within the (part of) the organization of concern. A score in the 0-20 percent cell implies that there is no formal responsibility arranged at all for managing risk. Contrary, as score in the 80-100 percent cell indicates that formal responsibilities for management risk are perceived present to the maximum possible degree. Clearly, the perceived degree of presence of the key condition in between these two extremes should be assessed by ticking 20-40 percent cell, the 40-60 percent cell, or the 60-80 percent cell. Similarly, all of the degrees of presence of the remaining 21 key conditions for social systems should be assessed.

For assessing the degree of presence of social system key conditions, the same *key rule* rules as for assessing key conditions for risk management methodologies. One should only gives scores to those key conditions of which one thinks of being able to make a sensible assessment about. Therefore, also in case of social systems, if a number of key conditions are generally not scored by a group of people, then apparently these people are not able to judge those key conditions for social systems. Such a situation may reveal a serious lack of knowledge of the social systems of concern. While at first sight this may seem less relevant than a lack of knowledge about risk management methodologies, also a basic understanding of social systems is of utmost important for actors dealing with risk management. This is because of the inherent psychological and social complexity of dealing with risk, in which the social systems of organizations seem to play a dominant role.[170] Therefore, also a lack of knowledge about social systems would require at least some (additional) communication about its features, as well as some (additional) education of the actors who completed the questionnaires. Probably, in organizations with a relatively high number of well-educated professionals, this need for fundamental social system knowledge would probably be higher than in for

170 The inherent psychological and social complexity of dealing with risk, in which the social systems of organizations seem to play a dominant role, seems to be a highly complicated area. This topic has been only briefly touched in the literature survey parts of Section 3.2.3 (Concepts about human agency and risk management) and of Section 4.2.1 (about organizations and systems). While there is a substantial amount of literature available about the psychlogical and social aspects of risk and risk management, the role of these aspects with regard to *implementing* risk management in organizations seems largely unexplored. At least, during the literature survey in the exploratory research, this knowledge remained hidden. It seems a promising area of future research, given the relevance of adequately implemented risk management in an organization and the key roles of individuals and groups of people in these implementation processes.

instance production oriented organizations with largely less educated employees. This is because the latter group would not as much question situations in (social systems of) organizations as the usually more empowered group of well-educated professionals do.

The questionnaire for auditing key interventions for risk management user groups

Also about similar to the ones for risk management methodologies and social systems, the *questionnaire* for auditing *key interventions* (Appendix 13) includes three main columns. These columns represent (1) the main risk management user groups, (2) the identification numbers and descriptions of key interventions that should be sufficiently executed for providing motivation and commitment of the members of the risk management user groups, and (3) five subcolumns for assessing the actual degree of execution of the key interventions within the risk management user groups. Also for the judgement of key interventions, a five-point scale is included, with five intervals ranging from between 0 and 20 percent to between 80 and 100 percent. The latter represents the maximum possible degree of execution of a key intervention.

In principle, any type of actor can complete the questionnaire, which should be done individually, for generating the individual (subjective) perception of each person completing the questionnaire. However, while the questionnaires for assessing the degree of key conditions for risk management methodologies and social systems seem well-applicable for *all* types of *risk management users* (except perhaps the laggards), the questionnaires for assessing the degree of executed key conditions seem particularly relevant for the actor groups of *managers*, *change agents*, and perhaps the *champions*. This is due to the fact that the key interventions are formulated in rather abstract terms. These terms are probably well understood by the mentioned managers and change agents, but not by the average professional, who belongs to a targeted risk management user group. Given their special roles within the risk management implementation process, it may be useful asking *champions* to complete the questionnaire for gaining their perception on executed key conditions. The same applies to *innovators*, who are by definition more than average eager to support new developments within an organization. In addition, their view on the degree of targeted key interventions may be valuable. Nevertheless, due to their inherent enthusiasm, both champions and innovators may overvalue the actual degree of execution of key conditions within an organization. This should be acknowledged, when interpreting their results.

Once again, any differences in perception about the degree of execution of the key interventions can be revealed between individuals (either being the same or different types of actor), as well as between groups of people, such as distinct risk management user groups. From a series of questionnaires, average values of the assessed execution of key interventions can easily be calculated, for generating some sort of patterns about the perceived degree of presence of key conditions amongst individuals or amongst groups of people within an organization.

For example, key intervention number 1 in Appendix 13 (apply situational leadership with teamwork), which seems particularly relevant for managers and change agents, should be present as one of the two key interventions for all groups. Therefore, independent of the targeted risk management user group, this key intervention should be executed. Any individual completing the questionnaire has to assess by him- or herself to which degree situational leadership and teamwork are indeed applied within the organization or organizational unit of concern. A score in the 0-20 percent cell implies that there is (nearly) no situational leadership with teamwork at all applied within the organization. Contrary, as score in the 80-100 percent cell indicates that situational leadership with teamwork is perceived present to the maximum possible degree. Clearly, the perceived degree of presence of the key intervention in between these two extremes should be assessed by ticking 20-40 percent cell, the 40-60 percent cell, or the 60-80 percent cell. Similarly, all of the degrees of execution of the remaining nine key interventions should be assessed.

For assessing the degree of presence of key interventions, the same *key rule* applies as for assessing key conditions. One should only gives scores to those key interventions of which one thinks of being able to make a sensible assessment about. Therefore, if a number of key interventions are generally not scored by a group of people, then apparently these people are not able to judge those key interventions. Such a situation may reveal a lack of knowledge about the key interventions, which may be serious if the persons completing the questionnaires are managers of change agents. These situations should be discussed between the people involved. Probably, additional information, education, or support of managers by consultants who are specialized in interventions, may solve this problem. Moreover, the intervention proposition, which will be introduced in the forthcoming Section 9.5 and is presented in Table 9.3, may provided guidance.

Finally, particularly for monitoring progress in the execution phase of the risk management implementation (see Figure 9.2 in Section 9.3), it may be valuable to *compare* the results of the questionnaires for assessing the degree of execution of *key interventions* with those about the degree of presence of *key conditions* for risk management methodologies and social systems. Plotting average values of key interventions and key conditions in the tabular format of the conceptual model for risk management implementation (see Table 9.1 in Section 9.2) may be helpful. This comparison may reveal the (in)effectiveness of key interventions for realizing key conditions within the same intervention aspect.[171] The results may be used for selecting alternative key interventions, for which the intervention proposition presented in Table 9.3 of Section 9.5 may be useful.

9.5 The intervention proposition for implementing risk management

The objective of the *intervention proposition*, which stems from organisational change management, is providing guidance for selecting and executing key interventions and supporting activities. These should foster motivation and commitment of the risk management users, as well as key conditions for risk management methodologies and the social systems. *Using* the intervention proposition is proposed in the end of the *initiation phase* and at the start of the *execution phase* of the risk management implementation process in organizations. This is indicated in the structure part of the design process model in Figure 9.2 of Section 9.3. Moreover and mentioned in the previous section, the intervention proposition may also be helpful after monitoring risk management implementation progress by the audit instrument. If the results of such an audit reveal that key conditions are not yet present to a required degree, then additional or other key interventions may be required. These interventions, together with supporting activities, can be derived from the intervention proposition for risk management user groups.

The intervention proposition acknowledges the five risk management user groups with their corresponding intervention aspects, being (1) innovators, (2) early adopters, (3) early majority, (4) late majority and (5) laggards. This allows *targeting* key interventions to each specific user group, by selecting user group-specific interventions. Furthermore, the intervention proposition assists in selecting particular interventions for setting or strengthening key conditions for the risk management methodologies, which provides *reinvention* and *customization* of these methodologies. The intervention proposition provides also interventions for setting or strengthening key conditions for the social system of the targeted risk

171 For more information about possible relationships between key interventions and key conditions, which may reveal under-proportional, proportional and even over-proportional impact of key interventions, reference is made to the cross-case analysis of the field study results in Section 7.4.2 of Chapter 7.

management users, in which the risk management methodologies have to been implemented. This provides *contextualization* of the social system for becoming supportive to risk management implementation. The intervention aspects are leading for selecting any key interventions and supporting activities. For instance, if the risk management implementation audit within an organization reveals that particularly rational and emotional sorts of key conditions for the social system need to be strengthened, then rational and emotional types of intervention and supporting activities should be selected.

Table 9.3 (on page 308 and 309) shows the resulting intervention proposition, which includes the ten *key interventions*. Moreover, for each key intervention a number of *supporting activities* are selected and presented. These have been derived from the literature and field research presented in Chapter 5 about change management. According to the conceptual model for risk management implementation, the key interventions and supporting activities are attributed to the five intervention aspects: (1) learning aspect, (2) autonomous aspect, (3) rational aspect, (4) emotional aspect, and (5) political aspect. These intervention aspects are connected to the five mentioned risk management users groups.

In addition, key interventions belonging to the *learning aspect* are considered user group-independent and should be executed to all risk management user-groups. However, *how* to apply the learning type of key interventions and supporting activities is dependant on the targeted user groups. Then the dominating aspect of each user-group should be considered. For instance, risk management training to innovators should have an autonomous focus, while risk management training for the late majority should include a high degree of formalization, by applying risk management standards.

Finally, the right side of Table 9.3 shows two columns. These present whether the key interventions and supporting activities are generally considered useful, or not, for setting risk management and social system key conditions. This classification results from the knowledge gained during this research. It should be considered only for some practical guidance, rather than for being the absolute scientific truth. [172] Most of the key interventions for setting or strengthening the key conditions for risk management methodologies are considered relevant. Only the autonomous type of key intervention of out-of-the-box risk management sessions for innovators seems

172 The cross-case analysis in Section 7.4.2 of Chapter 7 learned how complex the theoretically assumed relationships between key interventions and key conditions of the same intervention aspect actually are. More research, particularly with longitudinal and quantitative data, would be required for empirically confirming or rejecting these relationships. Nevertheless, based on common sense, the main characteristics of the key conditions for risk management methodologies and social systems have been analyzed in view of the main intervention aspects and their features. Based on this analysis, the two most right columns of Table 9.3 have been completed.

not to strengthen any of the key conditions for the risk management methodologies. Furthermore, all of the key interventions are considered useful for setting social system key conditions.

Regarding the intervention proposition, one final remark needs to be made. Because of the considerable and ever increasing number of possible interventions, there is some risk of sticking to one's own well-known and proven interventions. In addition, according to for instance Blanchard (1998) and Vermaak (2002), it is not realistic to expect that one single professional is able to judge and apply *all* available intervention techniques. Therefore, assistance of intervention professionals may be required for selecting and executing those specific interventions that are expected to have the highest impact on setting the targeted key conditions, while usurping a minimum of inherently scarce organizational resources, such as time and money.

Table 9.3 Intervention proposition for risk management user groups.

Risk management user groups	Intervention aspects	Key interventions			
		No.	**Description of key interventions and supporting actions (RM = Risk Management)**	**Useful for setting risk management key conditions**	**Useful for setting social system key conditions**
All groups	Learning	1	Apply situational leadership with teamwork by: – Transformational leadership for innovators – Transactional leadership for other RM user groups – Fostering multi-disciplinary teamwork – Teambuilding	Yes	Yes
		2	Provide RM education and training by: – Courses about RM awareness and theories – Courses about RM applications – Exercises about RM applications – RM gaming – RM training on the job – RM circles – RM coaching – After RM action review sessions – Establishing a lessons-learned desk	Yes	Yes
Innovators	Autonomous	3	Arrange out-of-the-box RM sessions by: – Strategic dialogues – Co-creation with all actors involved – Sense-making – Multi-disciplinary risk workshops – Open space meetings – Appreciative inquiry – Learning histories – Electronic group decision support systems	No	Yes
		4	Forster RM self-monitoring and self-evaluation by: – Regular RM peer group meetings	Yes	Yes
Early adopters	Rational	5	Apply a staged RM implementation process by: – Integrating RM in organizational processes – Re-designing existing work processes – Integrating RM with project management and with strategic management – Integrating RM with quality management – Integrating RM with health & safety management	Yes	Yes

Table 9.3 Continued

Risk management user groups	Intervention aspects	Key interventions			
		No.	**Description of key interventions and supporting actions (RM = Risk Management)**	**Useful for setting risk management key conditions**	**Useful for setting social system key conditions**
		6	Facilitate the application of RM with resources: – Time – Budget – Supporting guidelines, software, reporting formats – Risk checklists and risk databases – Risk evaluation protocols – Human support by a helpdesk	Yes	Yes
		7	Set, monitor, and communicate RM added value by: – Targeting and monitoring risk profiles – Cost-benefit analyses – Benchmarking – Risk management (electronic) newsletters – Case studies with success stories	Yes	Yes
Early majority	Emotional	8	Ensure identification of risk management by: – Organizing social gatherings – Mobilizing opinion leaders – Mobilizing champions – Task extensions by applying RM – Assessing and rewarding RM application – Rewarding RM gate keeping – Career development by applying RM	Yes	Yes
	Political	9	Do task, responsibility, and authority sessions by: – Clarifying risk management responsibilities – Setting personal RM commitment statements	Yes	Yes
Late majority		10	Enforce risk management application by: – Top management of the organization – Clients and contracts – Accreditation – Using the ISO 31000 RM Guideline – Media attention	Yes	Yes
Laggards		-	None – do not waste energy and resources	-	-

9.6 Results and next research step

Research results

In this chapter, the *modified* conceptual model, design process model, and audit instrument from Chapter 8 have been refined into *final* versions. All but one of the suggested recommendations, made by the professional expert panel in Chapter 8, were incorporated. Moreover, an *intervention proposition* with suggestions *how* to apply *key interventions* by undertaking supporting actions was developed. Therefore, this chapter generated the final design propositions for implementing risk management within organizations by developing a knowledge base including:

1. A *conceptual model*, which aims to provide insight in the relevant *mechanisms* that need to be acknowledged for effective, efficient, as well as persistent implementation of risk management within organizations. The model includes three dimensions of (1) *risk management users*, (2) *risk management methodologies*, and (3) *social systems*. Also, the model includes three sets of in total 50 key variables: 10 *key interventions* for five distinct risk management user groups, 18 *key conditions* for risk management methodologies, and 22 *key conditions* for social systems. Individuals of targeted risk management user groups are members of social systems, in which risk management methodologies are implemented. Within the model, five distinct *risk management user groups* are (1) innovators, (2) early adopters, (3) early majority, (4) late majority, and (5) laggards. Five *intervention aspects* connect user groups to specific key interventions and related key conditions: (1) the learning aspect, (2) the autonomous aspect, (3) the rational aspect, (4) the emotional aspect, and (5) the political aspect;
2. A *design process model*, which facilitates context-specific design of risk management implementation *processes* within organizations. The *process structure part* of the design process model distinguishes three phases. These are (1) the *feasibility* phase, (2) the *decision* phase, and (3) the *execution* phase for risk management implementation. The *role structure part* of the design process model provides guidance for defining *roles*, *tasks*, and *responsibilities* of the five main types of actor during risk management implementation processes. These *actors* are (1) *risk management users*, (2) their *managers*, (3) *change agents*, including risk management experts, intervention experts, and organizational experts, (4) *opinion leaders*, and (5) *champions*;
3. An *audit instrument*, for measuring *organizational readiness* for implementing risk management and monitoring *progress* over time. The audit instrument

includes three *questionnaires* for (1) auditing the presence of key conditions for *risk management methodologies*, (2) auditing the presence of key conditions for *social systems*, and (3) auditing the execution of key interventions in *risk management user groups*;

4. An *intervention proposition*, which aims to provide *guidance* for selecting *key interventions* and *supporting activities* in each of the five intervention aspects. These interventions aim (1) to provide user group-specific motivation and commitment (targeting), (2) to adapt risk management methodologies (reinvention and customization), and (3) to generate organization-specific conditions for implementing risk management in social systems (contextualization).

Acknowledging the *conceptual model* for implementing risk management is considered relevant for any *researcher*, *manager*, or *professional*, who is involved, or will become involved, in implementing risk management in organizations. The *design process model*, as well as the *audit instrument* and *intervention proposition*, aim to facilitate *risk management consultants*, as well as *organizational consultants* and *change management consultants*, during the context-specific *design* and actual *execution* of risk management implementation processes in organizations.

Research limitations

All but one of the recommendations of the expert panel were included in the resulting design propositions for implementing risk management in organizations. Only the call for examples of actually applying the conceptual model, the process design model, and the audit instrument in the professional practice could not be fulfilled. Generating examples in addition to the four case studies of Chapter 7 were beyond the scope of this research. Nevertheless, the relevance of examples, for the professional practice as well as for academia, is paramount. Therefore, generating examples for designing and executing risk management implementation, by using the developed design propositions in real pilot projects, is a fundamental element of the recommendations for future research, as presented in the next chapter.

Next research step

The next and last research step involved evaluating the final research results, and providing conclusions and recommendations for future research. The forthcoming Chapter 10 reports the results of this evaluation research.

10

CONCLUSIONS AND RECOMMENDATIONS

10.1 Introduction

After reporting the *final* research results, by the design propositions for implementing risk management in organizations in the previous chapter, one more chapter remains. This last chapter involves the *evaluation* research part of this Ph.D. research. It aims to present the main conclusions drawn from this research, as well as the most relevant recommendations for future research.

The next section starts with presenting the main research *conclusions*. Then it concludes about the scientific and practical *contributions* of this research. The *scientific* contribution considers particularly the developed conceptual model for risk management implementation design, by comparing it with state-of-the-art models in the literature. The *practical* contribution of this research addresses how the design process model, as well as the audit instrument and the intervention proposition, may assist professionals in their practices with designing, executing, and monitoring risk management implementation within organizations. The applied design *science* research approach aims to provide solution-oriented and prescriptive knowledge that supports solving *practical* problems by professionals. Consequently, two types of research *limitations* are distinguished, scientific limitations and those from a practical point of view.

The last section of this chapter presents *recommendations* for future research. These are logically derived from the previously raised research limitations. Subsequently, recommendations for future research from a scientific point of view, from a professional practice point of view, and from a synthesizing point of view are presented. The latter recommendations synthesize the three disciplines of this research, risk management, innovation management, and change management, to an aggregate level beyond the scope of this research. The synthesizing types of recommendation aim to further develop prescriptive and solution-oriented knowledge, by applying the still rather innovative design science research approach.

10.2 Conclusions

Research conclusions

Based on the exploration oriented research of risk management, innovation management, and change management, and the development oriented research of implementing risk management in organizations, four main conclusions are drawn. Because of the research objective, these conclusions focus on problems and solutions for *how* to implement risk management in organizations in the construction industry:

Conclusion 1: Form, function and meaning of risk management are largely intangible and subjective, which makes effective, efficient, and persistent implementation in organizations highly complex;

Conclusion 2: Implementing risk management in organizations requires a design approach that synthesizes risk management, innovation management, and change management concepts and practices;

Conclusion 3: Specific attention to routinize the use of risk management methodologies, defined implementation, is highly underdeveloped;

Conclusion 4: For real implementation, risk management methodologies need to be adapted to organizational social systems with their distinct risk management user groups.

Conclusion 1 and Conclusion 3 are field problems in the professional practice of the Dutch construction industry, for which Conclusion 2 and Conclusion 4 provide solutions. Regarding the first two conclusions, the *complexity* of implementing risk management in organizations has been revealed by 480 identified variables, during the exploration research. This complexity is considerably higher than that of implementing other types of organizational innovations, such as quality systems or information and communication technology. Inherent difficulties causing this complexity are the intangible and subjective form, function and meaning of risk management, together with the *preventive* character from an innovation perspective. For being able to handle this complexity effectively and efficiently, well-structured design propositions are required, by synthesizing risk management, innovation management, and change management concepts and practices. By the developed design propositions, the original number of 480 variables could be responsibly reduced to a well-workable series of 50 key variables.

With regard to the last two conclusions, most organizations focus entirely on *developing* risk management methodologies, when starting with *applying* risk management. Giving specific attention to *routinizing* the use of these methodologies, which has been defined *implementation*, is highly underdeveloped. The two fundamental dimensions of organisational *social systems* and their distinct *risk management user-groups* are commonly neglected, particularly in technically oriented organizations in the construction industry. This has been confirmed by the four cases studies, performed in a geotechnical institute, a project management consultancy, a contractor, and a public client organization within the Dutch construction industry. In overall conclusion, this research demonstrated that for effective, efficient, and persistent risk management implementation in organizations, it is required to:

1. Provide user group-specific motivation and commitment of individuals, by targeting distinct user groups with purposeful *interventions*, according to learning, autonomous, rational, emotional, and political intervention aspects;
2. Adapt risk management methodologies by *reinvention* and *customization* for realizing conditions that create the required fit of these methodologies with the targeted risk management user groups;
3. Generate organization-specific conditions for social systems, for *contextualization* of risk management in social systems of organizations.

The developed design propositions for implementing risk management in organizations provide guidance *how* to realize these *interventions* within risk management user groups. Moreover, the design propositions guide how to set *conditions* for reinvention and customization of existing risk management methodologies, as well as for contextualization of risk management in social systems. Knowledge about risk management, innovation management, and change management is required for realizing these interventions and conditions. Therefore, professional experts in risk management, innovation management, and organizational change management will have to work closely together, during preparing, executing, and monitoring risk management implementation in organizations. Only then, there is a fair chance for effectively and persistently realizing risk management implementation in an efficient way.

Conclusions about the scientific contribution of the research results

The conclusions about the *scientific* contribution of the research results focus on the developed c*onceptual model* for implementing risk management, by comparing it with state-of-the-art models in the literature. This aims to facilitate scientists doing research in the disciplines of risk management, innovation management, and planned organizational change management. The remaining research products are evaluated in the forthcoming subsection about the *practical* contribution of the research results.

This research did not reveal any comparable scientifically designed and validated conceptual models that explicitly address the implementation of risk management in organizations in the construction industry.[173] Also for organizations in other industries, these types of model appeared non-existing. The developed conceptual model for implementing *risk management* in organizations appeared to be the first in its kind. Therefore, the model could not be compared with similar risk management implementation models. Consequently, the developed conceptual model has been compared with existing models for implementing organizational *innovations*, such as information technologies and quality management systems. This comparison revealed four *unique* and *distinguishing* features of the conceptual model that resulted from this research:

1. The conceptual model *synthesizes* state-of-the-art concepts for *managing risk* with those for *implementing innovations* and realizing *planned organizational change*;
2. The conceptual model combines *three dimensions* of (1) risk management methodologies, (2) social systems, and (3) risk management user-groups;

173 The only scientific research encountered, which explicitly addresses risk management implementation in organizations in the construction industry, is the management-level model. This model has been developed during the M.Sc. research by Van der Heijden (2006) and is discussed in Halman (2008). Risk management implementation by using this model in a project management consultancy served as one of the four cases for this Ph.D. research in Chapter 7.

3. Within the conceptual model, five degrees of individual user *motivation* and *commitment* have been combined with five distinct *risk management user-groups* and five *intervention aspects* for realizing organizational change;
4. Contrary to existing models for implementing innovations, the designed conceptual model for implementing risk management includes a considerable, yet workable, number of 50 key variables.[174] This well-structured series of key variables includes 18 *key conditions* for risk management methodologies, 22 *key conditions* for organizational social systems and 10 *key interventions* for individual members of five risk management user groups.

In overall conclusion, the main *scientific contribution* of this research is providing a unique, scientifically designed and validated conceptual model, which explicitly addresses implementing risk management in organizations in general, and in the construction industry in particular. The developed conceptual model inhibits four distinguishing features, when compared with scientifically designed and validated models for implementing organizational innovations.

Conclusions about the practical contribution of the research results

Many organizations, in many industries, struggle with implementing innovations in general, and with implementing risk management in particular. These struggles bear large and partly avoidable costs, while objectives are only partly, or not at all, realized. Therefore, conclusions about the *practical* contribution of this research address the developed and evaluated *design process model*, *audit instrument* and *intervention proposition*. These may assist *consultants*, *managers* and *professionals* in *practice* with more effective, more efficient, and more persistent risk management implementation within organizations. This aims to reduce implementation costs and to increase implementation benefits, such as more competitiveness, more client satisfaction, higher revenues and profits, and better reputation. Similar to the conceptual model for risk management implementation, the developed design process model, audit instrument, and intervention proposition are unique. Over the years, disciplines such as the design science, innovation management, and change management generated abundant design process models, audit instruments, and intervention propositions.[175] However, none of these appeared specifically

174 Apparently for reasons of simplicity, most existing theoretical frameworks for implementing innovations focus only on a *few*, yet different, *key variables.*

175 Some risk management textbooks for professionals do refer to change management literature, when considering the implementation of risk management (Edwards and Bowen, 2005), or discuss the interaction between risk and

developed for risk management implementation.[176] The developed products of this research have the following eight *unique* and *distinguishing* features:

1. The design process model, audit instrument and intervention proposition synthesize state-of-the-art knowledge and international experiences of applying *risk management*, implementing *innovations*, and realizing planned *organizational change*;
2. The design process model, audit instrument, and intervention proposition combine guidance how to implement risk management in organizations by the *logic of prescription*, with a large degree of *flexibility*. This allows context-specific redevelopment by a second design, which supports application in a variety of organizations, even beyond the construction industry, in many different countries;
3. The design process model, audit instrument, and intervention proposition are applicable for implementing risk management at *multiple levels*: (1) at *discipline* level, such as geotechnical risk management, (2) at *project* level, such as project risk management, and (3) at *organizational* level, such as portfolio risk management;
4. The *process structure part* of the design process model provides planned *discrete steps* for the process of implementing risk management within organizations;
5. The *role structure part* of the design process model suggests *roles*, *tasks*, and *responsibilities* of the *actors* within risk management implementation processes;
6. The audit instrument reveals the degree of presence of relevant *key conditions* for risk management methodologies and those for organizational social systems. The degree of presence of these key conditions corresponds with the degree of risk management implementation in an organization;
7. The audit instrument provides the ability to *measure* and *monitor* the *readiness* for, as well as *progress* and *persistence* of, risk management implementation over time. This provides the following benefits:

change in a general way (Waring and Glendon, 1998). Nevertheless, any scientific or more practical literature that explicitly applies change management concepts and variables for implementing risk management in organizations, in addition to the literature mentioned in footnote 173, has not been encountered during the literature surveys for this Ph.D. research.

176 The only identified *audit instrument* from the literature that seems to be related to risk management implementation in organizations is the *risk maturity test* (Hillson, 2002, 1997). This instrument measures the level of organizational risk maturity. However, it does not synthesize risk management, innovation management, and change management. Also modifications of the risk maturity test, as provided by Olsson (2006) and Van der Heijden (2006), do not demonstrate a similar extensive and in-depth synthesis of these three different disciplines.

a. It delivers precious information about the *relevance*, *presence*, and *change* of key conditions for implementing risk management within an organizational context;
b. Comparing audit questionnaires of different respondents provides insight in *differences* in *perceptions* about the risk management implementation process. Discussing these differences increases shared understanding about the risk management implementation process and the required interventions for improving the process;
c. Comparing the degrees of execution of key interventions with the degree of presence of key conditions provides learning about the *effectiveness* of key interventions for establishing key conditions for organizational risk management implementation.

8. The intervention proposition suggests specific *key interventions* and supporting activities for five distinct risk management user groups: (1) innovators, (2) early adopters, (3) early majority, (4) late majority and (5) laggards. Executing these key interventions, according to learning, autonomous, rational, emotional, and political aspects with supporting activities fosters building motivation and commitment of the individuals within the risk management user groups.

The wealth of key interventions and key conditions, connected by similar intervention aspects that are incorporated in the research products, acknowledges the inherent idiosyncrasies within the social systems, sub-systems, and aspect systems of each organization. Together with the conceptual model for risk management implementation, professional use of the research products in a variety of (parts of) organizations appeared possible and useful. Applying these research products may refrain change agents from common one-size-fits-all approaches for implementing innovations in general, and risk management in particular. Such approaches are often ineffective, because they neglect the unique features of each and every (part of an) organization.

The specialized discipline of geotechnical engineering served as basis for this research. Other specialized disciplines, such as structural engineering, as well as more generic disciplines like civil engineering and construction, are able to use the developed practical knowledge base for risk management implementation. The same applies to the other two distinguished risk management levels. At project level, the project management discipline can be strengthened by incorporating risk management and its implementation knowledge. At organizational level, for instance innovation managers will be able to use the knowledge base for implementing innovations, other than risk management, in organizations.

In overall conclusion, the main *practical contribution* of this research is providing a unique, scientifically developed and evaluated design process model, audit instrument, and intervention proposition. These research products are purposefully developed for supporting organizational risk management implementation in general, and in the construction industry in particular. The developed research products inhibit eight unique and distinguishing features, when compared with existing design process models, audit instruments, and intervention propositions developed in the disciplines of design science, innovation management, and change management.

Research limitations

Two types of *research limitations* are acknowledged. These are limitations from a *scientific* point of view and those from a *professional practice* point of view. *Science* primarily aims to answer the question: *Is it true*? The *professional practice* is more interested in answering the question: *Does it work*? The applied practical design science approach aims to provide solution-oriented and prescriptive knowledge that supports solving field problems by professionals. This research approach has been purposefully selected for answering both types of question. Four principles maximize the scientific validity and reliability of the organizational research results.[177] First, evidence from both literature survey and field research guaranteed completeness of research data. Second, rival explanations from the literature and the interviews have been compared and confronted. Third, during the multiple-case study, the results of the four single cases were analyzed in a cross-case analyse. Fourth, expert knowledge and experience from scholars and professionals from the United States, the United Kingdom, The Netherlands and South Africa, from risk management, innovation management, and change management perspectives, have been incorporated in the research results.

Nevertheless, limitations emerged during the research process. Given the applied practical design science approach for this research, any research limitations are primarily considered in view of the pre-set design specifications. *Specific design specifications* for to the developed design proposition for implementing risk management in organizations are a subset of the *meta-design specifications* concerning the design of the entire research.[178]

177 Because of being an organizational sort of research, Yin's (2003) *four principles* underlying all good social science research have been applied in this research.

178 The two criteria for the *meta-design specifications* for this research were (1) from a scientific point of view, guaranteeing reliability and validity (Becker, 1998; Kardon et al., 2006; Yin, 2003), and (2) from a practical point if view, providing *solution-oriented* and *prescriptive knowledge* that supports solving field problems by professionals (Van Aken, 2008a). From a *scientific* point of view, the initial criteria for the specific design specification for imple-

At the end of Chapter 2 through to Chapter 9, research results have been summarized and their limitations have been highlighted. These limitations served as drivers for the next research steps taken. The two forthcoming subsections present the recognized limitations of the final research results from a *scientific* and a *professional practice* point of view. These limitations served as basis for the recommendations for future research, presented in the next section of this chapter.

Research limitations from a scientific point of view

Research limitations from a *scientific* point of view have been evaluated by acknowledging construct validity, internal validity, external validity, and reliability of the design proposition for implementing risk management in organizations in the construction industry.[179] The following seven research limitations are acknowledged and discussed:

1. Lack of *invariant laws* for implementing risk management within organizations. As predicted by van Aken (2008a), by referring to Numagami (1998), only some sort of patterns and regularities in behaviour within social systems of organizations can be identified in organizational research.[180] For risk management implementation, five distinguished intervention aspects represent these patterns. These are the learning, autonomous, rational, emotional, and political aspects. For each intervention aspect, sets of key conditions and related key interventions with supporting activities have been provided. Nevertheless, invariant laws for the presence of the causal relationships between key conditions and key interventions, which would guarantee risk management implementation success, did not emerge. [181]

menting risk management in organizations were (1) perceived *relevance* of key conditions and key interventions by the actors during the risk management implementation process, (2) *causal relationships* between key interventions and key conditions, and (3) *causal relationships* between key conditions and risk management implementation. During the modification of the initial design proposition, eight *additional* criteria were added to the specific design specification. From a *professional practice* point of view, the final design proposition for implementing risk management should also be (1) state-of-the-art, (2) complete, (3) suitable, (4) applicable, (5) flexible, (6) effective (7) efficient, and (8) transferable to other professionals.

179 These scientific criteria are widely considered being the main criteria for judging scientific quality. As for instance presented in Kardon et al. (2006), Yin (2003), and Becker (1998), *validity* expresses to what degree a research method investigates what it aims to. By referring to Kidder and Judge (1986), Yin (2003) distinguishes (1) *construct* validity, (2) *internal* validity, and (3) *external* validity. *Reliability* implies the ability to replicate the same research results, when the research is repeated by other researchers under the same circumstances (Yin, 2003).

180 Recognizing patterns and regularities in organizational research, rather than invariant laws, has for example been confirmed by a study of fifty Dutch innovation projects by Cozijnsen et al. (2000). They concluded that the success and failure factors for innovations are not uniform. Such factors differ per type innovation.

181 Within this research, the CIMO-logic of context-intervention-mechanism-outcome (Denyer et al., 2008) provided this causality. According to this concept, causality should be considered heuristically and context dependant, rather

These consequences may be judged as a lack of *construct validity* (incorrect operational measures for the concepts studied) and *internal validity* (lacking causal relationships between variables) from a conventional and mechanistic scientific point of view, usually fostered in the natural sciences. However, from the purposeful selected design science point of view within this organizational research, the intervention aspects actually *do* provide the searched patterns and regularities in behaviour during implementing risk management within social systems of organizations, which provides construct validity and internal validity of the design propositions;

2. Occurrence of *equifinality,* when applying the design propositions for risk management implementation. Holahan et al. (2004), Klein and Sorra (1996), and Nord and Tucker (1987) relate the concept of equifinality to the implementation of innovations in organizations. It means that different paths or approaches may give the same end result. Therefore, *differently* designed risk management implementation processes may create the *same* degree of organizational risk management implementation. Moreover, in different organizations the presence of key conditions and key interventions to different degrees may result in similar degrees of risk management implementation. Therefore, any design process proposition for implementing risk management within an organization should be considered with modesty and care. Other design propositions may be possible as well. This concept of equifinality within research of organizational design is closely related the former lack of invariant laws. From a traditional scientific perspective, this situation may raise concerns about the *external validity* of the design propositions for risk management implementation (lack of non-uniform generalization).[182] However, from the design science point of view, occurrence of equifinality is an inherent characteristic of the design science approach;[183]
3. Incomplete *case study data* about the implementation of risk management in two of the four case studies. Eisenhardt (1989) suggests using the concept of *theoretical saturation* for building evidence by applying multiple-case

than linear and universally valid. The CIMO-logic aims providing *solution-oriented* and *prescriptive* knowledge that effectively and efficiently *supports* solving field problems by professionals themselves.

182 Van Aken (2008a) stresses the importance of external validity of organizational research results for transfering findings within one organizational context to another one. However, due to the mentioned lack of invariant laws, conventional generalization is highly complicated for scientific organizational research results.

183 See for instance Van Aken (2005b: 397), which explains that a process design is realized by contextualization through *internalization* of a design proposition by the designers in question. Any professional designing a risk management implementation process need to contextualize the developed design propositions for implementing risk management that result from this research.

studies. The lack of implementation data reduces the *validity* and *reliability* of the design propositions for risk management implementation from a design science point of view;

4. Incomplete *longitudinal* data for confirming the persistence of risk management implementation within an organization over time. For instance, Danserau et al. (1999) acknowledge the inherent instability of individuals and organizations over time. This lack of longitudinal data reduces the *reliability* of the research results from a design science point of view;
5. Limited amount of *quantitative* research results. Due to the available data sets, the applied analyses were largely qualitative. Some quantitative research, as for instance proposed by Klein and Sorra (1996), and Ragin (1987) in Becker (1998), is performed by executing a Delphi analysis (Verschuren and Doorewaard, 2000) on the results of the interviews with the international risk management experts. Because of the limited size of this quantitative data set, statistically acceptable correlations between variables, such as key interventions and key conditions for implementing risk management, were not possible. However, because of the inherent lack of invariant laws within organizational research (as discussed above), the reliability of any statistical correlation between organizational variables will be at best modest. Therefore, the limited amount of quantitative data is not considered involving serious research limitations from a design science point of view;
6. No availability of *beta-test* results of the developed design propositions for implementing risk management in organizations. As for instance suggested by Van Aken (2001) and already applied by Halman (1994), beta-testing would replicate the validation of the design propositions by *other* researchers. While Romme's (2003) other recommendations for organization research have been followed, such as applying insider-outsider approaches by interviewing experts of different disciplines and providing comparative case studies by the single- and cross-case analyses, beta-testing of the final design proposition was outside the scope of this research. Instead, but obviously not fully replacing beta-testing, an expert panel evaluated the design propositions. The recommendations of the experts were incorporated in the final design. Nevertheless, the actually missing beta-test results may reduce the *reliability* of the developed design propositions for risk management implementation, from a scientific point of view;
7. Limited *generalization*, according to the concept of analytical induction (Becker, 1998). The conceptual model and the audit instrument have been checked by case studies in a geotechnical knowledge institute, a project management

consultancy, a contractor, and a public client in the construction industry. A variety of professional experts, working in the construction industry, evaluated the research products. However, the external validity has not yet been checked in other types of organization, in other industries, or in other countries with different cultures.

The first two limitations are unavoidable when applying organizational research, performed either according to the design science methodology or according to conventional social science approaches. These inherent limitations were expected, anticipated, and acknowledged. Therefore, these limitations do not limit the research results, from a design science point of view.

The five remaining limitations are not inherent to organizational research. Consequently, from a design science perspective these limitations do influence the reliability and validity of the research results to an unknown extend. Because of the applied research methodologies, it is concluded that the effects of the limitations are probably rather restricted. There are no reasons to hesitate about the practical use of the developed design propositions from a design science point of view. Moreover, it is very well possible to reduce any of the limitations by additional research, as presented in the next section of this chapter, after presenting and discussing the research limitations from a professional point of view.

Research limitations from a professional practice point of view

Research limitations from a *professional practice* perspective have been evaluated by considering the *overall usefulness* of the developed knowledge base for risk management implementation in organizations, including the conceptual model, design process model, and audit instrument. The *overall usefulness* has been expressed by eight specific design criteria: (1) state-of-the-artness, (2) completeness, (3) suitability, (4) applicability, (5) flexibility, (6) effectiveness, (7) efficiency, and (8) transferability to other professionals. These criteria should be satisfied to a sufficient degree in the perceptions of the professional actors. An expert panel with nine participants from a variety of organizations in the Dutch construction industry judged these criteria positively. Their partial to full agreement with 24 statements representing the eight criteria was on average 74 percent.[184] Apparently, the design proposition for implementing risk management in organizations has a substantial degree of overall usefulness, from a professional practice point of view. Therefore, it

184 As mentioned in Chapter 8 and in Chapter 9, all but one of the recommendations from the expert panel have been incorporated in the final design propositions for implementing risk management in organizations, after the expert panel meeting. Therefore, a second expert panel evaluation of the *final* design propositions by the same experts would highly likely increase their average agreement to a value above 74 percent.

is concluded that the research limitations of the design proposition for implementing risk management in organizations are very low from a professional practice point of view.

Nevertheless, one main limitation of the developed design propositions and research products, raised by the expert panel, remained untouched, even in the final design. This is the request for *practical examples*. In addition to the four cases studies, which have been analyzed by back-casting with two of the four research products (the initial conceptual model and the initial audit instrument), such examples would demonstrate the effect of the *full* application of all of the four final research products, including the design process model and the intervention proposition, during the implementation of risk management in *real* situations.

Addressing the foregoing *scientific* limitations about validity and reliability, particularly by applying the design propositions for risk management implementation in pilot projects, would at the same time deliver the requested practical examples. Executing and carefully evaluating pilot projects, including a comparison with the four case organizations, would generate additional knowledge and experience. This would increase the overall usefulness of the conceptual model, design process model, audit instrument, and intervention proposition for implementing risk management in the professional practice. Therefore, executing pilot projects is one of the suggestions for the future research agenda of the next section.

10.3 Recommendations for future research

Research recommendations

In this section, an agenda for (near) future research is proposed. This particularly empirical research agenda aims to address the *scientific* and *practical* limitations of the research results, as raised and discussed in the previous section. Moreover, by considering risk management an *organizational innovation*, additional research suggestions are presented for generalizing the design propositions for implementing *risk management* in organizations towards knowledge about implementing *innovations* in organizations. This generalization strengthens external validity of the research results towards disciplines beyond risk management.

Recommendations for future research from a scientific point of view

Suggested directions for strengthening reliability and validity of the research results for implementing risk management in organizations research are:

1. Applying the conceptual model, design process model, audit instrument, and intervention proposition for implementing risk management in a few *additional* case studies in preferably the same, or otherwise *similar* types of organization. These pilots should generate additional data for building evidence by using the concept of theoretical saturation (Eisenhardt, 1989). Furthermore, the results of new case studies would provide examples about the application of the models and instruments in reality (with or without added value), which has been recommended by the expert panel;
2. Performing *longitudinal* research about the persistence of risk management implementation within the additional case studies, for example suggested by Danserau et al. (1999). It is recommended to measure and monitor the degree of risk management implementation within an organization over time, preferably in the order of years, by using the models and instruments of the developed knowledge base;
3. Performing *quantitative* research, as for instance proposed by Klein and Sorra (1996), and Ragin (1987) in Becker (1998). Theoretically, this may generate statistically acceptable correlations between variables, such as key interventions and key conditions for implementing risk management. However, due to the lack of invariant laws within organizational research, the additional reliability and practical relevance of these statistical correlations would probably be rather limited;
4. Executing *beta-testing* of the designed risk management implementation approach, by its application by *other* researchers, as recommended by for instance Van Aken (2001);
5. Applying the models and instruments of the developed knowledge base in a number of *other* types of organizations, outside the construction industry, preferably even outside The Netherlands. This would contribute to *generalizing* the risk management implementation research results, according to the concept of analytical induction, as for instance raised by Becker (1998).

All of these suggested types of additional empirical research for implementing risk management in organization may reject existing variables and their interrelationships, reveal new variables, or reveal new relations between existing variables. By recalling the CIMO-logic (Pawson, 2002 in Denyer et al., 2008), the recommended additional research may reveal in what context, for which actors, in what respect, and why, certain interventions and underlying mechanisms generate targeted outcomes of implemented risk management within organizations. Favourable contexts (C+), interventions (I+) and mechanisms (M+) producing intended outcomes (O+) should be distinguished from unfavourable contexts (C-), interventions (I-) and mechanisms (M-) not generating intended outcomes (O-).

The resulting additional empirical knowledge should be used for refining, and when required modifying, the developed models and instruments for implementing risk management in organizations. Moreover, the socio-psychological complexity of individuals dealing with risk in social systems of organizations seems ask for additional research.[185] While there is a substantial amount of literature available about the psychological and social aspects of risk and risk management, the role of these aspects with regard to *implementing* risk management in organizations appeared yet unexplored. Because of the relevance of adequately implemented risk management in organizations, and the key roles of individuals and groups of people in these processes, this seems a promising area of future research. Finally, it is expected that a follow up of each of the recommendations strengthens the scientific validity and reliability of the conceptual model, design process model, audit instrument, and intervention proposition for implementing risk management in organizations that resulted from this research. Fulfilling more of the recommendations will obviously increase this effect.

Recommendations for future research from a professional practice point of view

In addition to strengthening the reliability and validity, follow up of the scientific types of recommendation will also contribute to the overall usefulness of the design propositions from a practical point of view. All of the scientific recommendations made involve the application of the design propositions in real projects, which directly answers the call for real project examples. Strengthening the reliability and validity of the conceptual model, the design process model, the audit instrument, as well as the intervention proposition, will therefore also contribute to the overall usefulness of the research products and herewith to the societal relevance of this research.

Furthermore, as already emerged during the literature survey and field research, suggested by the expert panel, and advocated by Van Staveren (2006), applying risk management should become (much more) integrated in other managerial disciplines, such as project management, innovation management, quality management, and

185 Based on Van Staveren (2006), this topic has briefly been touched in the literature survey in Section 3.2.3 (Concepts about human agency and risk management) and in Section 4.2.1 (about organizations and systems).

strategic management.[186] Ideally, risk management dissolves entirely in these existing managerial disciplines, in due time. True incorporation of risk management aims making the inherent and implicit uncertainties within these disciplines explicit, without having the necessity of a separate risk management discipline. Such a merger of disciplines may reduce the often huge amount of paperwork and therefore generate substantial economies of scale. Moreover, economies of learning are likely, because explicitly dealing with risk in the mentioned disciplines will reveal the consequences of risk-laden decisions over time.

As a first next step, for the near future it is recommended to investigate whether more closely coupling of risk management to these other and well-established managerial disciplines indeed contributes to organizational effectiveness and efficiency. This may also reveal to which degree these conventional managerial disciplines are strengthened by a close(r) connection with risk management.

Recommendations for future research from a synthesizing point of view

The following future research recommendations from a synthesizing point of view stem from the practical design science approach, as applied during this research. These recommendations aim to strengthen particularly the external validation of the design propositions with its models and instruments. This would allow generalization of the research products (far) beyond implementing risk management in organizations in the construction industry.

According to the view of risk management being a specific type of an organizational innovation, *specific* scientific knowledge about implementing *risk management* may be useful for answering rather *generic* organizational research questions about implementing *innovations* in organizations. By building forward on Klein and Knight (2005), examples of these research questions are:

1. How and why does the implementation of *technological* innovations, such as new computer systems, differ from the implementation of *semi-technological* innovations, such as risk management, and differ from the implementation of *non-technological* innovations, such as new managerial, educational, or patient treatment innovations?
2. Does the *difference* between technical, semi-technical and non-technical innovations make sense anymore, because most of today's innovations will be supported by some form of technology?

186 An example is connecting the Risk Diagnosing Method for successfully generating product innovations (Keizer et al., 2002; Halman, 1994) to the GeoQ concept for geotechnical risk management in construction projects (Van Staveren, 2006).

3. How does implementation success or failure in one team *diffuse* to other *teams* in the same organization?
4. How does implementation success or failure in one organization *diffuse* to other *organizations* in the same industry?
5. How does implementation success or failure in one industry *diffuse* to other *industries* in the same region or country?
6. How does implementation success or failure in one region of country *diffuse* to other *regions* or *countries*
7. Do teams, organizations, industries, regions, or countries that succeed in implementing one innovation also *succeed* in implementing other innovations? In other words, are there any generically favourable conditions for successfully implementing innovations in a team, an organization, an industry, a region, or a country out there?

In conclusion, conducting the proposed additional research activities is expected to contribute to the very limited knowledge base about implementing risk management in organizations in the construction industry. It will also contribute to an almost equally small knowledge base about implementing risk management in organizations in other industries, inside and outside The Netherlands. Finally, this additional research may contribute to the larger, yet modest, knowledge base about implementing other types of innovation in organizations.

REFERENCES

Aiman-Smith, L. and Green, S.G. (2002). Implementing new manufacturing technology: The related effects of technology characteristics and user learning activities. *The Academy of Management Journal*, 45, 421-30.

Ahaus, K. and Van den Water, H. (1994). Quality instruments for defining authority. *Training for Quality*, 2(1), 14-22.

Al-Jibouri, S. (2006). *A framework for identifying and managing geotechnical failure costs in construction*. Unpublished Ph.D. project proposal, University of Twente, Enschede.

Altabba, B., Einstein, H. and Hugh, C. (2004). An economic approach to risk management for tunnels. In *Proceedings North American Tunnelling 2004* (Ozdemir, ed.) pp. 295-301, Taylor & Francis Group, New York.

American Society of Civil Engineers (1980). *Construction Risks and Liability Sharing, Volume II.* ASCE, Reston.

Anderson, E.S. and Jessen, S.A. (2002). Project maturity in organization. *International Journal or Project Management*, 21, 457-61.

Anderson, N.R. and West, M.A. (1998). Measuring climate for work group innovation: development and validation of the team climate inventory. *Journal of Organizational Behaviour*, 19, 235-58.

Ansoff, H.I. (1984). *Implanting Strategic Management*. Prentice Hall, Englewood Cliffs.

Arbnor, I. and Bjerke, B. (1997). *Methodology for Creating Business Knowledge* (2nd Ed.). Sage Publications, Thousand Oaks.

Archer, L.B. (1984). Whatever became of design methodology. In *Developments in Design Methodology* (N. Cross, ed.) pp. 347-50. John Wiley, New York.

Argyris, C. (1993). *Knowledge for Action*. Jossey-Bass Publishers, San Francisco

Argyris, C. and Schön, D. (1978). *Organizational Learning: A Theory of Action Perspective*. Addison-Wesley, Reading, MA.

Argyris, C. and Schön, D. (1974). *Theory in Practice: Increasing Professional Effectiveness.* Jossey-Bass, San Francisco.

Arvai, J.L., R. Gregory, and T.L. McDaniels. (2001). Testing a structured decision approach: Value focused thinking for deliberative risk communication. *Risk Analysis,* 21(6), 1065-76.

Aufenhanger, J. (1985). *Philosophy* (Dutch ed.). Het Spectrum, Utrecht.

Augustijn, R.M. (2006). *Projectoverstijgend Risicomanagement. Een Onderzoek naar Risicomanagement op Portfolio Niveau binnen Rijkswaterstaat* (in Dutch). M.Sc. Thesis, University of Twente, Enschede.

Avendano Castillo, J.E., Al-Jibouri, S.H. and Halman, J.I.M. (2008). Conceptual model for failure costs management in construction. In *Proceedings Fifth International Conference on Innovation in Architecture, Engineering and Construction (ACE)*, July, 23-25. Antalya, Turkey.

Avolio, B.J. and Bass, B.M. (1995). Individual consideration viewed at multiple levels of analysis: A multiple-level framework for examining the diffusion of transformational leadership. *Leadership Quarterly*, 6, 199-218.

Baarda, D.B., de Goede, M.P.M. and van der Meer- Middelburg, A.G.E. (1996). *Open Interviewen: Praktische Handleiding voor het Voorbereiden en Afnemen van Open Interviews* (in Dutch), Stenfert Kroese, Groningen.

Baer, M. and Frese, M. (2003). Innovation is not enough: Climates for initiative and psychological safety, process innovations and firm performance. Journal of Organizational Behaviour, 24, 45-68.

Barber P., Graves A., Sheath D. and Tomkins, C. (2000). Quality failure costs in civil engineering projects. *International Journal of Quality & Reliability Management*, 17 (4/5).

Barends, F.B.J. (2005). Associating with advancing insight: Terzaghi Oration 2005. In *Proceedings 16th International Conference on Soil Mechanics and Geotechnical Engineering,* 12-16 September, Osaka, Japan, pp. 217-48, Millpress, Rotterdam.

Barends, F.B.J., and Mischgofsky, F.H. (2005). European innovation programmes for urban infrastructure. In *Proceedings International Symposium on Urban Geotechnics*, 9 pages, GeocityNet2005, Lille.

Baskerville, R. and Meijers, M.D. (2004). Special issue on action research in information systems: Making IS research relevant for practice – foreword. *MIS Quarterly*, 28(3), 329-335.

Basta C., Neuvel, J.M.M, Zlatanova, S. and Ale, B. (2007). Risk-maps informing land-use planning processes: A survey on the Netherlands and the United Kingdom, recent developments. *Journal of Hazardous Materials*, 145(1-2), 241-9.

Bate, P. (1992). The impact of organizational culture on approaches to organizational problem-solving. In *Human Resource Strategies* (G. Salman, ed.). Sage, London.

Bateson, G. (1972). *Steps to an Ecology of Mind*. Ballantine, New York.

Bauder, D.Y. (1993). Computer integration in K-12 schools: Conditions related to adoption and implementation. *Dissertation Abstracts International*, 54(8), 2991A.

Baya, D., Oluwoye, J. and Lenard, D. (1997). An analysis of contractor's approach to risk identification in New South Wales, Australia. *Construction Management and Economics* 15, 363–9.

Bazerman, M. (1986). *Judgment in Managerial Decision Making*. Wiley, New York.

Bea, R.G. (2006). Reliability and human factors in geotechnical engineering. *Journal of Geotechnical and Geoenvironmental Engineering*. May, 631-44.

Bea, R.G. (2002a). Human and organizational factors in reliability assessment and management of offshore structures. Risk Analysis, 22(1), 29-45.

Bea, R.G. (2002b). Human and organizational factors in design and operation of deep water structures. OTC14293. In Proceedings Offshore Technology Conference, Society of Petroleum Engineers, Richardson, Texas, 1-19.

Bea, R.G. (2001). Risk assessment and management of offshore structures. Progress in Structural Engineering and Materials, 3, 180-7.

Bea, R.G. (2000a). Achieving Step Change in Risk Assessment and Management (RAM). Centre for Oil and Gas Engineering, University of Western Australia Press, Nedlands.

Bea, R.G. (2000b). Human and Organizational Factors in Design and Reliability of Offshore Structure. Ph.D. Thesis, Centre for Oil and Gas Engineering, University of Western Australia Press, Nedlands.

Beal, A.N. (2007). CDM Regulations: 12 years of pain but little gain. New Civil Engineer International, August, 82-8.

Becker, H.S. (1998). *Tricks of the Trade: How to Think About Your Research While You Are Doing It.* The University of Chicago Press, Chicago.

Belbin, R.M. (1993). *Team Roles at Work*. Butterworth-Heinemann, Oxford.

Bennis, W.G. (1966). *Changing Organizations*. McGraw Hill, New York.

Bennis, W.G., Benne, K.D., Chin, R. and Corey, K.E. (1976). *The Planning of Change*. Holt, Rinehart and Winston, New York.

Bernstein, P.L. (1996). *Against the Gods: The Remarkable Story of Risk.* John Wiley & Sons, New York.

Bijsterveld, K. (2005) Hoe geef je invulling aan klantgericht bouwen?(in Dutch) *Building Business*, 1, 62-3.

Blanchard, K. (1998). Rethink training. *Executive Excellence*, 15(2), 11-2.

Blau, P.M. (1964). *Exchange and Power in Social Life*. Wiley, New York.

Blau, P.M. and Scott, W.R. (1962). *Formal Organizations: A Comparative Approach*. Chandler Publishing, San Francisco.

Block P. (2002). *The Answer to How is Yes: Acting on What Matters*. Berret-Koehler Publishers, San Francisco.

Blockley, D. and Godfrey, P. (2000). *Doing It Differently: Systems for Rethinking Construction*. Thomas Telford, London.

Boonstra, J.J. (1996). Strategieën en succesfactoren bij organisatieverandering (in Dutch). In*: Effectieve Communicatie bij Verandering* (Proceedings in Dutch). Amsterdam, 5 juni 1996. Focus, Amsterdam.

Boonstra, J. and De Caluwé, L. (2006). *Interveniëren en Veranderen: Zoeken naar Betekenis in Interacties* (in Dutch). Kluwer, Deventer.

Boonstra, J.J. & Steensma, H.O. (1996). Succesvol veranderen van organisaties (in Dutch). In: *Ontwerpen en Ontwikkelen van Organisaties* (in Dutch), (J.J. Boonstra, H.O. Steensma, and M.I. Demenint, eds.). De Tijdstroom, Utrecht, 275-310.

Boothroyd, C. and Emmet, J. (1996). *Risk Management: A Practical Guide for Construction Professionals.* Witherby, London.

Bos, S.F.J. (2005). Aannemer wordt "psycho-techneut" (in Dutch). *Cobouw*, 180, 19.

Brandl, H. (2004). *The Civil and Geotechnical Engineer in Society: Ethical and Philosophical Thoughts, Challenges and Recommendations*. The Deep Foundations Institute, Hawthorne.

Brennan, N.E. (1994). *Lessons taught by Baldridge winners*. Conference Board, New York.

British Tunnelling Society (2003). *The Joint Code of Practice for Risk Management of Tunnel Works in the UK*. British Tunnelling Society, London.

Brokelman, L. and Vermande, H. (2005). *Faalkosten de Bouwwereld uit* (In Dutch). SBR, Rotterdam.

Brown, S.L. and Eisenhardt, K.M. (1997). The art of continuous change: Linking complexity theory and time–paced evolution in relentlessly shifting organizations. *Administrative Science Quarterly*, 42, 1-34.

Brunsson, N. (1982). The irrationality of action and action rationality: Decision, ideologies and organizational actions. *Journal of Management Studies*, 19, 29-44.

Bunge, M. (1967). *Scientific Research II: The Search for Truth*. Springer Verlag, Berlin.

Caerteling, J.S., Halman, J.I.M., and Dorée, A.G. (2008a). Technology commercialization in road infrastructure: How government affects the variation and appropriability of technology. *Journal of Product Innovation Management*, 25(2), 143-61.

Caerteling, J.S., Halman, J.I.M., and Dorée, A.G. (2008b). Strategy implementation in project-based firms: An empirical analysis of three road construction firms (in press).

Cahill, J. and Lee, M. (2006). Ground control at Leinster Nickel Operations. *Journal of South African Institute of Mining and Metallurgy*, 106(7), 471-8.

Cameron, K.S. and Quinn, R.E. (1998). *Diagnosing and Changing Organisational Culture*. Addison-Wesley, Reading, MA.

Carlsson, M., Hintze, S. and Stille, H. (2005). On risk management in large infrastructure projects. In *Proceedings 16th International Conference on Soil Mechanics and Geotechnical Engineering,* 12-16 September, Osaka, Japan, pp. 2785-8, Millpress, Rotterdam.

Carnall, C.A. (1980). *Managing Change in Organizations*. Prentice Hall, New York.

Carr, A. (1996). *Managing the Change Process: A Fieldbook for Change Agent Consultants*. Coopers & Lybrand Publishing Division, London.

Chapman, C. and Ward, S. (1997). *Project Risk Management: Processes,Techniques and Insights*. John Wiley and Sons, Chichester.

Chapman, T.J.P., Van Staveren, M.Th., Stacey, T.R., and Hellings, J.E. (2007). Ground risk mitigation by better geotechnical design and construction management. In *Proceedings First International Symposium on Geotechnical Safety and Risk*. Shanghai, 18-19 October, pp. 645-56. Tongji University, Shanghai.

Checkland, P. (2000). Soft systems methodology: A thirty year retrospective. *Systems Research and Behavioural Science*, 17, S11-58.

Checkland, P. and Winter (2006). Process and content: Two ways of using SSM. *Journal of the Operational Research Society*, 57, 1435-41.

Choi, J.N. and Price, R.H. (2005). The effects of person-innovation fit on individual responses to innovation. *Journal of Occupational and Organizational Psychology*, March(78), 83-96.

CIPS (2007). *Risk Management Practice Guideline*. Risk Management Task Force, Canadian Information Processing Society, Ontario.

Clayton, C.R.I. (ed.). (2001). *Managing Geotechnical Risk: Improving Productivity in UK Building and Construction*. The Institution of Civil Engineers, London.

Clayton, P. (1997). *Implementation of Organizational Innovation*. Academic Press, San Diego.

Cleland, D.I. (1998). *The Project Management Institute: Project Management Handbook*. Jossey-Bass, San Francisco.

Cooperrider, D.L., Sorensen Jr., P.F, Whitney, D and Yaeger, T.F. (2000). Appreciative Inquiry, rethinking the organization towards a positive theory of change. *Stipes Publishing,* Illinois.

Connell, N.A.D. (2001). Evaluating soft OR: Some reflections on an apparetly "unsuccessful" implementation using a Soft Systems Methodology (SSM) based approach. *Journal of the Operational Research Society*, 52, 150-60.

Counte, M.A. and Meurer, S. (2001). Issues in the assessment of continuous quality improvement implementation in health care organizations. *International Journal for Quality in Health Care*, 13(3), 197-207.

Covello, V.T., McCallum, D.B. and Pavlova, M.T. (eds.) (1989). *Effective Risk Communication: The Role and Responsibility of Government and Non-Government Organizations*. Plenum Press, New York.

Covey, S.R. (1989). *The Seven Habits of Highly Effective People*. Simon and Schuster, New York.

Cozzani, V., Bandini, R., Basta C. and Christou, M.D. (2006). Application of land-use planning criteria for the control of major accident hazards: A case study. *Journal of Hazardous Materials*, A136, 170-80.

Cozijnsen, A.J., Vrakking, W.J. and Van IJzerloo, M. (2000). Success and failure of 50 innovation projects in Dutch companies. *European Journal of Innovation Management*, 3(3), 150-9.

Cross, N. (1993). Science and design methodology: A review. *Research in Engineering Design*, 5, 63-9.

Csikszentmihalyi, M. (1997). *Finding Flow: The Psychology of Engagement with Everyday Life.* BasicBooks, New York.

Cummings, D. and Kenton, F.J. (2004). Eleven case studies of failures in geotechnical engineering, engineering geology, and geophysics: how they could have been avoided. In *Proceedings Fifth International Conference on Case Histories in Geotechnical Engineering*, 13–17 April, New York (S. Prakash, ed.). Paper No. 7.01, pp. 1-12, University of Missouri-Rolla, Rolla.

Daft, R.L. (1997). *Organisation Theory and Behaviour*, 6th edn. South Western College Publishing, Cincinnati.

Dake, K. (1992). Myths of nature: Culture and the social construction of risk. *Journal of Social Issues*, 48, 21-7.

Dake, K. (1991). Orienting dispositions in the perception of risk: An analysis of contemporary worldviews and cultural biases. *Journal of Cross-Cultural Psychology*, 22, 61-82.

Damanpour, F. and Schneider, M. (2006). Phases of adoption of innovation in organizations: Effects of environment, organization and top managers. *British Journal of Management*, 17, 215-36.

Danserau, F., Yammarino, F.J., and Kohles, J.C. (1999). Multiple levels of analysis from a longitudinal perspective: Some implications for theory building. *The Academy of Management Review*, 24(2), 346-57.

Davis, E.D. (1989). Perceived usefulness, perceived ease of use, and and user acceptance of information technology. *MIS Quaterly*, 13(3), 319-340.

De Bono, E. (1998). *Simplicity*. Pinguin Books, New York.

De Bruin, J.A., Ten Heuvelhof, E.F., and In 't Veld, R.J. (2002). Procesmanagement: Over Procesmanagement en Besluitvorming (in Dutch). Academic Service, The Hague.

De Caluwé, L. and Vermaak, H. (2004). Change paradigms: An overview. *Organization Development Journal*, 22(4), 9-18.

De Meyer, A., Loch, C.H. and Pich, M.T. (2006). Management of novel projects under conditions of high uncertainty. *Working Paper Series*, 21/2006, Judge Business School, University of Cambridge, Cambridge, UK.

De Ridder, H.A.J. (1998). Omgaan met risico's in de funderingstechniek (in Dutch).*Geotechniek*, October, 49-51.

De Vries, W., jr. (2002). *Riskant: Management van informatie- en communicatietechnologie door complexiteitsreductie* (in Dutch). Ten Hagen en Stam Uitgevers, Den Haag.

Delft Cluster (2007a). *Verslag Workshop: Risicomanagement in de Alledaagse Praktijk* (In Dutch). Internal Note of a Workshop on 15th February, 3p, Delft Cluster, Delft.

Delft Cluster (2007b). *GRIP: Implementatie van Risicomanagement bij Gemeenten* (in Dutch). Report 25th July, 2007, Delft Cluster, Delft.

Delft Cluster (2006). *Verslag Delft Clustersessie GRIP: Risicomanagement: Van Vage Belofte naar Alledaagse Praktijk*. (In Dutch). Internal Note of Workshop on 9th November, 3p, Delft Cluster, Delft.

Denyer, D., Tranfield, D. and Van Aken, J.E. (2008). Developing design propositions through research synthesis. *Organization Studies*, 29, 393-413.

Derdink, M.F.A., Hamerlinck, A.F. and Van der Sluis, H.R. (eds.) (2005). *Leren van Instortingen* (in Dutch). CUR rapport, fase 1, juni 2005, Gouda.

Detert, J.R., Schroeder, R.G. and Mauriel, J.J. (2000). A framework for linking culture and improvement initiatives in organizations. *The Academy of Management Review*, 25(4), 850-63.

Dibb, S., Simkin, L., Pride, W.M. and Ferrel, O.C. (1997). *Marketing: Concepts and Strategies*, 3rd European edition. Houghton Mifflin Company, Boston.

Douglas, W.S. (1974). Role of specifications in foundation construction. *ASCE Journal of the Construction Division*, 100, 199-201.

Douglas, M. and Wildawsky, A. (1982). *Risk and Culture*. University of California Press, Berkeley.

Drazin, R., Glynn, M.A. and Kazanjian, R.K. (1999). Multilevel theorizing about creativity in organizations: a sense making perspective. *The Academy of Management Review*, 24(2), 286-307.

Edwards, L. (1995). *Practical Risk Management in the Construction Industry*. Thomas Telford, London.

Edwards, P.J. and Bowen, P.A. (2005). *Risk Management in Project Organisations*. Butterworth-Heinemann, Oxford.

Egan, J. (1998). *Rethinking Construction: The Report of the Construction Task Force*. Department of the Environment, Transport and the Regions, HMSO, London.

Eisenhardt, K.M. (1989). Building theories from case study research. *Academy of Management Review*, 14(4), 532-50.

Eisenhardt, K.M. and Graebner, M.E. (2006). Theory building from cases: Opportunities and challenges. *Academy of Management Journal*, 50(1), 25-32.

Elliot, D., Letza S.R., McGuiness, M. and Smallman, C. (2000). Governance, control and operational risk: The Turnbill effect. *Syllabus Crisis Management*, NIMBAS University, Utrecht.

Ely, D.P. (1999). Conditions that facilitate the implementation of educational technology innovations. *Educational Technology*, 39, 23-7.

Emans, B. (1986). *Interviewen: Theorie, Techniek en Training* (in Dutch), 2nd edn. Wolters-Noordhoff, Groningen.

Emory, W.C. (1985). *Business Research Methods*. Irwin, Homewood (Ill.).

Enderlie, R. (2008). *Liars, Damn Liars, and Statistics: Gartner Goofs on Server Numbers*. Weblog posted by Rob Enderle on July 7, 2008 at 10:32 am. Http://www.itbusinessedge.com/blogs/rob/?p=238.

Ensminger, D.C., Surry, D.W., Porter, B.E., and Wright, D. (2004). Factors contributing to the successful implementation of technology innovations. *Educational Technology & Society*, 7(3), 61-72.

Ericson, R.V. and Doyle, A. (eds.). (2003). *Risk and Morality*. University of Toronto Press, Toronto.

Essex, R.J. (2003). Design-bid-build contracting: Climbing out of a paradigm sinkhole. In *Proceedings Rapid Excavation and Tunnelling Conference*, Society of Mining, Metallurgy and Exploration, New Orleans.

Essex R.J. (ed.). (1997). *Geotechnical Baseline Reports for Underground Construction.* Technical Committee on Geotechnical Reports of the Underground Technology Research Council, ASCE, Danvers.

European Construction Technology Platform (2005). *Challenges and Developments for the Built Environment in Europe: The Harmonised Vision for 2030 for a Sustainable and Competitive Construction Sector*. ECTP, Brussels.

Evbuonwan, N.F.O., Sivaloganathan, S. and Jebb, A. (1996). A survey of design philosophies, models, methods, and systems. *Proceedings Institute of Mechanical Engineers*, 210, 301-20.

Fentener van Vlissingen. P. (1995*). Ondernemers zijn Ezels* (in Dutch). Balans, Amsterdam.

Fiske, S.T. and Taylor, S.E. (1978). *Social Cognition*. Addison-Wesley, Reading, MA.

Flanagan, R. and Norman, G. (1993). *Risk Management and Construction*. Blackwell Scientific Publications, Oxford.

Flyvbjerg, B. (2006). Making organization research matter. In *The Sage Handbook of Organization Studies* Stewart (R. Clegg, C. Hardy, T. B. Lawrence and W. R. Nord, eds.), second edition. Sage, Thousand Oaks, CA, pp. 370-87.

Flyvbjerg, B. (2004). Five misunderstandings about case-study research. In *Quality Research Practice* (C. Seale, G. Gobo, J.F. Gubrium and D. Silverman, eds.). Sage, London, pp. 420-34.

Flyvberg, B., Bruzelius, N., and Rothengatter, W. (2003). *Megaprojects and Risks: An Anatomy of Ambition*. Cambridge University Press, Cambridge.

Fookes P.G., Baynes, F.J. and Hutchinson, J.N. (2000). Total geological history: A model approach to the anticipation, observation and understanding of site conditions. In *Proceedings International Conference on Geotechnical and Geological Engineering*, *EngGeo2000*, 19-24 November, Melbourne, Australia, Vol. 1, pp. 370-460, Technomic, Basel.

Frambach, R.T. and Schillewaert, N. (2002). Organisational innovation adoption: A multi-level framework of determinants and opportunities for future research*. Journal of Business Research*, 55(2), 163-76.

Frank, M.V. (1999). Treatment of uncertainties in space and nuclear risk assessment with examples from Cassini mission implications. *Reliability Engineering and System Safety*, 66, 203-21.

Freeman, R.E. (1984). *Strategic Management: A Stakeholder Approach*. Pitman, Boston.

GeoDelft (2000). *Strategic Plan 2001-2004*, GeoDelft, Delft.

Giddens, A. (1979). *Central Problems in Social Theory: Action, Structure and Contradiction in Social Analysis*. University of California Press, Berkeley

Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P. and Trow, M. (1994). *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*. Sage, London.

Godfrey, P.S. (1996). *Control of Risk: A Guide to the Systematic Management of Risk from Construction*. CIRIA Special Publication 125. CIRIA, London.

Goffee, R. and Jones, G. (2005). Managing authenticity: The paradox of great leadership. *Harvard Business Review*, December, 86-94.

Goleman, D. (1996) *Emotional Intelligence* (Dutch ed.). Pandora Pockets, Amsterdam.

Gould, J.P. (1995). Geotechnology in dispute resolution: The twenty-sixth Karl Terzaghi lecture. *Journal of Geotechnical Engineering*, 121-7, 523-34.

Grant, R.M. (1998). *Contemporary Strategy Analysis*. Blackwell, Oxford.

Greiner, L. and Schein, V. (1988). *Power and Organization Development: Mobilizing Power to Implement Change*. Addison-Wesley, Reading, M.A.

Groot, G. (2004). Verliefd op de onbetrouwbare taal (in Dutch). *NRC*, 15 October, p 34.

Gummesson, E. (1988). *Qualitative Methods in Management Research*. Studentlitteratur, Lund.

Gunderman, R.B. and Sistrom, C. (2006). Avoiding errors in reasoning: An introduction to logical fallacies. *American Journal of Roentgenology*, 187, 469-71.

Gurabardhi, Z., Gutteling, J.M. and Kuttschreuter, M.W.M. (2004). The development of risk communication. Science Communication, 25(4), 323-49.

Gurabardhi, Z and Gutteling, J.M. (2002). Developments in thinking about risk communication. In *Marketing for Sustainablity* (G.C. Bartels and W.J.A. Nelissen, eds.), pp. 421-431. IOS Press, Amsterdam.

Gutteling, J.M. and Kuttschreuter M.W.M. (2002). The role of expertise in risk communication: Lay people's and expert's perception of the millennium bug risk in The Netherlands. *Journal of Risk Research*, 5(1), 35-47.

Halman, J.I.M. (ed.). (2008). *Risicomanagement in de Bouw* (in Dutch). AEneas, Boxtel.

Halman, J.I.M. (1994). *Risicodiagnose in Produktinnovatie: Ontwikkeling van de Risicodiagnosemethode RDM* (in Dutch). Ph.D. thesis, Eindhoven Technical University, Wibro Publishers, Helmond.

Hamel, G. and Prahalad, C.K. (1994). *Competing for the Future*. Harvard Business School Press, Boston.

Hammer, M. and Champy, J. (1993). *Reengineering the Cooperation: A Manifesto for Business Revolution*. Harper Collins, London.

Han, S.H., Kim, D.Y., Kim, H., Jang, W.S. (2008). A web-based integrated system for international project risk management. *Automation in Construction*, 17, 342-56.

Handy, C. (2002). *The Elephant and the Flea*. Harvard Business School Press, Boston.

Hatch, M.J. (1997). *Organisation Theory: Modern, Symbolic and Post-modern Perspectives*. Oxford University Press, Oxford

Hatchuel, A. (2001). The two pillars of new management research. *British Journal of Management*, 12, 33-9.

Hatem, D.J. (1998). Professional liability and risk allocation-management considerations for design and construction management professionals involved in subsurface projects. In *Subsurface Conditions: Risk Management for Design and Construction Management Professionals* (D.J. Hatem, ed.), pp. 223-57. John Wiley & Sons, New York.

Heath, R.I., and Abel, D.D. (1998). Risk communication: A two-way analysis of proximity, dread, trust, involvement, uncertainty, openness/accessibility, and knowledge on support/opposition toward chemical companies. *Journal of Public Relations Research*, 8, 35-55.

Hedges, A. (1985). Group interviewing. In *Applied Qualitative Research* (R. Walker, ed.). Gower Publishers, Aldershot.

Helton, J.C. (1994). Treatment of uncertainty in performance assessments in complex systems. *Risk Analysis*, 14(4), 483-511.

Henrion, M. and Fischhoff, B. (1986). Assessing uncertainty in physical constants. *Annual Journal of Physics*, 54(9), 791-7.

Her Majesty's Government (1999). *The Management of Health and Safety at Work Regulations 1999*. The Stationary Office, London.

Hicks, M.A. and Samy, K. (2002). Reliability-based characteristic values: a stochastic approach to Eurocode 7. *Ground Engineering*, December, 30-4.

Hillson, D. (2002). *Risk Management Maturity Level Development*. Risk Management Specific Interest Group, Project Management Institute. Newton Square, Pennsylvania.

Hillson, D. (1997). Towards a risk maturity model. *The International Journal of Project & Business Risk Management*, 1(1), 35-45.

Hillson, D.A. and Murray-Webster, R. (2007). *Understanding and Managing Risk Attitude*, 2nd edition. Gower, Aldershot.

Ho, K., Leroi, E. and Roberds, B. (2000). Quantitative risk assesment: Application, myths and future direction. In *Proceedings International Conference on Geotechnical and Geological Engineering*, *EngGeo2000*, 19-24 November, Melbourne, Australia, Vol. 1, pp. 269-312. Technomic, Basel.

Hoek E. and Palmieri, A. (1998). Geotechnical risks on large civil engineering projects. In *Proceedings 8th Congress IAEG,* Vol. 1, pp. 79-88. A.A. Balkema, Rotterdam.

Hofstede, G. (1980). *Culture's Consequences: International Differences in Work-Related Values*. Sage, London.

Holahan, P.J., Aronson, Z.H., Jurkat, M.P. and Schoorman, F.D. (2004). Implementing computer technology: A multiorganizational test of Klein and Sorra's model. *Journal of Engineering and Technology Management*, 21, 31-50.

Holt, R. (2004). Risk management: The talking cure. *Organization*, 11(2), 251-70.

Huy, Q.N. (2001). Time, temporal capability, and planned change. *The Academy of Management Review*, 26(4), 601-23.

Huy, Q.N. (1999). Emotional capability, emotional intelligence and radical change. *The Academy of Management Review*, 24(2), 325-45.

Imai, M. (1986). *Kaizen: The Key to Japan's Competitive Success*. Random House, New York.

INK (2003). *Handleiding Positiebepaling Ondernemingen* (In Dutch). INK, Zaltbommel.

International Tunnelling Insurance Group (2006). *A Code of Practice for Risk Management in Tunnel Works*. The International Association of Engineering Insurers (IMIA), www.imia.com.

ISO (2007a). *Committee Draft of ISO/IEC Guide 73 Risk Management: Vocabulary*. ISO TMB WG on Risk Management, www.iso.org/rm.

ISO (2007b). *Committee Draft of ISO 31000 Risk Management: Guidelines on Principles and Implementation of Risk Management*. ISO TMB WG on Risk Management, www.iso.org/rm.

Jackson, S. (2001). Successfully implementing total quality management tools within health care: What are key actions? *International Journal of Health Care Quality Assurance*, 14(4), 157-63.

Janis, I.L. (1972). *Victims of Groupthink*. Houghton Miflin, Boston.

Jansen, C.E.C. (2001). *Totstandkoming en Inhoud van Design & Construct Contracten voor Complexe Infrastructurele Projecten* (in Dutch). Publicatie van de Vereniging voor Bouwrecht nr. 29. Kluwer, Deventer.

Järvinen, P. (2005). *Action Research as an Approach in Design Science*. Publication D-2005-2, Department of Computer Sciences, University of Tampere. Presented at the European Academy of Management Conference, May 4-7, Munich.

Jasperson, J., Carter, P.E. and Zmud, R.W. (2005). A comprehensive conceptualization of post-adoptive behaviours associated with information technology enabled work systems. *MIS Quarterly*, 29(3), 525-57.

Jeffery, J.A. (1993). Conditions that facilitate implementation of peer coaching. *Dissertation Abstracts International*, 54(8), 2826A.
Jick, T.D. (1993). Implementing change. In *Managing Change: Cases and Concepts* (T.D Jick, ed.). Irwin/McGraw-Hill, Boston.
Johnson, J.D. (2000). Levels of success in implementing information technologies. *Innovative Higher Education*, 25(1), 59-76.
Jonker, F., Blankers, M. and Van Reeuwijk, T. (2008). RISNET op de Dag van Maarssen (in Dutch). CUR-Info, *Geotechniek* January, 17.
Juran, J.M. (1982). *Upper Management and Quality*. Juran Institute, New York.
Kahneman, D. and Tversky, A. (1982). Variants of uncertainty. In: *Variants of Uncertainty* (D. Kahneman, P. Slovic, and A Tversky, eds.). Cambridge University Press, Cambridge, UK.
Kahneman, D. and Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica*, 47, 263-91.
Kamal, M.M. (2006). IT innovation in the government sector: Identifying the critical success factors. *Journal of Enterprise Information Management*, 19(2), 192-222.
Kardon, J.B., Bea, R.G. and Williamson, R.B. (2006). Validity and reliability of forensic engineering methods and processes. In *Proceedings of the 4th Forensic Congress,* ASCE Technical council on Forensic Engineering, October 6–9, Cleveland.
Karstens, S.A.M., Mooiman, M.A. and In 't Veld, S. (2006). *Evaluatie van Risicomanagement bij Gemeentelijke Bouwprojecten* (in Dutch). DC2-03.30-01, Delft Cluster, Delft.
Katz, M.L. and Shapiro, C. (1986). Technology adoption in the presence of network externalities. *The Journal of Political Economy*, 94(4), 822-41.
Katz, M.L. and Shapiro, C. (1985). Network externalities, competition and compatibility. *The American Economic Review*, 75(3), 424-40.
Katzenbach, J.R.and Smith, D.K. (1994). *The Wisdom of Teams: Creating the High-Performance Organisation*. Harvard Business School Press, Boston.
Keizer, J.A., Halman, J.I.M. and Song, M. (2002). From experience: Applying the risk diagnosing methodology. *Journal of Product Innovation Management*, 19, 213-32.
Kelly, K. (1996). The new biology of business. In *Rethinking the Future* (R. Gibson, ed.), pp. 250-68. Nicholas Brealy, London.
Kelman, H.C. (1954). Compliance, identification and internalization: Three processes of attitude change? *Journal of Conflict Resolution*, 2, 51-60.
Kets de Vries, M.F.R. (2000). *Het Geluk: Een Handleiding* (in Dutch). Nieuwerzijds, Amsterdam.
Kets de Vries, M.F.R. (2002). *The Happiness Equation*. Vermilion, London.
Kidder, L. and Judge, C. (1986). *Research Methods in Social Relations*, 5th ed. Holt, Rinehart & Winston, New York.
Klein, K.J., Conn, A.B. and Sorra, J.S. (2001). Implementing computerized technology: An organizational analysis. *Journal of Applied Psychology*, 86, 811-24.
Klein, K.J. and Knight, A.P. (2005). Innovation implementation: Overcoming the challenge. *Current Directions in Psychological Science*, 15(5), 243-6.
Klein, K.J. and Sorra, J.S. (1996). The challenge of innovation implementation. *The Academy of Management Review*, 21(4), 1055-80.
Klein, K.J., Tossi, H. and Cannella, A.A.jr. (1999). Multilevel theory building: Benefits, barriers, and new developments. *The Academy of Management Review*, 24(2), 243-48.

Knorr-Cetina, K.D. (1981). *The Manufacture of Knowledge: An Essay on the Constructivist and Contextual Nature of Science.* Pergamon, Oxford.

Koopmans, T.C. (1957). *Three Essays on the State of Economic Science*. McGraw-Hill Book, New York.

Kotter, J.P. (2000). Leading change: Why transformation efforts fail. *Harvard Business Review*, March-April, 59-67.

Kotter, J.P. and Cohen, D.S. (2002). Creative ways to empower action to change the organization: Cases in point. *Journal of Organizational Excellence*, Winter, 73-82.

Kreling, T. (2007). Fout op fout in Bos en Lommer (in Dutch). *NRC*, 16 January, 2.

Kuhn, T.S. (1962). *The Structure of Scientific Revolution*. The University of Chicago Press, Chicago.

Lapointe, L. and Rivard, S. (2006). A multilevel model of resistance to information technology implementation. *MIS Quarterly*, 29(3), 461-91.

Latham, M. (1994). *Constructing the Team: Joint Review of Procurement and Contractual Arrangements in the UK Construction Industry*. Department of the Environment, HMSO, London.

Latour, B. and Woolgar, S. (1979). *Laboratory Life: The Social Construction of Scientific Facts*. Sage, Beverly hills.

Laverman, W. (2005). Het vergt tijd om een goed opdrachtgever te worden (in Dutch). *Building Business*, 1, 28-31.

Lazarus, R.S. (1993). From psychological stress to emotions: A history of changing outlooks. *Annual Review of Psychology*, 44, 1-21.

Lefcourt, H.M. (1973). The functions of the illusions of control and freedom. *American Psychologist*, May, 417-25.

Leiss, W.(1996). Three phases in the evolution of risk communication practice. *The Annals of American Academy of Political and Social Science*, 545, 85-94.

Lewin, C. (ed.). (2005). *RAMP, Risk Analysis and Management for Projects: A strategic Framework for Managing Project Risk and its Financial Implications*. Institution of Civil Engineers & Institute of Actuaries, London.

Lewis, L.K. and Seibold, D.R. (1993). Innovation modification during intra-organizational adoption. *The Academy of Management Review*, 18(2), 322-54.

Lincoln, Y.S. and Guba, E.G. (1985). *Naturalistic Inquiry*. Sage, Newbury.

Little, M.J. (2006). *Geotechnical strategy and tactics at Anglo Platinum's PPRust Open Pit operation, Limpopo Province, South Africa*. M.Sc. Eng. Research Report, University of the Witwatersrand, Johannesburg, 177p.

Little, M.J., Bye, A.R. and Stacey, T.R. (2007). Safety and financial value created by good slope management strategies and tactics. In *Proceedings 7th Large Open Pit Conference,* September 2007, Perth.

Lobkowitz, N. (1967). *Theory and Practice: History of a Concept from Aristotle to Marx*. University of Notre Dam Press, Notre Dame.

Lucas, D.A. (1992). Understanding the human factor in disasters. *Interdisciplinary Science Views*, 17, 185-190.

Lucas, D.A. (1990). *Wise men learn by other's harms, fools by their own*. Paper given to the *Safety and Reliability Society Symposium on Safety and Reliability in the 90s*, 19-20 September. Altrincham, Manchester.

Macpherson, F. (2001). Risky business. *International Construction*, 40- 3, 41.

Malhorta, Y. And Galetta, D. (2002). Role of commitment and motivation in knowledge management systems implementation: Theory, conceptualization, and measurement of antecedents of success. In *Proceedings of the 36th Hawaii International Conference on System Sciences,* January 6-9. Big Island.

March, J.G. and Shapira, Z. (1987). Managerial perspectives on risk and risk taking. *Management Science*, 33, 1404-18.

Marcus, A.A. (1988). Implementing externally induced innovations: A comparison of rule-bound and autonomous approaches. *Academy of Management Journal*, 31(2), 235-56.

Marr A, (2001). *Why Monitor Geotechnical Performance*? 49th Geotechnical Conference, Minnesota.

Masterman, M. (1970). The nature of paradigm. In *Criticism and the Growth of Knowledg*e (I. Lakatos and A.Musgrave, eds.), pp. 59-89. Cambridge University Press, Cambridge.

Mayo, E. (1933). *The Human Problems of an Industrial Civilization*. McGraw-Hill, New York.

Miles, M.B. and Huberman, A.M. (1994). *Qualitative data analysis,* 2nd edition. Sage Publications, Thousand Oaks, CA.

Mintzberg, H. (1998). The professional organisation. In *The Strategy Process-Revised European Edition* (H. Mintzberg, J.B. Quinn and S. Goshal, eds.), pp. 681-96. Pearson Education, Essex.

Molendijk, W.O. and Aantjes, A.T. (2003). Risk management of earthworks using GeoQ. In *Proceedings 22nd World Road Congress*, October, Durban, 7 pages. PIARC, Paris.

Monroe, K.B. (1976). The influence of price differences and brand familiarity on brand preferences. *Journal of Consumer Research*, 3, 42-9.

Morgan, M.G. and Henrion, M. (1990). *Uncertainty: A Guide to Dealing with Uncertainty in Quantitative Risk and Policy Analysis*. Cambridge University Press, Cambridge, UK.

Morgenstern, N.R. (2000). *Performance in Geotechnical Practice*. The Inaugural Lumb Lecture, 10 May, 28 pages, Hong Kong.

Mulhearn, C. and Vane, H.R. (1999). *Economics*. Macmillian Press, London.

Mullaly, M. (2006). *Longitudinal Analysis of Project Management Maturity*. Project Management Institute, Newton Square, PA.

Munfah, N., Zlatanic, S. and Baraclough, P. (2004). Managing underground construction risk in New York. In *North American Tunnelling 2004* (Ozdemir, ed.), pp.163-70. Taylor & Francis Group, London.

Naisbitt, J. (1984). *Megatrends: Ten New Directions Transforming our Lives.* Warner Books, New York.

Naismith, A. and Wessels, S.D. (2006). Management of a major slope failure at Nchanga Open Pit, Zambia. *Journal of South African Institute of Mining and Metallurgy*, 105(9), 619-26.

NASA (2004). *Risk Management Procedures and Guidelines*. NASA Program Requirement 8000.4, NASA, Houston.

Natke, H.G. and Ben-Haim, Y. (1996). Uncertainty: A discussion from various points of view. In: *Uncertainty: A Discussion From Various Points of View* (H.G. Natke and Y. Ben-Haim, eds.). Akademie Verlag, Berlin.

Nord, W.R. and Tucker, S. (1987). *Implementing Routine and Radical Innovations*. Lexington Books, Lexington, MA.

Numagami, T. (1998). The infeasibility of invariant laws in management studies: A reflective dialogue in defence of case studies. *Organization Science*, 9, 2-15.

Nußbaumer, M. and Nübel, K. (2005). Portfolio based approach to project risk management. In *Proceedings 16^{th} International Conference on Soil Mechanics and Geotechnical Engineering,* 12-16 September, Osaka, Japan, pp. 2833-36. Millpress, Rotterdam.

Nutt, P.C. (1986). Tactics of implementation. *Academy of Management Journal*, 29, 230-61.

Oakland, J.S. (1993). *Total Quality Management*, 2^{nd} revised edition. Butterworth-Heinemann, Oxford.

Oates, B.J. and Fitzgerald, B. (2001). *Action Research: Putting Theory into Action*. Working Paper to the IFIP 8.2 Working Group on Information Systems in Organizations (OASIS) Workshop, December. New Orleans.

Oliver, D.W., Kelliher, P.T., and Keegan, J.G. Jr. (1997). *Engineering Complex Systems with Models and Objects*. McGraw-Hill, New York.

Olsson, R. (2006). *Managing Project Uncertainty by using and Enhanced Risk Management Process*. Ph.D. thesis, Mälardalen University Dissertations No. 34, Mälardalen University Press, Västerås.

O'Rourke, M. (2004). The ERM Gap. *Risk Management Magazine*, 51(5), 8-9.

Orton, J. D. and Weick, K.E. (1990). Loosely coupled systems: A reconceptualization*. Academy of Management Review*, 15(2), 203-23.

Otway, H. (1992). Public wisdom, expert fallability: Toward a contextual theory of risk. In *Social Theories of Risk* (S. Krimsky and D. Golding, eds.), pp. 215-228. Praeger, Westport, CT.

Ouchi, W.G. (1977). The relationship between organizaitonal structure and organizational control. *Administrative Science Quaterly*, 22, 95-113.

Oversight Systems (2006). *The 2006 Oversight Systems Financial Executive Report on Risk Management*. Oversight Systems, Atlanta, GA.

Oversight Systems (2005). *The 2005 Oversight Systems Financial Executive Report on Risk Management*. Oversight Systems, Atlanta, GA.

Owen, A.A. (1982). How to implement strategy. *Management Today*, July, 51-3.

Paine, L., Deshpandé, R., Margolis, J.D. and Bettcher, K.E. (2005). Up to code: Does your company's conduct meet world-class standards? *Harvard Business Review*, December, 122-33.

Pala, ⊠., Vennix, J.A.M. and Van Mullekom, T. (2003). Validity in SMM: Neglected areas. *Journal of the Operational Research Society*, 54, 706-12.

Patton, M.Q. (1987). *How to Use Qualitative Methods in Evaluation*. Sage, Newbury Park, CA.

Pawson, R. (2002). Evidence based policy: In search of a method. *Evaluation*, 8(2), 157-81.

Pawson, R. and Tilly, N. (1997). *Realistic Evaluation*. Sage, London.

Pelz, D.S. (1978). Some expanded perspectives on the use of social science in public policy. In *Major Social Issues: A Multidisciplinary View* (M. Yinger and S.J. Cutler, eds.), pp. 346-57. Free Press, New York.

Perrow, C. (1984). *Normal Accidents: Living with High-Risk Technologies*. Basic Book, New York.

Peters, T.J. and Waterman, RH. (1982). *In Search of Excellence*. Harper & Row, New York.

Peters, V. and Westelaken, M. (2008). The management approach: Thinking in system. In *Why Do Games Work? In Search of the Active Substance* (L. De Caluwé, G.J. Hofstede, and V. Peters, eds.). Kluwer, Deventer.

Pfeffer, J. (1981). *Power in Organizations*, Pitman, London.

Pfeffer, J. and Sutton, R.I. (2000). *The Knowing-Doing Gap: How Smart Companies Turn Knowledge into Action.* Harvard Business School Press, Boston.

Piercy, N. (1997). *Market-Led Strategic Change*, 2nd edition. Butterworth-Heinemann, Oxford.

Presley, A., Sarkis, J. and Liles, D.H. (2000). A soft-systems methodology approach for product and process innovation. *IEEE Transactions On Engineering Management*, 47(3), 379-92.

Prigonine, I. and Stengers, I. (1986). *Order out of chaos: Man's New Dialogue with Nature*. Fontana, London.

Rahman, M.M. and Kumaraswamy, M.M. (2005). Assembling integrated project teams for joint risk management. *Construction Management and Economics*, 23, 365-75.

Ragin, C.C. (1987). *The Comparative Method: Moving Beyond Qualitative and Quantitative Strategies*. University of California Press, Los Angeles.

Rao, A.R. and Monroe, K.B. (1988). The moderating effect of prior knowledge on cue utilization in product evaluations. *Journal of Consumer Research*, 15, 253-64.

Ravitz, J.L. (1999). Conditions that facilitate teacher internet use in schools with high internet connectivity: A national survey. *Dissertation Abstracts International*, 60(4), 1094A.

Ray-Couquard, I., Philip, T., Lehman, M., Fervers, B., Farsi, F. and Chauvin, F. (1997). Impact of clinical guidelines on: Program for breast and colon cancer in a French cancer centre. *Jama*, 278(19), 1591-5.

Read, C.H. (1994). Conditions that facilitate the use of shared decision making in schools. Dissertation Abstracts International, 55(8), 2239A.

Reason, J. (2006). Human Factors: A Personal Perspective. Presentation: Human Factors Seminar, 13 February. Helsinki.

Reason, J. (1997). Managing the Risks of Organizational Accidents. Ashgate, Aldershot.

Reason, J. (1990). *Human error*. Cambridge University Press, Cambridge.

Reisman, A. and Oral, M. (2005). Soft systems methodology: A context with a 50-year retrospective of OR/MS. Interfaces, 35(2), 164-78.

Repenning. N.P. and Sterman, J.D. (2002). A simulation-based approach to understanding the dynamics of innovation implementation. Organization Science, 13, 109-27.

Revans, R.W. (1982). *The Origin and Growth of Action Learning*. Chartwell Bratt, London.

Rider, L. (2002). Coaching as a strategic intervention. *Industrial and Commercial Training*, 34(6/7), 233-6.

RiskForum (2007). *Verspreiding van Kennis en Methoden voor Risicomanagement in de Praktijk* (in Dutch). Internal Note, 25th June. CUR Bouw & Infra, Gouda.

RISNET (2007). *Naar een Gedeeld Risicomanagement: Leren Communiceren over Risico's* (in Dutch). CUR Bouw & Infra, Gouda.

Roberts, K.H. and Bea, R.G. (2001). Must accidents happen: Lessons from high reliability organizations. *The Academy of Management Executive*, 15(3), 70-8.

Robertson, P.L. and Langlois, R.N. (1995). Innovation, networks, and vertical integration. *Research Policy*, 24(4), 543-62.

Roedler, G.J. (2006). A path to convergence of risk management standards. In *Proceedings of the Sixteenth Annual International Council On Systems Engineering* (INCOSE), 8-14 July. Orlando, Florida.

Roetlisberger, F.J. (1941). *Management and Morale*. Harvard University Press, Cambridge, MA.

Rogers, E.M. (2003). *Diffusion of Innovations,* 5th edn. Free Press, New York.

Rohrmann, B. (1998). The risk notion: Epistemological and empirical consideration. In *Integrated Risk Assessment* (M.G. Stewart and R.E. Melchers, eds.), pp. 39-46. Balkema, Rotterdam.

Romme, A.G.L. (2003). Making a difference: Organization as Design. *Organization Science*, 14 (5), 558-73.

Roobeek, A., Mandersloot, E. and Du Marchie Servaas, C. (1998). Organizational transformation through strategic dialogue: The Schiphol case. *Concepts and Transformation: International Journal of Action Research and Organizational Renewal*, 3, 53-77.

Roozenburg, N.F.M. and Eekels, J. (1995). *Product Design: Fundamentals and Methods*. Wiley, Chichester.

Roth, G.L. (1996). *Learning Histories: Using Documentation to Assess and Facilitate Organizational Learning.* Working Paper SWP#396. MIT Centre for Organizational Learning, Boston.

Rotmans, J. (2006). *Transitiemanagement: Sleutel tot een Duurzame Samenleving* (in Dutch). Van Gorkum, Assen.

Rousseau, D.M. (2001). Location, location, location: Contextualizing organizational research. *Journal of Organizational Behavior*, 22, 1-12.

Rowe, W.D. (1994). Understanding uncertainty. *Risk Analysis*, 14(5), 743-50.

Sasou, K. and Reason, J. (1999). Team errors: Definition and taxonomy. *Reliability Engineering and System Safety*, 65, 1-9.

Shackle, G.L.S. (1955). *Uncertainty in Economics and Other Reflections*. Cambridge University Press, Cambridge.

Schafersman, S.D. (1997). *An Introduction to Science: Scientific Thinking and the Scientific Method*. (Available at http://www.muohio.edu/~schafesd/documents/intro-to-sci.htmlx). Department of Geology, Miami University, Miami.

Schein, E.H. (1985). *Organizational Culture and Leadership*. Jossey-Bass, San Francisco.

Schinzinger, R. and Martin, M.W. (2000). *Introduction to Engineering Ethics.* McGraw-Hill.

Schmeichel, B.J., Vohs, K.D. and Baumeister, R.F. (2006). Intellectual performance and ego-depletion: Role of the self in logical reasoning and other information processes. *Journal of Personality and Social Psychology*, 85(1), 33-46.

Schmidt, C., Dart, P., Johnston, L., Sterling, L. and Thorne, P. (1999). Disincentives for communicating risk: A risk paradox. *Information and Software Technology*, 41, 403-11.

Schneider, B. (1990). The climate for service: An application of the climate construct. In *Organizational Climate and Culture* (B. Schneider, ed.), pp.383-412. Jossey-Bass, San Francisco.

Schoemaker, M.J.R. (1994). *Managen van Mensen en Organisaties: Personeelsmanagement in Moderne Organisaties* (in Dutch). Kluwer Bedrijfswetenschappen, Deventer.

Schön, D. (1983). *The Reflective Practioner*. Basic Books, New York.

Schumpeter, J.A. (1950). *Capitalism, Socialism and Democracy*, 3rd edn. Harper Torchbooks, New York.

Scott, S.G. and Lane V. R. (2000). A stakeholder approach to organisational identity. *Academy of Management Review*, 25(1), 43-62.

Senge, P.M. (1990). *The Fifth Discipline: The Art and Practice of the Learning Organisation*. Doubleday, New York.

Shrivastava, P., Mitroff, I.I., Miller, D. and Miglani, A. (1988). Understanding industrial crises. *Journal of Management Studies*, 25, 283–303.

Simon, H.A. (1996). *The Sciences of the Artificial*, 3rd edn. MIT Press, Cambridge, MA.

Sirkin, H.L., Keenan, P. and Jackson, A. (2005). The hard side of change management. *Harvard Business Review*, October, 108-18.

Sitkin, S.B. and Pablo, A.L. (1992). Reconceptualizing the determinants of risk behavior. *Academy of Management Review*, 17(1), 9-38.

Skipp B.O. (ed.). (1993). *Risk and Reliability in Ground Engineering*. Thomas Telford, London.

Sleight, C. (2005a). Construction growth expected to increase. *International Construction*, January-February, 12-4.

Sleight, C. (2005b). IC comment. *International Construction*, July-August, 3.

Slovic, P. (2000). *The Perception of Risk.* Earthscan Publications, London.

Slovic, P. (1972). Information processing, situation specificity, and generality of risk-taking behavior. *Journal of Personality and Social Psychology*, 22, 128-34.

Slovic, P. Fischhoff, B., and Lichtenstein, S. (1980). Facts versus fears: Understanding perceived risk. In *Judgement Under Uncertainty: Heuristics and Biases* (D. Kahneman, P. Slovic, A. Tversky, eds.), pp. 463-89. Cambridge University Press, Cambridge.

Smallman, C. (2000). *Crisis and Risk Management*. Lecture Presentation, NIMBAS-Bradford MBA Programme, September, NIMBAS University, Utrecht.

Smallman, C. (1999). The Risk Factor. *Financial Times*, 30 December, 42-5.

Smallman, C. (1998). *Risk Perception: State of the Art*. University of Bradford Management Centre Working Paper No. 9820, University of Bradford Management Centre, Bradford.

Smallman, C. (1996). Challenging the orthodoxy in risk management. *Safety Science*, 22(1-3), 245-62.

Smith, N. (2003). *Appraisal, Risk and Uncertainty*. Thomas Telford, London.

Smith, N. (ed.). (1998). *Managing Risk in Construction Projects*. Blackwell Science, Oxford.

Smith R. (1996). Allocation of risk: the case for manageability. *The International Construction Law Review,* 4, 549-69.

Smith, R.E. (2008). An evolving view of geotechnical engineering: A focus on geo-risk management. In *Proceedings of the GeoCongress 2008: The Challenge of Sustainability in the Geoenvironment*, 9-12 March, New Orleans. ASCE, Reston.

Song, M. (2006). A research presentation at the University of Twente, including the Direct / Indirect Network Externalities Adoption Model DINAM. Construction Management & Engineering Group, University of Twente, Enschede.

Sowers, G.F. (1993). Human factors in civil and geotechnical engineering failures. *Journal of Geotechnical Engineering*. 119(2), 238-56.

Sperry, P.E. (1981). Evaluation of savings for underground construction. *Underground Space*, 6, 29-42.

Stacey, T.R. (2006). Design: A strategic issue. In *Proceedings Second International Seminar on Strategic vs Tactical Approaches in Mining*, Section 4, 13p. Australian Centre for Geomechanics, Perth.

Stacey, R.D. (1996). *Complexity and Creativity in Organizations*. Berret-Koehler Publishers, San Francisco.

Stein, R.F. (1997). Conditions that facilitate the implementation of innovative freshman experience courses: A comparative analysis of three courses. *Dissertation Abstracts International*, 58(12), 4586A.

Stoner, J. (1968). Risky and cautious shifts in group decisions. *Journal of Experimental and Social Psychology*, 4, 442-59.

Squires, G. (1999). *Teaching as a Professional Discipline*. Falmer, London.

Susman, G.I. and Evered, R.D. (1978). An assessment of the academic merits of action research. *Administrative Science Quarterly*, 23, 582-603.

Swanson, E.B. and Ramiller, N.C. (2004). Innovating mindfully with information technology. *MIS Quarterly*, 28(4), 553-83.

Taleb, N.N. (2007). *The Black Swan: The Impact of the Highly Improbable*. Penguin Books, London.

Tanner P.R. and Sternin, J. (2005). Your company's secret change agents. *Harvard Business Review*, May, 72-81.

Taylor, F.W. (1913). *The Principles of Scientific Management*. Harper and Row, New York.

Tichy, N.M. (1983). *Managing Strategic Change: Technical, Political and Cultural Dynamics*. John Wiley & Sons, Chichester.

Thompson, J.L. (1997). *Strategic Management: Awareness and Change*, 3rd edn. International Thompson Business Press, London.

Thompson, K.M. and Bloom, D.L. (2000). Communication of risk assessment information to risk managers. *Journal of Risk Research*, 3(4), 333-52.

Thompson, P. and Perry, J. (1992). *Engineering Construction Risks*. Thomas Telford, London.

Toft, B. (1996) Limits to the mathematical models of disasters. In *Accident and Design: Contemporary Debates in Risk Management* (C. Hood and D. Jones, eds.), pp. 99-110. UCL Press, London.

Toft, B. (1993). Behavioural aspects of risk management. In *Proceedings Annual Conference of Association of Risk Managers in Industry and Commerce*, 1-4 April. University of Warwick, Warwick.

Transparency International (2005). *Global Corruption Report 2005*. T.I. Pluto Press, London.

Tranfield, D. and Starkey, K. (1998). The nature, social organization and promotion of management research. *British Journal of Management*, 9, 341-53.

Tuckman, B.W. (1965). Developmental sequence in small groups. *Psychological Bulletin*, 63, 384-99.

Turner, B. (1978), *Man-made Disaster*. Wykeham, London.

Tyre, M.J. and Orlokowski, W.J. (1994). Windows of opportunity: Temporal patterns of technological adaptation in organizations. *Organization Science*, 5(1), 98-118.

Uhlfelder, H.F. (2000). It's all about improving performance. *Quality Progress*, February, 47-52.

Van Aken, J.E. (2008a). Organization studies as applied science: Finding firm ground in the swamp. Version 9 October. *Paper in preparation*.

Van Aken, J.E. (2008b). The process of organization design and change: Partly visible and managed, partly invisible and unmanaged. Version August 2008. *Paper in preparation*.

Van Aken, J.E. (2007). Design science and organizational development interventions: Aligning business and humanistic values. *Journal of Applied Behavioral Science*, 43(1), 67-88.

Van Aken, J.E. (2005a). Management research as a design science: Articulating the research products of mode 2 knowledge production in management. *British Journal of Management,* 16, 19-36.

Van Aken, J.E. (2005b). Valid knowledge for the professional design of large and complex design processes. *Design Studies*, 26, 379-404.

Van Aken, J.E. (2004). Management research based on the paradigm of the design science: The quest for field-tested and grounded technological rules. *Journal of Management Studies,* 41(2), 219-46.

Van Aken, J.E. (2001). *Improving the relevance of management research by developing tested and grounded technological rules.* Working paper 1.19, Eindhoven University of Technology, Department of Technology Management, Eindhoven.

Van Aken, T.G.C. (1996). *De Weg naar Projectsucces: Eerder via Werkstijl dan via Instrumenten* (in Dutch). Ph.D. Thesis, De Tijdstroom, Utrecht.

Van Asselt, M.B.A. and Rotmans, J. (2002). Uncertainty in integrated assessment modelling: From positivism to pluralism. *Climatic Change*, 54, 75-105.

Van Asselt, M.B.A. and Vos, E. (2006). The precautionary principle and the uncertainty paradox. *Journal of Risk Research*, 9(4), 313-36.

Van de Ven, A.H. and Rogers, E.M. (1988). Innovations and organizations: Critical perspectives. *Communication Research*, 15(5), 632-51.

Van de Ven, A.H. (1986). Central problems in the management of innovation. *Management Science*, 32(5), 590-607.

Van der Heijden, W.L.F. (2006). *Risicomanagement in de Aderen?! Een Onderzoek naar het Invoeren en Inbedden van Project Risicomanagement binnen NS Project Consult* (in Dutch). M.Sc. Thesis, University of Twente, Enschede.

Van der Panne, G., van Beers, C. and Kleinknecht, A. (2003). Success and failure of innovation: A literature review. *International Journal of Innovation Management*, 7(3), 309-38.

Van Oirschot, R. (2003). *Future Management: De Paradox van de Beheersbare Toekomst* (in Dutch). Business Contact, Amsterdam.

Van Oosterhout, B. (2007) Het ICT-drama: Hoe de overheid miljarden verspilt (in Dutch). *Intermediar*, 14 December, 18-23.

Van Schaik, H.H.J. (2006). *Risicomanagement binnen Dura Vermeer RailInfra b.v:. Building the Risk Diagnosing Methodology* (in Dutch). M.Sc. Thesis, University of Twente, Enschede.

Van Staveren, M.Th. (2008a). Towards risk-driven site characterization. In *Proceedings Third International Conference on Site Characterisation*, April 1-4, Taipei. A.A. Balkema Publishers, Lisse.

Van Staveren, M.Th. (2008b). Geo risk management: A new engineering approach. In *Proceedings First International Conference on Education and Training in Geo-engineering Sciences*, June 2-4, Constantza, pp. 345-50. A.A. Balkema Publishers, Lisse.

Van Staveren, M.Th. (2007a). Extending to geotechnical risk management. In: *Proceedings First International Symposium on Geotechnical Safety and Risk,* Shanghai, 18-19 October, pp 133-43. Tongji University, Shanghai.

Van Staveren, M.Th. (2007b). *Hurdles and Conditions for Implementing Risk Management in Public Project Organizations*. Delft Cluster Working Paper, Work Package 2, November 2007. Delft Cluster, Delft.

Van Staveren, M.Th. (2006). *Uncertainty and Ground Conditions: A Risk Management Approach*. Butterworth-Heinemann, Oxford.

Van Staveren, M.Th. (2001). *Divestment or Leadership?* MBA Thesis, NIMBAS-Bradford MBA Programme, TIAS-NIMBAS Business School, Utrecht

Van Staveren, M.Th. and Chapman, T.J.P. (2007). Complementing code requirements: Managing ground risk in urban environments. In *Proc. XIV European Conference on Soil Mechanics and Geotechnical Engineering*, September 24-27, Madrid. Millpress Science Publishers, Rotterdam.

Van Staveren, M.Th. and Van der Meer, M.T. (2007). Educating geotechnical risk management. In *Proceedings First International Symposium on Geotechnical Safety and Risk*, Shanghai, 18-19 October, pp. 811-22. Tongji University, Shanghai.

Van Staveren M.Th. and Van Seters A. (2004). Smart site investigations save money! In *Proceedings EurEnGeo 2004*, May, Liege: 792–800. Springer Verlag, Berlin.

Van Tol, A.F. (2008). Schadegevallen bij bouwputten (in Dutch). *Cement*, 6, 6-13.

Van Well-Stam, D., Lindenaar, F., van Kinderen, S. & van den Bunt, B.P. (2003). *Risicomanagement voor Projecten: De RISMAN-Methode Toegepast* (in Dutch). Het Spectrum, Utrecht.

Verschuren, P. and Doorewaard, H. (2000). *Het Ontwerpen van een Onderzoek* (in Dutch), 3rd edn. Lemma, Utrecht.

Vatimo, G. (1992). *The Transparent Society*. Polity Press, Cambridge.

Vermaak, J.G. (2002). Veranderkunde in zeven vragen (in Dutch). *Holland Management Review*, 84, 8-22.

Viehöfer, Th.C. (2002). *Tools and Methods for Geotechnical Risk Analysis as Part of Risk Management within the RISMAN Framework* (in Dutch). Report 510160.0001. GeoDelft, Delft.

Vlek, C.A.J. and Hendrickx, L. (1988). Statistical risk versus personal control as conceptual basis for evaluating (traffic) safety. In *Road User Behaviour: Theory and Research* (J.A. Rothengarther and R.A. de Bruin, eds.). Van Gorcum, Assen.

Vrakking, W. J. (1995). The implementation game. *Journal of Organizational Change Management*, 8(3), 31-46.

Vrakking, W.J. and Cozijnsen, A.J. (1992). *Ondernemen en Vernieuwen: Basisboek Innoveren en Implementeren* (in Dutch). Kluwer Bedrijfswetenschappen, Deventer.

Waring, A.E. (1996). *Safety Management Systems*. Chapman & Hall/ITBP, London.

Waring A.E. and Glendon, A.I. (1998), *Managing Risk,* 1st edition. International Thomson Business Press, London.

Watzlawick, P., Beavin, J.H. and Jackson, D.D. (1967). *Pragmatics of Human Communications*. W.W. Norton & Company, New York.

Weatherhead, M., Owen, K. and Hall, C. (2005). *Integrating Value and Risk in Construction*. CIRIA, London.

Weggeman, M.C.D.P. (1992). *Leidinggeven aan Professionals* (in Dutch). Kluwer Bedrijfswetenschappen, Deventer.

Weick, K.E. (1995). *Sensemaking in Organizations*. Sage Publications, Thousand Oaks, CA.

Weick, K.E. and Sutcliffe, K.M. (2001). *Managing the Unexpected: Assuring High Performance in an Age of Complexity*, Jossey-Bass, San Francisco.

Weisscher, V.J.T. (2006). *Welke Meerwaarde Biedt de GeoQ Methode? Een Onderzoek naar de Meerwaarde van de door GeoDelft Ontwikkelde GeoQ Methode voor Risicomanagement van de Ondergrond* (in Dutch). M.Sc. Thesis, University of Twente, Enschede.

Werkman, R.A., Boonstra, J.J. and Elving, W.J.L. (2005a). Complexiteit en weerbarstigheid in veranderprocessen (in Dutch). M&O, 5 (September/October), 5-29.

Werkman, R.A., Van der Kloot, W., & Boonstra, J.J. (2005b): Changing organizations: Reducing complexity, not denying it. *Academy of Management Annual Meeting*, Honolulu.

West, M.A. and Farr, J.L. (1989). Innovation at work: Psychological perspectives. *Social Behaviour*, 4, 15-30.

Westrum, R. (1992). Cultures with requisite information. In *Verification and Validation of Complex Systems: Human Factor Issues*. (J. Wise, D. Hopkin, and P Stager, eds.), pp. 401-12. Springer-Verlag, Berlin.

Wholey, J. (1979). *Evaluation: Performance and Promise*. The Urban Institute, Washington, DC.

Wichers Hoeth, A.W. and Fleuren, K.G.A. (2006). *De Bouw Moet Om: Op Weg naar Feilloos Bouwen* (in Dutch). SBR, Rotterdam.

Wildavsky, A. and Dake, K. (1990). Theories of risk perception: Who fears what and why? *Daedalus*, 199-4, 41-60.

Wildman, W.R. (2004). Risk allocation in tunnel construction contracts. In *North American Tunneling* (Ozdemir, ed.), pp. 171-6. Taylor & Francis Group, London.

Williams, T.M. (1996). The two-dimensionality of project risk. *International Journal of Project Risk*, 14(3), 185-6.

Wilson, T.D. (2002). *Strangers to Ourselves: Discovering the Adaptive Unconscious*. The Belknap Press of Harvard University Press, Cambridge, MA.

Witten. D. and Tulku Rinpoche, A. (1998). *Enlightened Management*. Random House, London.

Yin, R.K. (2003). *Case Study Research: Design and Methods,* 3rd edn. Sage Publications, Thousands Oaks.

Zaltman, G., Duncan, R. and Holdback, J. (1973). *Innovations in Organisations*. Wiley & Sons, New York.

Zohar, D. and Marshall, I. (2004). *Spiritual Capital*. Bloomsbury, London.

APPENDICES

Appendix 1 Hurdles for applying risk management from interviews with geotechnical experts

No.	Description of hurdles for applying geotechnical risk management
1	The risk management motivation of team members is conflicting.
2	Geotechnical risk management is perceived as a hollow process without content.
3	Fear that demonstrating uncertainty about geotechnical topics is perceived as professional ignorance.
4	Deterministic thinking by geotechnical engineers, rather than probabilistic thinking.
5	Clients pay no attention to geotechnical risk management
6	Chance for being sued by mal performance of geotechnical constructions is very small.
7	Applying geotechnical risk management is creating extra problems that need to be solved.
8	Rigorously applying geotechnical risk management stops professional thinking.
9	Rigorously applying geotechnical risk management does not guarantee well-performing projects.
10	Gathering information as input for geotechnical risk management is considered expensive.
11	Jurisprudence is not aligned with using geotechnical risk management in projects.
12	Risk management is not included in the ruling geotechnical codes.
13	Geotechnical engineers are uneasy to express their experience in numbers for risk classification purposes.
14	Unknown how including human, organizational, and knowledge uncertainties in risk management process.
15	Costs for applying geotechnical risk management are too high in projects with tight budgets.
16	Non-geotechnical engineers, such as structural engineers, are often not aware of geotechnical uncertainty.
17	Applying geotechnical risk management is perceived as not fitting within the planning of the project.
18	There are no economic drivers that motivate applying geotechnical risk management.
19	Explicit geotechnical risk management is seldom applied in infrastructural projects.
20	There is no understanding of geotechnical risk management.
21	Probability-based geotechnical risk management software is too complex.
23	Risk management software does not explicitly include quantification of human uncertainties.
24	A lack of sufficient geotechnical data for applying probabilistic design methods.
25	Results of Monte Carlo type of geotechnical risk analysis are not representative
26	User friendly risk management software allows unwanted ''rubbish in is rubbish out" effects.
26	There are no suitable tools available for quantifying geotechnical risk.
27	Probability-based risk management software is not much used.
28	User-friendly probability-based geotechnical design software is not available.
29	Probabilistic geotechnical design is more complicated than conventional and deterministic design.
30	Existing geotechnical codes, such as the Euro code, are still deterministic and not explicitly facing uncertainty.
31	Existing risk management tools do not identify rare and single adverse events.

No.	Description of hurdles for applying geotechnical risk management
32	Accountancy standards do not include probability and impact of risk in money terms.
33	Probability-based risk analysis is not standard practice within geotechnical engineering.
34	There is a lack of databases that can be used for geotechnical risk management.
35	Geotechnical risk management training is useless to non-dedicated and non-talented people.
36	A lack of in-depth geotechnical knowledge reduces the effects of risk management training.
37	Unawareness about geotechnical uncertainty reduces the effects of geotechnical risk management training.
38	It difficulty deciding whether an engineer is competent for applying geotechnical risk management.
39	Training that results in formal accreditation and registration does not guarantee good professional practice.
40	Geotechnical risk terminology is not well established and standardized.
41	Lacking convincing case studies demonstrating geotechnical risk management benefits for training purposes.
42	Formal geotechnical risk management training is not available.
43	Conventional health and safety training does not replace geotechnical risk management training.
44	Risk management training will not change negative attitudes of professionals to risk management.
45	Pushing professionals for attending risk management workshops results in poor motivation.
46	Low fees for geotechnical engineering services do not support applying geotechnical risk management.
47	Clients are unwilling to pay for geotechnical quality and expertise.
48	Most geotechnical problems are not publicized and remain unknown, which gives limited risk management urgency.
49	Much that occurs in the ground remains unseen, resulting in low geotechnical risk management urgency.
50	The managerial level does not take responsibility for geotechnical failures.
51	Geotechnical success stories are not written down and communicated.
52	Risk-driven geotechnical innovation is not yet common practice.
53	Financial analysts have a short- term attention, conflicting with long term benefits of risk management
54	Geotechnical engineering is still opinion-based, rather than rational-based.
55	Top managers are often non-technical people with low understanding of geotechnical risks.
56	Money dominates over geotechnical safety.
57	Cost cutting rules in geotechnical engineering, rather than investing and creating additional value.
58	The low-cost culture is driven by keeping up share-prices of listed companies.
59	The low-cost culture is driven by maximizing employability in the industry.
60	The lowest bid-price criterion results in loosing the contract when costs of risk management are included.
61	A growing public aversion against cost and time overruns creates difficulties for starting large projects.
62	For political reasons, public owners concentrate on lowest cost estimates, which conflicts with explicit risk management
63	Despite its low risk tolerance, the public is not driving public owners for applying risk management.

Appendix 2 Conditions for applying risk management from interviews with geotechnical experts

No.	Description of conditions for applying geotechnical risk management
1	Media pressure for using risk management, as prerequisite for quality projects at reasonable costs.
2	Shared beliefs, values, visions, and feelings about the role of geotechnical risk management.
3	Public-private partnerships with shared responsibilities for dealing with risk.
4	Published geotechnical risk management success stories in professional journals and the mass media.
5	Enforced geotechnical risk management by professional indemnity insurers.
6	Demonstration of time and costs involved, when senior staff has to fight failing projects in court.
7	Financial incentives for applying risk management by individuals and teams.
8	Applying risk management aligns with the client's interests.
9	Demand for performance warranties from geotechnical engineers by the client's lawyers.
10	Application of content-driven and knowledge-based geotechnical risk management approaches.
11	Anonymity of engineers who bring risks into the open.
12	Lean and mean risk management reporting without unnecessary complexity.
13	Probabilistic thinking, rather than deterministic thinking, while capturing the knowledge of professionals.
14	Application of risk management is related to insurance premiums of projects.
15	Application of qualitative risk management is enforced in geotechnical codes by law.
16	Use of value-driven business models, rather than production-driven ones, for achieving higher profitability.
17	Small, highly motivated, and highly paid work teams.
18	Permanent risk management awareness of managers is enforced by regular external risk management reviews.
19	Economical reasons for applying risk management are expressed, rather than professional or ethical reasons.
20	Risk-driven engineering codes are enforced by stock exchanges, for protecting shareholders from financial losses.
21	Financial incentives for zero-accidents are related to the application of risk management.
23	Key performance indicators and individual targets are related to risk management.
24	Risk management focuses on enthusiastic young engineers, who are dedicated to make a difference.
25	Dispute Review Boards demonstrate risk management effectiveness during their involvement.
26	Clients and contractors enforce engineers to high payments for their design failures.
26	Promotion of risk-driven capital investments for increasing productivity and thus profitability.
27	Use of corporate risk registers for organizational learning and creating a corporate memory.
28	Risk management is integrated with safety management.
29	Risk management is related to financial out performance.
30	Risk management is related to timesavings in projects.
31	Public owners enforce risk management in their projects for demonstrating effective spending of public money.

No.	Description of conditions for applying geotechnical risk management
32	Applying risk management is a prerequisite for fund raising in the private financial sector.
33	Professional knowledge and skills are combined with risk management knowledge, skills, and compassion.
34	Availability of codes with pre-set probabilities of failure, rather than deterministic factors of safety.
35	Use of the Net Present Value of projects in the feasibility phase, with pre-set confidence levels for structures.
36	Application of risk management is enforced by insurance companies for getting insurance.
37	Use of suitable contractual frameworks that support and reward risk management applications.
38	Risk-driven leadership, project management, and teamwork are integrated.
39	Availability of contingency budgets for reducing the unknown known type of uncertainties during the project.
40	Awareness of the consequences and responsibilities, when geotechnical risks occur.
41	Presence of a good climate with trust between the parties involved in the project.
42	Fees for geotechnical engineers enable them to apply geotechnical risk management.
43	The risk management process is repeated in each new project phase.
44	Formalized peer reviews on each other's work within the project.
45	Presence of sufficient knowledge and experience for being able to perform hazard identifications.
46	Targeted risk profiles are established by managers, rather than by engineers.
47	Risk management is integrated with strategic management.
48	Applying risk management maintains good reputations of the partied involved during the project.
49	Use of pencils and paper, combined with experienced brains, rather than software tools, for applying risk management.
50	Simplicity of risk management guidelines
51	Existing geotechnical approaches and software being adequate for effective and efficient risk management.
52	A project risk evaluation protocol, such as provided by the American Society of Foundation Engineers.
53	ICT-supported risk identification and classification tools for teams.
54	Probabilistic geotechnical design approaches.
55	Geological and geotechnical databases with location-specific data.
56	Three-dimensional geotechnical block models, for quantifying the financial returns of site investigations.
57	Software for demonstrating risk and cost-benefits ratios of different geotechnical design options.
58	Reverse engineering approaches, for risk-driven definitions of site investigations.
59	Software for executing risk analyses.
60	Balance-sheet type of risk registers for communicating risks with financial decision makers.
61	Integration of risk management with widely used project management tools.
62	Long-term monitoring of construction processes, for learning whether identified risks occur or not.
63	Risk management workshops for creating a shared understanding of risk management.
64	Selected teams with a variety of skills and talents.
65	Fundamental knowledge of the social sciences, such as psychology and sociology.
66	Risk management training is integrated with in-depth geotechnical training, for making it applicable in daily practice.

No.	Description of conditions for applying geotechnical risk management
67	Suitable management skills for creating risk awareness.
68	Risk management is part of the education of engineers at universities.
69	Formal risk management training is a requirement for keeping the license to engineer.
70	A multi-disciplinary risk management workshop at the start of a project.
71	Technical and social sciences are integrated within risk management training programs.
72	Risk appreciation and management are an integral part of geotechnical engineering.
73	Ability for organizational learning and changing.

Appendix 3 Data sources of key hurdles for applying risk management

KEY HURDLES FOR APPLYING RISK MANAGEMENT

No.	Description	Data sources and numbers of clustered hurdles			
		Literature research		Field research	
		References in Van Staveren (2006) Table 3.1	Additional literature Table 3.3	Interviews with 7 geotechnical experts Appendix 1	Delft Cluster and RISNET Table 3.5
	Motivation				
1	Lack of risk management awareness.	1	14	**5***, **16**, 55	4
2	Lack of clear risk management benefits.	4, 5	17	**1**, 2, 6, 8, **9**, 10, 12, 15, 17, **18**, 30, 32, 45, 46, 47, **48**, 49, 53, 56, 57, 58, 60, 62, 63	3, 12, 14, 18, 19, 20, 21, 22, 23
3	Fear for risk transparency.		1, 10	3, 7, 11, 13, 50	7, 13, 24
4	Difficulty to apply risk management.	2	3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 16	14, 21, 29, 33, 38, 52	8, 10
	Training				
5	Lack of risk management understanding.	3	2, 15	4, 20, **41**, **43**, 54	2, 5, 6, 11, 15, 16, 17
	Tools				
6	Lack of risk management methods, protocols, tools, and data.			22, 23, 24, 25, 26, 27, 28, 31, 34, 40	1
7	Lack of risk management benchmarks.		17		9

* Hurdles that are presented in **bold** letters are generic hurdles that resulted from the Delphi analysis.

Remark: Hurdles number 7, 19, 35, 36, 37, 39, 42, 44, 51, 59, and 61 of Appendix 1 could not be related to corresponding key conditions. This minority of apparently very context-specific hurdles have not been considered anymore.

Appendix 4 Data sources of key conditions for applying risk management

KEY CONDITIONS FOR APPLYING RISK MANAGEMENT

No.	Description	Data sources and numbers of clustered conditions			
		Literature research		Field research	
		References in Van Staveren (2006) Table 3.2	Additional literature Table 3.4	Interviews with 7 geotechnical experts Appendix 2	Delft Cluster and RISNET Table 3.6
	Motivation				
1	Setting of clear goals and objectives.		19, 20, 21, 25	**5***, 7, **8**, 9, 14, 15, 20, 21, 22, 25, 29, 30, **31**, **32**, 36, **37**, 40, 46, 49	17, 34, 37
2	Raising awareness about risk consequences and risk management benefits.	1, 7	5, 6, 15	1, 4, 6, 16, 18, 19, 24, 48, **62**	2, 9, 14, 16, 20, 21, 27, 38
3	Providing clear contractual risk responsibility.			3	11, 35
4	Relating risk management to other management approaches.		4	28, **47**, 61	6, 26, 28
5	Involving all project stakeholders		7, 22, 23, 26	23, **41**, **63**	7, 8, 24, 25, 30, 32, 36
6	Providing resources for applying risk management.	4	18	39, **42**	3
	Training				
7	Risk management understanding.	2, 3, 5	8, 9, 10, 11, 12, 13, 16, 24	2, 10, 13, 33, 43, 45, 58, 65, 66, 68, 70, 71, 72	12, 13, 18, 19, 27, 29, 33
8	Understanding of the role of teams.		1, 2	17, **44**, **64**	1, 4, 5
9	Understanding the role of organizational culture.	6, 8	3, 14, 17	38, 67, 73	22
	Tools				
10	Project fit of risk management methods, protocols, tools and data.	9		12, 27, 34, 49, 50, 51, 52, 53, 54, 55, 56, 57, 59, 60	10, 15, 31

* Conditions that are presented in **bold** letters are generic conditions that resulted from the Delphi analysis.

Remarks: Condition number 10 of Table 3.2, identified in the references in Van Staveren (2006), could not be related to corresponding key conditions. Moreover, conditions number 11, 26, 35 and 69 of Appendix 2 could not be related to corresponding key conditions. This minority of apparently very context-specific conditions have not been considered anymore.

Appendix 5 Classification of hurdles and conditions in *innovation* characteristics

Innovation characteristics	Innovation subcharacteristics	Numbers of innovation-related hurdles (H) and conditions (C)				
		For implementing innovations				For applying risk management
		Literature Research			Field Research	Literature and field research
		Table 4.1, 4.2	Table 4.3, 4.4	Table 4.5, 4.6	Table 4.7, 4.8	Table 3.10, 3.11
		Ph.D. literature	Scientific journals	Additional literature	Interviews	Key hurdles and key conditions
1. Relative advantage	1.1 economic	C5		H7, C13	H28, C32, C33	H2
	1.2 social status	H4			C34	
	1.3 over-adoption	H1				
	1.4 preventive	C12			C35	
	1.5 incentive			C2, C22	H29	C6
	1.6 mandate				C36	
2. Compatibility	2.1 values and beliefs		C6	H3	H30, C5, C6, C37, C38	
	2.2 previous ideas	C6				
	2.3 needs			C6	C39, C40	H6, C10
	2.4 technology cluster				H31, C42	C4
	2.5 name				H32	
	2.6 position					
3. Complexity		C9, C14	H1	H2	H1, H33, C7, C43	H4
4. Triability				H4		
5. Observability				C11	H34, C44, C45	H7, C1
6. Direct network externality						
7. Indirect network externality					H35, C46	
8. Price						
9. Relative usefulness		C13		H1	C46, C48, C49	

Remark: The numbers of the hurdles (e.g. H1) and conditions (e.g. C13) within the cells of a column correspond with the numbers of the hurdles and conditions in the tables, which are indicated above each column.

Appendix 6 Classification of hurdles and conditions in *social system* characteristics

Social system characteristics	Social system subcharacteristics	Numbers of innovation-related hurdles (H) and conditions (C)				
		For implementing innovations				For applying risk management
		Literature Research			Field Research	Literature and field research
		Table 4.1, 4.2	Table 4.3, 4.4	Table 4.5, 4.6	Table 4.7, 4.8	Table 3.10, 3.11
		Ph.D. literature	Scientific journals	Additional literature	Interviews	Key hurdles and key conditions
1. Social structure	1.1 control, coordination, responsibility	C7, C8, C10	H4, C3	C17	C9, C11,C12, C13	C3
	1.2 stable or change and innovation prone	H2, C3		C14	H7, H8, H9, H15, C3, C14, C16	
	1.3 internal or external focus					
2. Norms	2.1 basis of truth and rationality	C1	H5, C5	H8, H10,C15	H2, H4, H10, H11, C2, C17, C18, C19	H1, H5, C7
	2.2 nature of time and its horizon		C2	C5	H5, H12, H13, C10, C15, C18, C21, C22, C23	
	2.3 motivation and commitment		H6	C12	H14, C1, C4, C15, C24, C25	
	2.4 work, task, co-worker orientation		H2, H7, C1	H9, C3	H3, H6, C26	C8
	2.5 isolation or cooperation	C4		C1, C16	H16, C27	C5
3. Innovation roles	3.1 change agents					
	3.2 opinion leaders					
	3.3 champions					
4. Innovation decision	4.1 optional					
	4.2 collective					
	4.3 authority			H6	H18	
	4.4 contingent					
5. Innovation consequences	5.1 (un)desirable		H3	H5	H19, H20,H21, H22, C28, C29	H3, C2
	5.2 (in)direct				H23, H24, C30	
	5.3 (un)anticipated				H25, H26,C8, C31	
	5.4 (un)equal				H27	

Remark: The numbers of hurdles (e.g. H1) and conditions (e.g. C13) within the cells of a column correspond with their numbers in the tables, which are indicated above each column.

Appendix 7 Deriving key conditions for the risk management dimension of the initial conceptual model for risk management implementation

Numbers of tables with hurdles (H) and conditions (C) from exploratory research of risk management (RM) and innovation management (IM)						Key conditions	
Source					**Description**	**Description**	**No.**
Risk Management	**Innovation Management**						
All	**Literature research**			**Field research**			
	PhD theses	**Scientific journals**	**Other literature**	**Interviews**			
Table 3.10 (H) Table 3.11 (C)	Table 4.1 (H) Table 4.2 (C)	Table 4.3 (H) Table 4.4 (C)	Table 4.5 (H) Table 4.6 (C)	Table 4.7 (H) Table 4.8 (C)	Tables in previous columns.	Table 6.2	Table 6.2

OVERVIEW: Numbers of tables with descriptions of hurdles and conditions for deriving key conditions for *risk management* characteristics and subcharacteristics.

Risk management methodology characteristic no. 1 = relative advantage; subcharacteristic no. 1.1 = economic relative advantage							
Hurdles (H) and conditions (C) from exploratory research of risk management (RM) and innovation management (IM)						**Key condition**	
Source number					**Description**	**Description**	**No.**
RM	**IM**						
All	**Literature research**			**Field research**			
	PhD	**ScJ**	**Other**	**Interviews**			
H2					Lack of clear risk management benefits.	Applying risk management methodologies increases effectiveness or efficiency.	1
	C5				Counting innovation outcome by its costs and benefits.		
			H7		The organization's inability to evaluate the implementation of an innovation by financial and other criteria.		
			C13		Understanding of the empirical benefits and costs or economic advantage of an innovation.		
				H28	Lack of economic benefits of the innovation.		
				C32	Clear benefits by increased (operational) efficiency, less time, and less costs required.		
				C33	Increased competitive advantage, either material or immaterial.		

EXAMPLE: Deriving one key condition for the *risk management* dimension of the initial conceptual model for risk management implementation.

Appendix 8 Deriving key conditions for the social system dimension of the initial conceptual model for risk management implementation

Numbers of tables with hurdles (H) and conditions (C) from exploratory research of risk management (RM) and innovation management (IM)						Key conditions	
Source					Description	Description	No.
Risk Management	Innovation Management						
All	Literature research			Field research			
	PhD theses	Scientific journals	Other literature	Interviews			
Table 3.10 (H) Table 3.11 (C)	Table 4.1 (H) Table 4.2 (C)	Table 4.3 (H) Table 4.4 (C)	Table 4.5 (H) Table 4.6 (H)	Table 4.7 (H) Table 4.8 (C)	Tables in previous columns.	Table 6.3	Table 6.3

OVERVIEW: Numbers of tables with descriptions of hurdles and conditions for deriving key conditions for *social system* characteristics and subcharacteristics.

Social system characteristic no. 1 = social structure; subcharacteristic no. 1.1 = control, coordination, and responsibility							
Hurdles (H) and conditions (C) from exploratory research of risk management (RM) and innovation management (IM)						**Key conditions**	
Source numbers					**Description**	**Description**	**No.**
RM	**IM**						
All	**Literature research**			**Field research**			
	PhD	**ScJ**	**Other**	**Interviews**			
C3					Providing clear contractual risk responsibility.	Presence of formalized risk management responsibility.	2
	C7				Explicit management responsibility about the implementation process.		
				C9	Risk responsibility at all organizational levels.		
				C11	Very explicit decision making about the implementation of the innovation.		
				C12	Presence of an organization-wide innovation framework and process.		
				C13	Professional registration of innovation users, e.g. risk managers for RM implementation (as accountants).		
			C17		Drawing clear lines between acceptable and unacceptable behaviour with regard to the implementation of the innovation.		
	C8				Delegation of responsibilities from managers to functional experts.	Presence of lowest-level risk management responsibility.	3
		H4			Rule-bound organizational culture.		
		C3			Autonomous organizational culture.		
	C10				Regular reporting of implementation progress to senior management.	Presence of formalized risk management reporting to senior management.	4

EXAMPLE: Deriving three key conditions for the *social system* dimension of the initial conceptual model for risk management implementation.

Appendix 9 Deriving key interventions for the risk management dimension of the initial conceptual model for risk management implementation

Numbers of tables with interventions (I) from exploratory research of change management (CM), risk management (RM), and innovation management (IM)				Key intervention	
Intervention source number			Description	Description	No.
Literature Research of CM	Field Research				
	RM	IM			
Table 5.1	Table 5.2	Table 5.3	Table in previous columns.	Table 6.4	Table 6.4

OVERVIEW: Numbers of tables with descriptions of interventions for deriving key interventions for the *risk management* dimension.

Rational type of interventions for setting conditions for the risk management (RM) dimension					
Interventions (I) from exploration research of change management				Key intervention	
Intervention source number			Description	Description	No.
Literature Research	Field research				
CM	RM	IM			
30			Ensuring positive bottom line effects of the innovation implementation.	Ensure positive financial bottom line effects of the RM implementation	2
	11		Providing cost-benefit software for calculating the cost-benefit ratios of risk reduction.		
	12		Providing financial risk-balance sheets.		
29			Executing integral implementation without experimentation.	Create RM fit by re-designing existing work processes and by RM inclusion in existing management practices	3
		15	Re-designing work processes for creating innovation fit.		
	13		Incorporating RM in strategic planning and strategic management.		
	14		Incorporating RM in project management.		
	15		Aligning RM with the development of reliable technical delivery systems (TDS) and high reliability organizations (HROs).		
	16		Relating risk management to zero-accident programmes.		
31			Providing support by a digital information system and an innovation newsletter.	Generate RM support by appropriate methodologies, tools, and assistance	4
	17		Providing simple RM guidelines.		
	18		Providing the ISO 31000 Risk Management Guideline.		
	19		Designing contractual frameworks that allow risk management.		
	20		Providing support to risk owners by risk managers.		
		16	Using case studies for convincing potential users for using the innovation.		
	6		Enforcing targeted risk profiles in projects by clients.	Set, monitor, and communicate risk profiles	5

EXAMPLE: Deriving four key interventions for the *risk management* dimension of the initial conceptual model for risk management implementation.

Appendix 10 Deriving key interventions for the social system dimension of the initial conceptual model for risk management implementation

Numbers of tables with interventions (I) from exploratory research of change management (CM), risk management (RM), and innovation management (IM)				Key intervention	
Intervention source number			Description	Description	No.
Literature Research of CM	Field research				
	RM	IM			
Table 5.1	Table 5.2	Table 5.3	Tables in previous columns	Table 6.5	Tables 6.5

OVERVIEW: Numbers of tables with descriptions of interventions for deriving key interventions for the *social system* dimension.

Autonomous type of interventions for setting conditions for the social system dimension					
Interventions (I) from exploratory research of change management				Key intervention	
Intervention source number			Description	Description	No.
Literature Research	Field research				
CM	RM	IM			
22			Arranging open space meetings, self-steering teams, and appreciative inquiry.	Arrange out-of-the-box sessions	1
23			Providing learning histories.		
24			Arranging out-of-the-box thinking workshops with group decision support systems.		
25			Providing self-monitoring.		
25			Arranging strategic dialogues.		
		12	Using dialogues in the unfreezing phase of the innovation implementation process.		
		13	Providing co-creation of the implementation process with all actors involved.		
		14	Applying innovative intervention techniques by interaction between people that address sense making.		
	3		Organizing multi-disciplinary risk workshops.		

EXAMPLE: Deriving four key interventions for the *social system* dimension of the initial conceptual model for risk management implementation.

Appendix 11 Questionnaire for auditing key conditions for risk management methodologies

Risk management methodology		Key conditions for risk management methodologies		Assessment of degree of presence (%)				
Characteristics	**Subcharacteristics**	**No.**	**Description**	**0-20**	**20-40**	**40-60**	**60-80**	**80-100**
Relative advantage	Economic	1	Managing risk is cost-effective.					
	Social status	2	Managing risk provides social status.					
	Over-adoption	3	Managing risk avoids tool pre-occupation.					
	Preventive	4	Managing risk provides preventive advantage.					
	Incentive	5	Managing risk is rewarded.					
	Mandate	6	Top management mandates applying risk management					
Compatibility	Values & beliefs	7	Managing risk fits values and beliefs.					
	Previous ideas	8	Managing risk fits existing practices.					
	Needs	9	Managing risk fulfils needs of its users.					
	Technology cluster	10	Managing risk strengthens innovativeness.					
	Name	11	Managing risk as a name has a positive meaning.					
Complexity		12	Managing risk has an acceptable complexity.					
Triability		13	Managing risk is easy to try out.					
Observability		14	Effects of managing risk are observable.					
		15	Case studies show risk management success.					
Indirect network externalities		16	External parties request managing risk.					
Price		17	Costs of managing risk are acceptable.					
Relative usefulness		18	Managing risk increases organizational reliability.					

Appendix 12 Questionnaire for auditing key conditions for social systems

Social system		Key conditions for social systems (RM = Risk Management)		Assessment of degree of presence (%)				
Characteristics	**Subcharacteristics**	**No.**	**Description**	**0-20**	**20-40**	**40-60**	**60-80**	**80-100**
Social structure	Control	1	Formal responsibilities for managing risk.					
		2	Formal delegation of responsibilities for managing risk.					
		3	Formal risk management reporting to senior management.					
	Flexibility	4	Organizational structure supports continuous RM adaptation.					
	Focus	5	Organizational structure allows inclusion of external environment.					
Social norms	Basis of truth	6	Shared risk management awareness and understanding.					
		7	Understanding of ratio and emotions of managing risk.					
		8	Understanding of risk management relationships with other disciplines.					
	Motivation	9	Acknowledgement of differences in risk management motivation.					
	Learning orientation	10	Understanding of different risk perceptions.					
	Cooperation	11	Institutionalized sharing of information about managing risk.					
		12	Institutionalized cooperative attitude to managing risk.					
Innovation roles	Change agents	13	Presence of change agents for implementing risk management.					
	Opinion leaders	14	Presence of opinion leaders who advocate managing risk.					
	Champions	15	Presence of champions who support managing risk.					
Innovation decision	Type	16	Shared decision making about how to implement RM.					
	Resources	17	Availability of time and budget for RM implementation.					
Innovation consequences	Desirable	18	Risk management consequences are perceived as desirable.					
	Direct	19	Acceptance of short-term organizational efficiency reduction.					
		20	Presence of risk management milestones and quick wins.					
	Uncertain	21	Acceptance of unanticipated risk management consequences.					
	Unequal	22	Acceptance of conflicting risk management consequences.					

Appendix 13 Questionnaire for auditing key interventions for risk management user groups

Risk managementuser groups	Key interventions for potential risk management (RM) users		Assessment of degree of execution (%)				
	No.	Description	0-20	20-40	40-60	60-80	80-100
All groups	1	Apply situational leadership with teamwork.					
	2	Provide risk management education and training.					
Innovators	3	Arrange out-of-the-box risk management sessions.					
	4	Forster self-monitoring and self-evaluation of RM.					
Early adopters	5	Apply a staged risk management implementation process.					
	6	Facilitate the application of RM with resources (time, budget).					
	7	Set, monitor, and communicate the added value of RM.					
Early majority	8	Ensure identification with risk management.					
	9	Organize task, responsibility, and authority sessions.					
Late majority	10	Enforce the application of risk management.					
Laggards	-	None, do not waste resources on inherently unwilling laggards.					

RISK, INNOVATION & CHANGE
DESIGN PROPOSITIONS FOR IMPLEMENTING RISK MANAGEMENT IN ORGANIZATIONS

Summary

Managing risk is difficult. Applying risk management is more difficult. Implementing risk management in organizations is the most difficult. Risks are inherently subjective and intangible. Risk management is about handling uncertainty, with which most people feel rather uncomfortable. Moreover, risk management has a preventive character. This means doing something to *avoid* something else happening. However, in most situations there is *no* direct relationship between the application and benefits of risk management. Otherwise, private and public organizations operating in our globalizing world *are* highly vulnerable to risk. Therefore, an increasing number of managers and executives acknowledge that the risk of *not* routinely applying risk management is unacceptable for their organizations, as well as for shareholders and other stakeholders.

Realizing actually implemented risk management in an organization is however by far not easy. Failure is more the rule than success. Consequently, large sums of money, seemingly invested in implementing risk management, are actually wasted. This appears an ill-defined and messy problem in a lot of industries, for risk management as well as for (other) innovations.
This research focussed on the Dutch construction industry. Within engineering and construction, complexity, safety, failure costs, and integrity are four key problems. By many, applying risk management is meanwhile considered a promising part of the solution. Nevertheless, there exists hardly scientifically validated and practically applicable knowledge about *how* to *implement* risk management in organizations. This situation occurs despite, or because of, the raised risk management problems. Therefore, the main research question of this research was:

How to implement risk management in organizations in the construction industry?

Within this research, *implementation* means the routinized application of risk management within an organization. The design science approach appeared to be the most appropriate research methodology. Subsequently, a number of exploration research and development research steps were taken. Comprehensive literature surveys and field research has been performed. Experts, from academia and the professional practice, in the disciplines of risk management, innovation management, and change management from The Netherlands, the United States, the United Kingdom, and South Africa, were interviewed. The results served as foundation for the development research part. Synthesizing concepts and variables about risk, innovation, and change generated four practically applicable research products. These were developed in three subsequent steps, validated in four case studies, and evaluated by an expert panel. Together, these research results provide unique design propositions for implementing risk management in organizations.

Research conclusions

Based on the research of implementing risk management in organizations, four general conclusions are drawn:

Conclusion 1: Form, function and meaning of risk management are largely intangible and subjective, which makes effective, efficient, and persistent implementation in organizations highly complex;

Conclusion 2: Implementing risk management in organizations requires a design approach that synthesizes risk management, innovation management, and change management concepts and practices;

Conclusion 3: Specific attention to routinize the use of risk management methodologies, defined implementation, is highly underdeveloped;

Conclusion 4: For real implementation, risk management methodologies need to be adapted to organizational social systems with their distinct risk management user groups.

Conclusion 1 and Conclusion 3 represent the ill-defined and messy problems with implementing risk management in the professional practice, for which Conclusion 2 and Conclusion 4 provide solutions.

The high degree of *complexity* has been revealed by identifying 480 variables. All of these are, in one way or another, influencing the implementation of risk management in organizations. For being able to handle this complexity, design propositions for implementation have been developed. These reduced the original number of nearly 500 variables with a factor 10 to 50 well-structured and workable key variables.

When starting with risk management, most organizations tend to focus almost entirely on *developing* risk management principles, processes, and tools. Giving specific attention to *routinizing* the use of these methodologies is underdeveloped. Commonly, two fundamental dimensions for implementing risk management, organisational *social systems* and distinct types of risk management *users*, are largely neglected. Amongst others, this appears from four cases studies. These were performed in a geotechnical institute, a project management consultant, a contractor, and a public client organization, over a three-year period. Within the Dutch construction industry, these four organizations are leading with regard to applying risk management in their activities.

Research products

The research products are two models and two instruments for implementing risk management:

1. A *conceptual model* that gives insight in the relevant *mechanisms* for effective, efficient, and persistent implementation of risk management in organizations. The three dimensions of the model are (1) risk management users, (2) risk management methodologies, and (3) social systems;
2. A *design process model* for context-specific design of risk management implementation *processes*. The model distinguishes the *feasibility* phase, the *decision* phase, and the *execution* phase. Moreover, it defines *roles*, *tasks*, and *responsibilities* of actors during the risk management implementation process;

3. An *audit instrument* for measuring implementation *readiness* of organizations. In addition, it can measure implementation *progress* over time. The audit instrument consists of three questionnaires. Completed questionnaires reveal individual perceptions of actors before, during, and after risk management implementation processes;
4. An *intervention proposition* for selecting adequate *key interventions* with supporting activities. These aim to increase individual motivation and commitment of risk management users.

All of the developed products facilitate designing, preparing, executing, and monitoring risk management implementation processes in organizations. Knowing about the conceptual model is relevant for any *researcher*, *manager*, and *professional*, who is or will become involved in implementing risk management in organizations. The design process model, the audit instrument, and the intervention proposition are specifically developed for *consultants* involved in implementation processes.

Scientific research contribution

The scientifically developed design propositions for implementing *risk management* in organizations are the *first* of its kind, and therefore unique. Moreover, from a *scientific* point of view, the research results have four other distinguishing features:

1. The developed products are the results of *synthesizing* state-of-the-art risk management, innovation management, and change management concepts and variables;
2. The results *combine* three fundamental dimensions for implementation: risk management users, methodologies, and social systems;
3. Five levels of motivation and commitment for implementing risk management have been *combined* with five different types of risk management users, according to five so-called aspect systems for interventions;
4. Despite the still considerable number, the fifty key variables for implementing risk management are well-applicable by their simple framework. Existing models in the discipline of *innovation management* either are restricted by just a few variables, or are so complicated that they are not workable anymore.

Based on these distinguishing features is has been concluded that the research results have a considerable scientific relevance for *researchers* of risk management, innovation management, and change management.

Practical research contribution

From a *professional practice* point of view, the overall usefulness of the research products has been specified by eight criteria: (1) state-of-the-artness, (2) completeness, (3) suitability, (4) applicability, (5) flexibility, (6) effectiveness, (7) efficiency, and (8) transferability. A vast majority (74 percent) of the expert panel agreed that the research products satisfy the eight criteria. Therefore, in conclusion, the research results have a substantially practical relevance for *consultants*, *managers*, and *professionals* who are or become involved in implementation issues.

Final remarks

This Ph.D. research generates an unique approach for implementing risk management in organizations. Due to the professional background of the researcher, the research started in the specialized discipline of geotechnical engineering. However, during the research process the area of interest widened largely. Implementing risk management appeared being a particular type of organizational innovation that needs change management approaches. Consequently, the research results have an organizational and rather generic character. Therefore, other technical as well as organizational disciplines are expected to benefit from the developed knowledge base and research products.

Worldwide, many public and private organizations, in a lot of industries, struggle with implementation issues. This is by far not restricted to risk management. For instance, also the implementation of information and communication technology, quality management, and safety management inhibits lots of opportunities for improvement. Implementation does usually involve considerable costs, while the targeted objectives are often not (fully) realized. Based on this research, it is expected that applying the developed knowledge base contributes considerably to more effective, efficient, and persistent implementation of risk management and (other) innovations. For *employees* at all levels within organizations this may increase their job satisfaction and productivity. For *organizations*, public as well as private ones, better implementation processes will reduce implementation costs and increase the material and immaterial benefits of routinely used innovations.

RISICO, INNOVATIE & VERANDERING

ONTWERPBENADERINGEN VOOR HET IMPLEMENTEREN VAN RISICOMANAGEMENT IN ORGANISATIES

Samenvatting

Het managen van risico's is moeilijk. Het toepassen van risicomanagement is nog moeilijker. Het implementeren van risicomanagement in organisaties is het moeilijkst. Risico's zijn van nature subjectief en niet tastbaar. Risicomanagement gaat over het omgaan met onzekerheid, waar de meeste mensen zich niet echt comfortabel bij voelen. Ook heeft risicomanagement een preventief karakter. Dit betekent actie ondernemen om iets te *voorkomen*. In de meeste gevallen is er echter *geen* direct meetbare relatie tussen de toepassing en de opbrengst van risicomanagement. Anderzijds zijn private en publieke organisaties *wel* kwetsbaar voor de gevolgen van optredende risico's, in een wereld die steeds verder globaliseert. Daardoor realiseert een toenemend aantal managers en bestuurders zich dat het risico van *niet* routinematig toegepast risicomanagement onacceptabel is. Dit geldt voor hun organisaties, maar ook voor aandeelhouders en overige stakeholders.

Het realiseren van daadwerkelijk geïmplementeerd risicomanagement in een organisatie is echter verre van eenvoudig. Falen is gebruikelijker dan succes. Hierdoor worden grote sommen geld, die ogenschijnlijk worden geïnvesteerd, in feite verspilt. In vele sectoren blijkt dit een slecht gedefinieerd en verwarrend probleem, voor zowel risicomanagement als (andere) innovaties.
Dit promotieonderzoek richt zich op de Nederlandse bouwsector. In deze sector zijn complexiteit, veiligheid, faalkosten en integriteit vier belangrijke problemen. Door velen in de sector wordt risicomanagement inmiddels beschouwd als een veelbelovend deel van de oplossing. Niettemin bestaat er nauwelijks wetenschappelijk gevalideerde en in de praktijk toepasbare kennis over *hoe* risicomanagement kan worden *geïmplementeerd*. Dit ondanks, of wellicht dankzij, de genoemde moeilijkheden van risicomanagement. Daarom was de belangrijkste onderzoeksvraag van dit onderzoek:

Hoe kan risicomanagement worden geïmplementeerd in organisaties in de bouwsector?

In dit onderzoek is *implementatie* het routinematig toepassen van risicomanagement in een organisatie. De wetenschappelijke ontwerpbenadering bleek de meest passende onderzoeksmethodiek te zijn. Achtereenvolgens zijn literatuur- en veldonderzoek uitgevoerd. Hierbij zijn ondermeer experts, zowel hoogleraren als professionals uit de praktijk, op het gebied van risicomanagement, innovatiemanagement en verandermanagement geïnterviewd in Nederland, de Verenigde Staten, het Verenigd Koninkrijk, en Zuid-Afrika. De resultaten vormden de basis voor het ontwikkelingsgerichte vervolgonderzoek. Een synthese van concepten en variabelen op het gebied van risico, innovatie, en verandering genereerde vier praktisch toepasbare producten. Deze zijn in drie stappen ontwikkeld, gevalideerd in vier gevalstudies, en geëvalueerd door een expert panel. Gezamenlijk leveren de onderzoeksresultaten unieke ontwerpbenaderingen voor het implementeren van risicomanagement in organisaties.

Conclusies uit het onderzoek

Op basis van het uitgevoerde onderzoek naar het implementeren van risicomanagement in organisaties zijn vier algemene conclusies getrokken:

1. De vorm, functie en betekenis van risicomanagement zijn grotendeels ontastbaar en subjectief, wat een effectieve, efficiënte, en duurzame implementatie in organisaties uiterst gecompliceerd maakt;

2. Het implementeren van risicomanagement in organisaties vereist een ontwerpbenadering, met een synthese van risicomanagement, innovatiemanagement, en verandermanagement;
3. Specifieke aandacht voor de implementatie van risicomanagement in organisaties is hoogst onderontwikkeld;
4. Voor daadwerkelijke implementatie in organisaties dienen methodieken voor risicomanagement te worden aangepast aan sociale systemen met verschillende typen gebruikers.

Conclusie 1 en Conclusie 3 verwoorden de slecht gedefinieerde en verwarrende problemen met het implementeren van risicomanagement in de praktijk, waarvoor Conclusie 2 en Conclusie 4 oplossingen bieden. De hoge mate van *complexiteit* bleek uit in totaal 480 geïdentificeerde variabelen. Al deze variabelen beïnvloeden, in meer of mindere mate, de implementatie van risicomanagement in organisaties. Om deze complexiteit hanteerbaar te maken zijn ontwerpbenaderingen voor de implementatie ontwikkeld. De bijna 500 variabelen konden met een factor 10 worden gereduceerd tot 50 goed gestructureerde en werkbare kernvariabelen.
Bij het starten met risicomanagement blijken de meeste organisaties zich vrijwel volledig te richten op het *ontwikkelen* van principes, processen en instrumenten voor het uitvoeren van risicomanagement. Specifieke aandacht aan het *routinematig toepassen* van dergelijke methodieken is hoogst onderontwikkeld. Gewoonlijk worden twee fundamentele dimensies voor het implementeren van risicomanagement grotendeels genegeerd. Dit zijn de *sociale systemen* en de verschillende typen *risicomanagement gebruikers* binnen een organisatie, wat onder andere blijkt uit vier gevalstudies. Deze zijn uitgevoerd in een geotechnisch instituut, een projectmanagement bureau, een bouwbedrijf en een publieke opdrachtgever, over een periode van drie jaar. Binnen de Nederlandse bouwsector zijn deze vier organisaties koplopers in de toepassing van risicomanagement.

Producten uit het onderzoek

De onderzoeksproducten bestaan uit twee modellen en twee instrumenten voor het implementeren van risicomanagement:

1. Een *conceptueel model* dat inzicht geeft in de *mechanismen* voor het effectief, efficiënt, en duurzaam implementeren van risicomanagement in organisaties. De drie dimensies van het model zijn (1) risicomanagement gebruikers, (2) risicomanagement methodologieën, en (3) sociale systemen;

2. Een *ontwerpproces model* voor het context-specifiek ontwerpen van *implementatieprocessen*. Het model onderscheidt de *haalbaarheidsfase*, de *besluitvormingsfase*, en de *uitvoeringsfase*. Tevens definieert het model *rollen*, *taken*, en *verantwoordelijkheden* voor actoren in implementatieproces;
3. Een *audit instrument* voor het vooraf meten van de *implementatiegereedheid* van een organisatie. Tevens kan de *implementatievoortgang* ermee worden gemeten. Het audit instrument bestaat uit drie vragenlijsten. Deze geven inzicht in individuele percepties van actoren, voor, tijdens, en na het implementatieproces;
4. Een *interventievoorstel* voor het selecteren van adequate *interventies* met ondersteunende activiteiten. De interventies vergroten de individuele motivatie en betrokkenheid van risicomanagement gebruikers.

Alle ontwikkelde producten faciliteren het ontwerpen, voorbereiden, uitvoeren en monitoren van implementatieprocessen in organisaties. Kennis van het conceptuele model is essentieel voor elke *onderzoeker*, *manager*, en *professional*, die betrokken is of raakt bij het implementeren van risicomanagement in organisaties. Het ontwerpproces model, audit instrument en interventievoorstel zijn specifiek ontwikkeld voor *adviseurs*, die het implementatieproces begeleiden.

Wetenschappelijke bijdrage van het onderzoek

De wetenschappelijk ontwikkelde ontwerpbenaderingen voor het implementeren van *risicomanagement* in organisaties zijn de *eerste* in hun soort en daarmee uniek. Daarbij zijn er vanuit *wetenschappelijk* oogpunt nog vier andere onderscheidende kenmerken van de onderzoeksresultaten:

1. De ontwikkelde producten zijn het resultaat van een *synthese* van risicomanagement, innovatiemanagement, en verandermanagement;
2. De resultaten *combineren* drie fundamentele implementatiedimensies: risicomanagement gebruikers, methodologieën, en sociale systemen;
3. Vijf niveau's van *motivatie* en *betrokkenheid* voor de implementatie van risicomanagement zijn gecombineerd met vijf verschillende typen *gebruikers*, via vijf zogenoemde *interventieaspecten*;
4. Door een eenvoudige *structuur* zijn de 50 kernvariabelen voor het implementeren van risicomanagement goed hanteerbaar, ondanks het nog forse aantal. Bestaande modellen op het gebied van *innovatiemanagement* beperken zich ofwel tot enkele variabelen, of zijn zo gecompliceerd dat ze niet meer werkbaar zijn.

Op basis van deze onderscheidende kenmerken wordt geconcludeerd dat de onderzoeksresultaten een aanzienlijke wetenschappelijke relevantie hebben voor *onderzoekers* van risicomanagement, innovatie-management en verandermanagement.

Praktische bijdrage van het onderzoek

Vanuit *praktisch* oogpunt is de *bruikbaarheid* van de onderzoeksproducten gespecificeerd. Het uitgangspunt was de toepassing in de dagelijkse praktijk van de bouwsector. Hiervoor zijn acht criteria gehanteerd: (1) originaliteit, (2) compleetheid, (3) geschiktheid, (4) toepasbaarheid, (5) flexibiliteit, (6) doelmatigheid, (7) efficiëntie, en (8) overdraagbaarheid. Een ruime meerderheid (74 procent) van het expert panel was het er mee eens dat de onderzoeksproducten voldoen aan deze criteria. Daarom wordt geconcludeerd dat de onderzoeksresultaten een hoge mate van praktische bruikbaarheid hebben voor adviseurs, managers, en professionals die betrokken zijn of raken bij implementatievraagstukken.

Afsluitende opmerkingen

Dit promotieonderzoek levert een unieke aanpak voor het implementeren van risicomanagement in organisaties. Door de professionele achtergrond van de onderzoeker is het onderzoek gestart in het gespecialiseerde vakgebied van de geotechniek. Het vervolgens uitgevoerde onderzoek is flink verbreed. De implementatie van risicomanagement bleek een bijzonder soort organisatorische innovatie te zijn, die een veranderkundige aanpak vereist. De resultaten hebben hiermee een organisatiekundig en generiek karakter gekregen. Daardoor kunnen ook andere technische en organisatorische vakgebieden profiteren van de ontwikkelde kennis, modellen en instrumenten.

Wereldwijd worstelen vele publieke en private organisaties, in diverse sectoren, met implementatievraagstukken. Dit betreft zeker niet alleen risicomanagement. Bijvoorbeeld ook bij het implementeren van informatie en communicatie technologie, kwaliteitsmanagement en veiligheidsmanagement valt nog veel te verbeteren en te besparen. Dergelijke implementatieprocessen vormen aanzienlijke kostenposten, terwijl de beoogde doelstellingen veelal niet (volledig) worden gerealiseerd. Op basis van dit onderzoek wordt verwacht dat toepassing van de ontwikkelde kennis aanzienlijk bijdraagt aan een effectieve, efficiënte en duurzame implementatie van zowel risicomanagement als (andere) innovaties. Voor *medewerkers* op alle niveau's in organisaties draagt dit bij aan meer werkplezier en een hogere productiviteit. Voor *organisaties*, zowel publieke als private, resulteert dit in een afname van implementatiekosten en een toename van de materiële en immateriële voordelen van het routinematig benutten van innovaties.

ACKNOWLEDGEMENTS

First of all, it is great pleasure to mention dr. ir. Sam Karim of the Construction Management & Engineering Research Group, University of Twente, The Netherlands. While my intention to perform Ph.D. research was in some sort of sleeping state, already for a number of years, he provided the required wake up call. After reading my book *Uncertainty and Ground Conditions: A Risk Management Approach*, Sam suggested to add scientific research for obtaining a Ph.D. degree. Thanks for this exceptional suggestion Sam, in return I owe you risk management lectures to the end of my time.

My first promotor, prof. dr. ir. Joop Halman, holds a chair in innovation and risk management at the University of Twente, adopted the Ph.D. idea immediately and with enthusiasm. Joop was a wise and pleasant guide during the adventurous research journey. I am gladly remembering our fruitful meetings, discussing the many ideas about risk and innovation management.

Prof. dr. ir. Joan van Aken, my second promotor, holds a chair in organizational studies at the Eindhoven University of Technology. For many years, Joan elaborates the design science approach for organizational studies. This innovative approach appeared to be the main scientific research paradigm for organizational studies I was looking for. His many papers, published or in preparation, were of great assistance.

Dear Joop and Joan, I owe both of you many thanks for sharing your wealth of expertise with me.

There is no public defence without the willingness of scientific experts becoming member of the graduation committee. It is a great honour to defend my dissertation for this committee. Therefore, prof. dr. F. Eising, prof. dr. G.P.M.R. Dewulf, prof. dr. P.B. Boorsma, and prof. dr. ir. J.J. Krabbendam of the University of Twente, as well as prof. dr. ir. J.W.F. Wamelink of the Delft University of Technology, many thanks for your participation.

While my Ph.D. research was taking off, the Dutch Delft Cluster Research Programme offered the opportunity for combining it with their risk management research project. The proposal to focus on the *implementation* of risk management was jointly agreed and fitted excellent with my research interests. Therefore, I would like to thank the members of the Scientific Advisory Board and Supervisory Board of Delft Cluster, for their ongoing support and useful suggestions.

Particularly, I am glad to mention prof. ir. Wijnand Dalmijn, scientific director of Delft Cluster, and Karin de Haas, strategic communication manager. Wijnand, thanks a lot for your persisting trust in the success of the project. Karin, your always high level of enthusiasm works very well. Thanks for all your great ideas and initiatives for communicating this research.

Moreover, there are three core members of the Delft Cluster risk management implementation research team: Michiel Brouwer and Mary-Ann Mooiman, both formerly of TNO, and Dirk Pereboom of Deltares. All of you did a great job. Thanks for the critical comments on my ideas and results, which were grounded in your extensive project experience with applying risk management. In addition, Michiel and Mary-Ann, it is great that you dared starting your own business, already during the research project, and transformed our research results in sound business activities.

I really appreciated that Delft Cluster provided the opportunity for in-depth interviewing a number of experts on applying geotechnical risk management (far) outside The Netherlands. Many thanks for sharing your impressive expertise, prof.dr. Robert Bea, University of California, Berkeley, prof.dr. Herbert Einstein, Massachusetts Institute of Technology, prof.dr. Chris Clayton, University of Southampton, prof.dr. Dick Stacey, University of the Witwatersrand, Tim Chapman, director at Arup's head office in London, dr. Jan Hellings of dr. Jan Hellings and Associates, and dr. Oskar Steffen, founder of SRK Consultants in Johannesburg, South Africa. Moreover, I thank Ed Mallens, director at the municipality of Bernisse, for the interview about his extensive risk management experience in public organizations.

For similar in-depth interviews, but now focusing on implementing organizational change and innovations, I would like to thank prof. dr. Kees Ahaus, University of Groningen and TNO Management Consultants, prof. dr. Peter Boorsma, University of Twente, prof. dr. Léon de Caluwé, Free University Amsterdam and Twynstra Gudde, prof. ir. drs. Willem Vrakking, Erasmus University Rotterdam and the Holland Consulting Group, and prof. dr. Mathieu Weggeman, Eindhoven University of Technology and De Baak Management Center. All of these interviews were very inspiring!

During the research, I was able to build my empirical research part on sound foundations. These were provided by four M.Sc. studies about risk management within the construction industry. The studies were performed by ir. Reinier Augustijn, ir. Wout van de Heijden, ir. Harmen van Schaik, and ir. Vincent Weisscher. I like to thank these dedicated engineers and consultants for the interviews, and for introducing me to representatives of the case study organizations. Also the representatives of these organizations, both managers and risk management users, many thanks for your valuable interviews.

Undertaking this research was combined with regular work. Therefore, particularly ir. Gerben Beetstra and dr. ir. Peter van den Berg, managers of the unit GeoEngineering of Deltares, thanks for your ongoing understanding and support. To both of you and all professionals at Deltares I would say: *Benefit from the research results, by implementing them!*

In addition, a few words to my friend, colleague, and organizational sparring partner, Marco Hutteman. Thanks a lot Marco, for your interest in the research topic, support, and most of all, our regular, informal, and great discussions about individual and organizational development.

Gerard Vennegoor and Carel Boers, thanks for the talks we had over the last few years, about individual human behaviour, organizations, and much more. These conversations were always a great mixture of wisdom and fun. Carel and Gerard, it is an art being able to generate such discussions!

Gentlemen of the Breda Veterans I Hockey Team, the weekly evenings of training with you were a truly effective catalyst. It shifted my mind from the research mode back to the real life mode. Obviously, the bar sessions afterwards may have contributed to this effect. It is good to play in this team.

From time to time, writing requires concentration in near-absolute quietness, at least for me. Niels, Margot, and Kaethe, De Korrenberg provided this key condition a couple of times. Many thanks for the possibility to write over there, and also for the nice time we spend there with our families and friends.

Over the years, more, and more it occurs to me that life is about balancing aspects of risk, innovation and change. Dear parents, Theo van Staveren and Mieke van Staveren – Wessels, I am very grateful that you together provided the required basis for developing this insight.

Finally, my lovely wife and daughters, Annelies, Charlotte, Josephine and Frédérique, more than anyone you know what this research means to me. How valuable it is, to experience the persistent inspiration and support of such a marvellous family. Most of the thanks go to you!

CURRICULUM VITAE

Martinus Theodorus (Martin) van Staveren was born on the 12th of May 1964, in Groningen, The Netherlands. He finished his secondary education in 1982 at Sint Maartens College in Haren. In 1987, he graduated in mining engineering, with a specialization in engineering geology, at the Delft University of Technology.

After joining the Dutch Armed Forces, Martin gained managerial experience as a production manager in a glass factory. In 1989, he started working as a junior geotechnical consultant with IGN, a geotechnical consultancy later acquired by Fugro. In 1991, he changed jobs to GeoDelft, the Dutch National Institute for GeoEngineering (which merged in 2008 with three organizations into Deltares).

During the period 1991-1997, Martin worked at a variety of geotechnical projects as consultant and project manager. Assignments in Europe, Africa, Asia, and the Middle East were completed for a variety of clients, such as Shell Global Solutions, Ballast Nedam International, Royal Haskoning, and Spie Batignolles.

In 1998, Martin was appointed product manager for foundation engineering at GeoDelft. In 1999, he joined a part-time MBA programme and in 2001 he received the MBA degree in International General Management of the Bradford University, United Kingdom.

During the period 2002-2006, Martin was director of the GeoLab Department of GeoDelft. This department included about 35 employees, high-tech site investigation and laboratory facilities, and one of the world's largest geocentrifuges. He became responsible for repositioning this department. This working experience raised his interest in innovation and change management.

Over the years, Martin became also particularly interested in risk management and the role of the human factor in it. In 2006, he published his book *Uncertainty and Ground Conditions: A Risk Management Approach* (Butterworth-Heinemann, Oxford). Motivated by the book's spin-off, he decided to focus his professional activities on risk management research and consultancy. Martin started in 2007 as director risk management and member of the Scientific Board of GeoDelft.

The book *Uncertainty and Ground Conditions* served as foundation for the new and unique M.Sc. course Geo Risk Management at the Delft University of Technology, and Martin was appointed part-time lecturer. He started research cooperation between GeoDelft and the Construction Engineering and Management Group of the University of Twente. This involves joint Ph.D. research and providing guest lectures. The Delft Cluster Research Programme requested Martin for their risk management project in the role of research leader. This resulted in the joint research project Implementing Risk Management with Deltares, TNO, and a number of other parties.

Martin is member of a number of Dutch and international committees working on risk management, contractual risk allocation, site investigations, learning from failures, and so on. For a number of years, he was board member of the Ingeokring, the Dutch affiliation of the International Association of Engineering Geology.

Martin authored and co-authored over 50 papers and book chapters. His essay *Willingness to See, to Be, and to Change* was nominated for the Dutch Management Essay of the Year Award in 2005. This essay is published in the change management book *Verandermanagement: Actuele Visies op Management* (Academic Service, The Hague). All over the world, Martin gives guest lectures, courses, seminars, and presentations on risk management.

Martin van Staveren is married with Annelies Mikx. Together, they have three daughters, Charlotte, Josephine and Frédérique. They live in Breda, The Netherlands. Apart from working, Martin likes running, hockey, diving, reading, and spending precious time with family and friends.

STELLINGEN

Behorende bij het proefschrift

Risico, Innovatie & Verandering
Ontwerpbenaderingen voor het Implementeren van Risicomanagement in Organisaties

1. Specifieke aandacht voor het implementeren van risicomanagement in organisaties is hoogst onderontwikkeld (*Hoofdstuk 1, paragraaf 1.2*).
2. Vorm, functie en betekenis van risicomanagement zijn ontastbaar en subjectief, wat implementatie uiterst gecompliceerd maakt (*Hoofdstuk 6, paragraaf 6.2*).
3. Voor daadwerkelijke implementatie dienen methodieken voor risicomanagement te worden aangepast aan sociale systemen met verschillende typen gebruikers (*Hoofdstuk 9, paragraaf 9.2*).
4. Implementatie van risicomanagement in organisaties vereist een ontwerpbenadering, met een synthese van risicomanagement, innovatiemanagement, en verandermanagement (*Hoofdstuk 9, paragraaf 9.3, 9.4 en 9.5*).
5. Omdat risico's niet eenduidig zijn, is eenduidig risicomanagement noodzakelijk.
6. De roep om methoden en instrumenten is omgekeerd evenredig met de motivatie om risicomanagement daadwerkelijk uit te voeren.
7. Geavanceerde risicoanalyses vergroten slechts de schijnzekerheid.
8. Een mening is een feit voor de eigenaar van de mening.
9. Vanzelfsprekendheid stopt waar een crisis begint.
10. Panta rhei: alles verandert (*Heraclitus van Ephese, circa 500 v. Chr.*).

Martin van Staveren, Enschede, 17 april 2009.